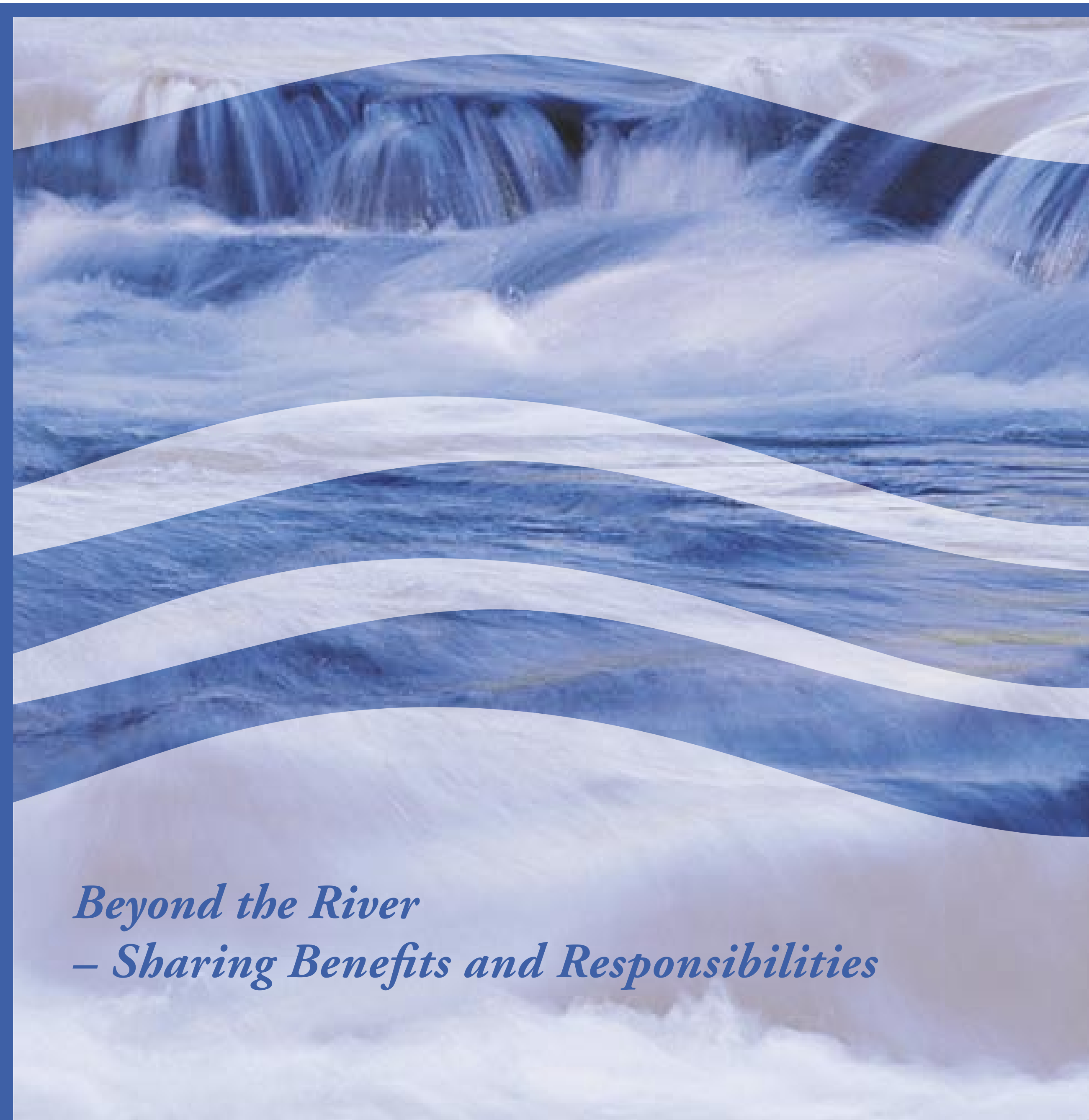
Abstract Volume

World Water Week in Stockholm
August 20–26, 2006



Beyond the River
– Sharing Benefits and Responsibilities

Abstract Volume, 2006 World Water Week in Stockholm

SIWI

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Abstract Volume

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– Sharing Benefits and Responsibilities

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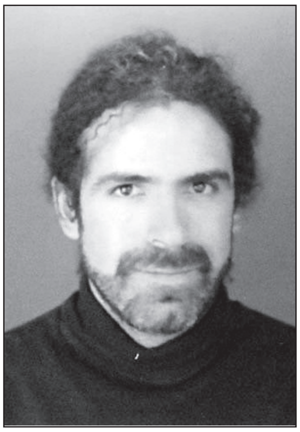
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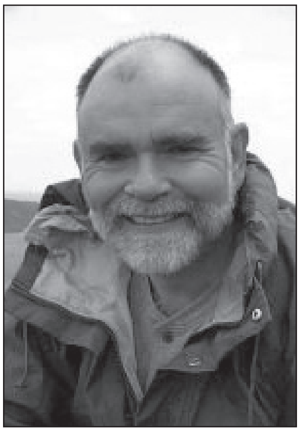
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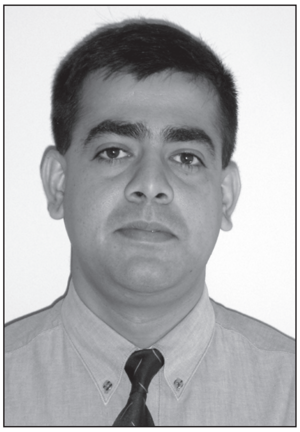
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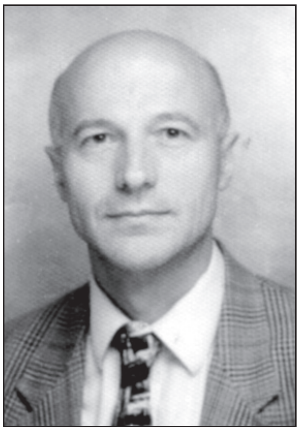

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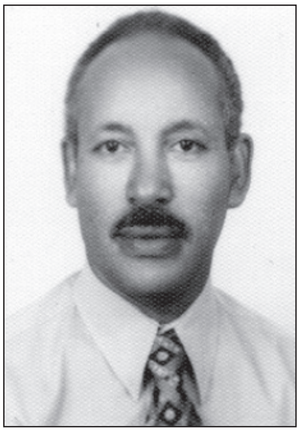

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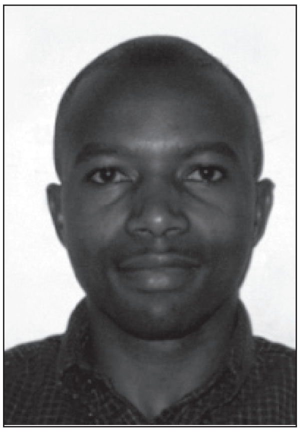

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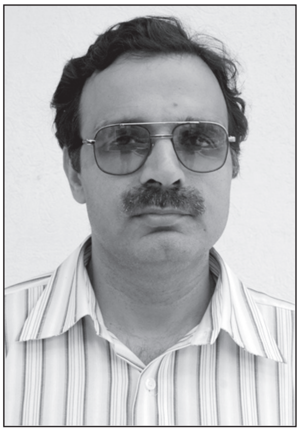

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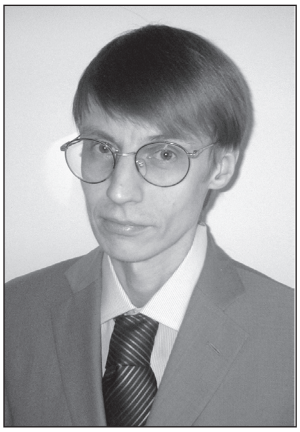
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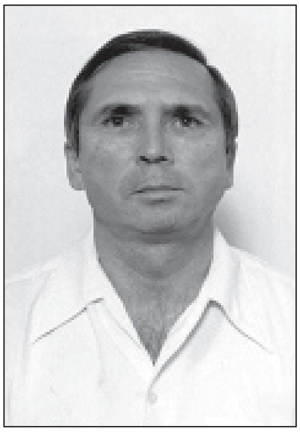
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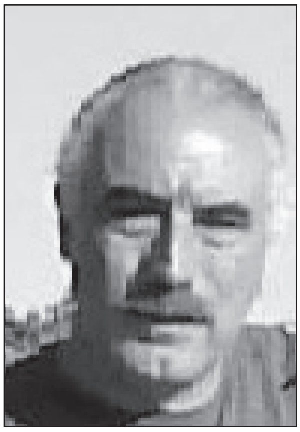
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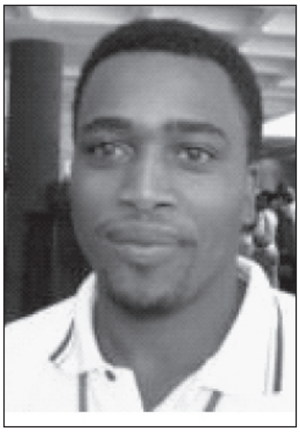
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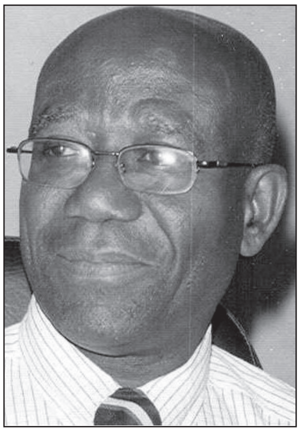
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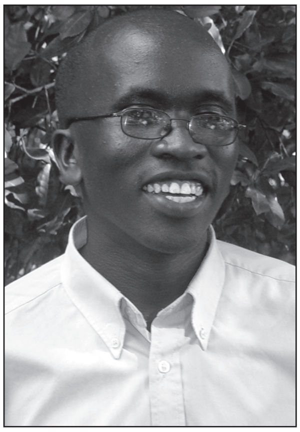
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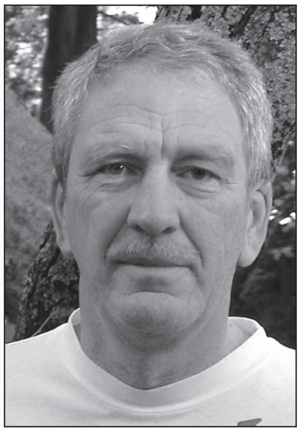
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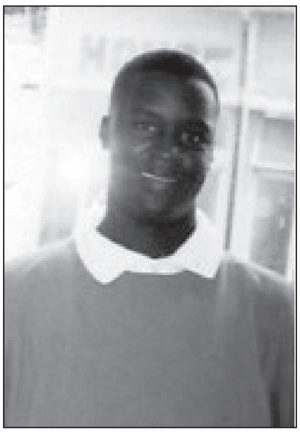
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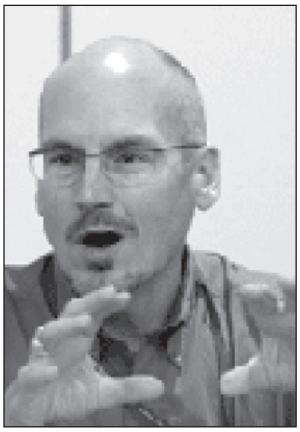
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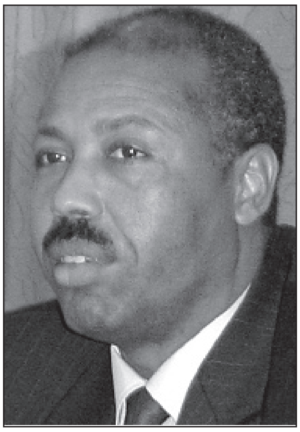
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Workshop 1:

Tools for Benefit Sharing in Transboundary Settings

International Cooperation as a Platform for Benefit Sharing within Transboundary River Basins: Ukrainian Experience

Author: **Dr. Viacheslav Manukalo,**
State Hydrometeorological Service, Ukraine

Keywords: Transboundary rivers, cooperation, benefit, development

Presentation of topic and analysis of issue: The international level of development of water-related activity has the very significant importance in the sustainable management of water resources and economic development of countries with shared watersheds. It should be a basis for the adequate and comparable practice for benefit sharing from an integrated water resources management.

Ukraine has a large amount of transboundary river basins with the neighboring countries: the Republic of Belarus, the Russian Federation, the Republic of Moldova, Romania, Hungary, the Slovak Republic, Poland.

The territories of the states with the developed industry, agriculture and with large population are situated within the transboundary river basins. Transboundary rivers and their numerous tributaries are extensively used for navigation, fishing, drinking-water supply and satisfy the demands of agriculture and industry. They provide hydropower production, and are used for recreation, as well as for disposal of waste waters.

River floods and inundations are characteristic for most of transboundary river basins of Ukraine. The natural conditions in Carpathians mountain river basins (Tysza, Prut, Dnister rivers) are particularly favourable for the flood runoff formation. In the past years, a number of accidental water pollution events were reported on the transboundary rivers.

Process of political and economical changes in the countries of Central and Eastern Europe, including new independent States of the former Soviet Union, posed new and compelling challenges to the national policy and international cooperation in the field of transboundary water management and protection. All these factors define the actuality of the transboundary cooperation of Ukraine and neighboring countries for an integrated water resources management, prevention of negative consequences of the river floods and prevention of water pollution.

Discussion of Results/Findings: During the last decade, the fundamental water-related agreements were achieved in the European region: in 1991, the Convention on Environmental Impact Assessment in a Transboundary Context; in 1992, the Convention on the Transboundary Effects of Industrial Accidents; in 1992, Convention of Protection and Use of Transboundary Watercources and International Lakes; in 1992, the Convention on Protection of the Black Sea from Pollution; in 1994, the Danube River Protection Convention; in 1998, the Convention on Access to Information, Public Participation in Decision-making; in 2000, the European Water Framework Directive. These agreements are the good basis for development of national and international activities for management of transboundary river basins.. Providing this goal not an easy task, especially in countries which face economic, social and ecological problems. The international cooperation in this area is needed in order to manage river basins effectively, and to use financial resources of individual countries most economically.

Since its independence, Ukraine has gained experience in the international cooperation required for management of transboundary river basins. Bilateral cooperation on transboundary rivers between Ukraine and the Republic of Belarus, the Russian Federation, the Republic of Moldova, Romania, Hungary, the Slovak Republic and Poland is regulated by intergovernmental agreements. Within the framework of these agreements, the Joint Commissions on transboundary waters have been created, headed by governmental representatives of each country. Initially, agreements mainly addressed flood control questions; at the second stage they were dealing with surface water management; later on they covered water quality issues and problems of integrated water resources management.

The international cooperation within the Dnipro and Danube river basins is particularly important for Ukraine. The Dnipro river provides about 80% of the total water resources used by Ukraine. Ukraine, the Russian Federation and the Republic of Belarus have joint conventions and programs addressing the rehabilitation and sustainable use of the Dnipro river basin ecosystem, considering water supply quality, environmental hazards to the population, impact of economic activity, and water protection from pollution and over-exploitation. These countries coordinate their national policies of water management and water protection.

The cooperation in the area of water- related issues between Ukraine and Danube countries has continued over many years. It is regulated by existing conventions, commissions, programs and agreements: the Danube Commission on Navigation; the Declaration on Cooperation in the Area of Water-related Issues; the Convention on Cooperation on Protection and Sustainable Use of the Danube River; the Convention on Protection and Use of Transboundary Watercources and International Lakes; the Forum of Directors of National Hydrological Services; the Regional Cooperation Within the Framework of the International Hydrological Program of UNESCO; the International Association for Danube Research; Transboundary Commissions; Bilateral and Multilateral agreements on water management on transboundary rivers.

The case of successful cooperation between Ukraine, Hungary and the Slovak Republic in the area of flood control and mitigation is provided by interaction between water management and hydrometeorological institutions during formation and passing of extreme floods in November 1998 and March 2001 within the Tisza river – the largest tributary of the Danube river. These coordinated actions make possible to use plenty of time in order to organize preventive measures against flood damage. In Ukraine, for example, these measures alone prevented damage to national economy amounting to tens millions dollars in value.

To improve the transboundary activity in the area of flood control within Tisza river, Ministers responsible for water management of Hungary, Romania, Serbia and Monte Negro, the Slovak Republic and Ukraine have met on initiative of Hungary, in Budapest, in May 2001, and signed the Agreement, called the Budapest Declaration, and established the Tisza River Basin Forum as executive organization of the Agreement. The Forum has stressed that neighbouring countries should establish and implement joint programs for developing of water resources management, including flood management. The implementation of these programs ensure sustainable development in adjoining regions of countries sharing transboundary watercources and using them for different purposes.

Conclusions and recommendations: International cooperation is a very important tool for improvement of the integrated water resources management and economic development within transboundary river basins, where water is both an asset and a potential danger to several countries. This cooperation allows for each participating country to make the best use of financial resources – an important factor considering economic problems, which Ukraine and other eastern European countries are facing.

Counter-hegemony in the Nile River Basin

Author: **Ms. Ana Cascao,**
Geography Department – King's College –
The Strand – London WC2R 2LS, UK

Keywords: Hegemony, Counter-Hegemony, Nile Basin, Financial mobilisation, Cooperation

This paper aims to contribute to the ongoing debate on hegemony and counter-hegemony in transboundary river basins. The Nile Basin case will be used to test the significance of counter-hegemonic mechanisms as political tools to improve hydropolitical relations. It is assumed that a hegemonic hydropolitical configuration exists in the Nile Basin and the benefits from water management have not been shared equitably across countries, nor within the countries of the Basin. The challenge is to understand how counter-hegemonic actions and discourses can eventually lead to improved water policies at the regional level. A problem in investigating counter-hegemonic approaches is that they challenge the status quo. Two aspects influencing the status quo will be examined – financial mobilisation and cooperation.

Ten riparian countries share the waters of the River Nile. Water resources, access and utilisation between upstream and downstream riparians are all asymmetric. Water utilisation is very much more influenced by the asymmetry of power relations than by endowments and geographical factors. Egypt is the most powerful riparian and has an ancient history of water resources development. The upstream riparians have not developed the water resources within their territories to any significant extent. The causes are varied, from civil wars to internal structural problems, weak technical and institutional capital, and lack of financial resources. The "hegemonic" factor is also of great importance. Through a range of strategies and tactics, Egypt was able to control the Nile waters and has influenced the rate of adoption by upstreamers of infrastructures that could have endangered the flow of water arriving to Lake Nasser-Nubia. How can riparians as Sudan and Ethiopia challenge the status quo configuration and at the same time develop better hydropolitical relations? Several strategies and tactics can be deployed. They can be material, discursive, diplomatic, and organisational. This paper highlights the role of two potential and controversial counter-hegemonic mechanisms – financial mobilisation and cooperation.

Financial Mobilisation

The role of external investment can play a significant role in counter-hegemonic strategies. There is a need to take into account the diverse financial sources for water policies and infrastructures in the Nile Basin. The "traditional" sources of financial assistance, such as the World Bank and UN, are currently financing the cooperative and capacity-building processes. There are other actors such as private investors from the Arab Gulf region or multinational Export Credit Agencies. There is evidence that these bodies can back controversial "white elephant" projects. The most significant new player in the last four or five years is China. The question posed is has Chinese funding for hydraulic developments in the Basin already transformed the nature of inter-riparian relationships? And how will China impact water resources management in future? Merowe and Tekezze dams, in Sudan and Ethiopia respectively, are being financed and constructed by Chinese companies. China has been providing financial support through unusual instruments and without imposing conditionalities. The Chinese presence might influence the balance of power. What will be the consequential shifts in regional geopolitics and in challenging Egyptian hegemony in the

Basin? The paper will evaluate hydropolitical scenarios and the new counter-hegemonic circumstances in the region and the changing nature of basin “realpolitik”.

Cooperation

The debate about cooperation over international river basins raises crucial questions. Is cooperation a subtle instrument used by the hegemon to preserve the status quo? Is cooperation a hegemonic mechanism to play with time and postpone the redefinition of allocative rights? On the other hand, can cooperation be a battleground for non-hegemonic riparians in order to lessen the existing inequality? The Nile Basin Initiative (NBI), launched in 1999, involves the ten riparians and several international donors. How are the benefits being shared? How are the costs being shared?

An analysis of the procedures and policies being followed within the NBI structure suggests that regional cooperation is taking shape. But how significant is this in terms of power relations? The lingering question is, is the decentralisation of power genuine? Is the Egyptian status quo being challenged? Are the non-hegemonic riparians actually influencing the agenda-setting and the decision-making process? Can the NBI serve as agent of change, promote “shared control” and a fairer distribution of benefits? A final question is, what have been the role of international actors in the creation and development of the NBI, especially the World Bank? The approach also analyses the several layers of political economy interaction – national, regional and global.

African Models of Transboundary Governance Project

Author: **Dr. Jacqueline Ann Goldin,**
AWIRU research associate and fieldwork team leader, South Africa

Keywords: indigenous, governance, policy contradictions, African, Limpopo

International Water Management Institute (IWMI, Pretoria)
African Water Issues Research Unit (AWIRU, Pretoria)
International Food Policy Research Institute (IFPRI, Washington)

The financing of the project by the Challenge Programme for Water and Food is acknowledged gratefully

This paper presents material collected within the context of the African Models Transboundary Governance Project that examined water-related governance structures and institutions in the Limpopo Basin of southern Africa.

One of the sites of investigation was the cultural heartland of the Bavenda people who inhabit the Limpopo Valley to the far north of the Limpopo Basin and large areas to the east of the Limpopo Province that surround the town of Thoyoandou. This landscape north of the Soutpansberg has played an important ecological and cultural role in the history of South Africa. The natural environment of the area has been an ideal terrain for thousands of years and has been occupied by many people.

Four distinct time periods: pre-colonial period; colonial period; post-colonial era; and post cold war period have shaped the political life – and the way in which resources have been shared and benefits distributed, of those living in this, and other regions of the Limpopo Basin. The paper provides an outline of the four distinct periods and examines ways in which colonisation systematically imposed authoritarian principles on human settlements with strategic political systems engineered for rigidity and control.

At present, there is no explicit formal recognition of customary water management structures in the National Water Act, the guiding policy framework for water resource management, and there are in practice no vehicles for integrating customary and statutory water management structures into a comprehensive water management system. The end of Apartheid in South Africa brought about a shift in traditional governance. Today, ten years into democracy, both customary and statutory tenure influence the way in which water and land is managed in South Africa.

There is tension between past and present because modern statutory laws do not yet articulate smoothly with traditional norms and values and these tensions are reflected in the data presented. The primary data collection raises the question of what new ethnic/indigenous water management practices are under construction in the Limpopo Basin today. The critical point here to understand and determine is the inherent but sometimes understated dynamism of indigenous water management practices.

The relationship between the present state and traditional/indigenous regimes is a crucial area of inquiry given that the state has had variable intervention successes. That is to say while the state has managed to claim the legal and administrative domain, there are still pockets or space that is available for indigenous water management to thrive.

The research findings indicate that government interventions at the local level are unable at the current moment to deliver benefits as indicated in policy laid out by the National Water Act. In response to inadequate political tools to implement integrated water resource management, traditional responses continue to provide communities, who would otherwise be deprived of water, with the benefits of the resource. However, state political structures have not yet recognized the critical role that indigenous management systems can play in ensuring that the benefits of water are shared amongst all citizens equally. Despite the potential of indigenous water management systems to respond to delivery and management needs, the problem of equity within traditional systems needs to be addressed. Women continue to carry much of the burden. This too demands a complex set of questions as issues of social cohesion and belonging are closely linked to the role that women play in servicing their household needs with this scarce resource. Political tools – both within the statutory as well as the traditional systems are alone inadequate in ensuring benefit sharing and in ensuring that the objectives of IWRM are met. A relationship between traditional and statutory that is based on synergy between the two governance systems would surely be able to both deliver and manage water in the Water Management Areas of South Africa.

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Sincere thanks to Doug Merrey, Barbara van Koppen and Amy Sullivan of IWMI.
The paper is inspired from a joint profile of the Limpopo Basin presented within the context of the first phase of the African Models for Transboundary Governance

The Development of Institutional Mechanisms to Facilitate Multilateral Cooperation in the Mobilization of Shared Resources in Internationally Shared Watercourse Systems: The Okavango River.

Author: **Mr. Pieter Heyns,**
Ministry of Agriculture, Namibia

Keywords: Water Commission, Secretariat, Project Steering Committee, Stakeholder Forum, Joint Projects

Presentation of topic and analysis of issue: The perennial Okavango River is shared between three sovereign states Angola, Namibia and Botswana. The future large scale utilization of the water resources was not only identified as an issue that would realize major benefits for the people of the basin, but may have major environmental consequences if not properly assessed before actual development would take place.

The basin states therefore decided to establish a Permanent Okavango River Basin Water Commission (OKACOM) with a mandate to assess the development potential of the basin and to advise the respective Governments about the best joint utilization of the resources of the basin for the maximum benefit of the people and the respective countries.

In order to enable the Commission to meet its obligations, a Steering Committee was created to initiate and direct the activities required to execute an environmental assessment in order to develop an integrated management plan for the basin. The Commission also agreed to approach the international donor community for support.

The projects and activities generated by this initiative grew to such an extent that the OKACOM had to investigate the feasibility to establish a formal Secretariat to support the Commission. As a result, an interim Secretariat is already functional and will soon evolve into a permanent Secretariat, the OKASEC. A number of institutions, universities, consultancies and non-governmental organizations have been involved with the respective basin states in scientific, social, environmental, infrastructure and institutional development projects, including the establishment of a basin wide stakeholder forum.

The OKACOM was the catalyst for the evolution of a large number of initiatives that are laying a sound foundation for the preparation of an integrated management plan for the Okavango. This demonstrated the benefits of collaboration to achieve major strategic objectives without conflict and places the development of the Okavango Basin well within the agenda for economic development and regional integration advocated by the Southern African Development Community.

The paper will therefore provide a comprehensive examination of the development, successes and constraints of this institutional development process on the Okavango so that it can serve as a practical example for politicians, professionals and practitioners in all resource utilization sectors to adjust for application to other shared river systems.

Prospects of Cooperation in the Euphrates-Tigris Basin

Author: **Dr. Olcay Ünver,**
Kent State University, USA

Keywords: transboundary river, transboundary cooperation, Euphrates-Tigris, benefit sharing, regional development

The author argues in this paper that, in spite of the past performance and the lack of a permanent agreement among the riparians of the Euphrates-Tigris System, there is hope and reason for optimism for a mutually beneficial framework.

The paper starts with a brief historical account of riparian relations in the Euphrates-Tigris Basin and the efforts by external parties to mediate. The difficulties encountered are categorized in a broader perspective in the bilateral and multilateral relations of the riparian countries. Existing setting and recent developments are explained and potential modalities are elaborated. The paper concludes by describing a new, unofficial initiative of riparian scholars and professionals emphasizing the value of civil society involvement in the process.

Official mechanisms, or Track 1 avenue, include early talks among the riparians that eventually led to the establishment of a Joint Technical Committee to discuss the issues regarding the flows in this river system. This Committee held 16 meetings until the First Gulf War and has not met since then. Although Track 1 efforts did not produce a permanent solution to the issue, they provided a channel for communication and offered a basis when the political climate would be opportune.

The 'hydronationality' in the riparian countries that can be ignited over relatively insignificant events also played a negative role.

The interdependence of water issues to broader problem areas and the failure to either resolve the latter or isolate the former delayed the discussion of alternatives with a potential of mutually acceptability. A lack of contact on water related issues 'froze' the positions of the parties and prevented new paradigms from being agenda items for consideration. These include benefit-sharing arrangements and cooperation around mutually acceptable broader frameworks, such as regional social and economic development.

In spite of an unfavorable setting for cooperation, the riparians of the Euphrates-Tigris System have managed to stay away from violent conflict over water and have kept one another relatively informed.

The current conjuncture in the region also presents opportunities that can work for a renewed and improved dialogue over water and water related issues.

The author argues that once the 'zero-sum' nature of the current framework is properly recognized, Track 1 avenue could progress more smoothly than it has in the past. Both regional development at large, and benefits from water can be uniting as all of the riparian countries do need social and economic development which can bring about synergy, economies of scale, and external financing if and when planned, implemented and managed in a cooperative or joint manner.

Track 2 initiatives and other developments can substantially help enhance mutual understanding and dialogue, as well as help riparians see the broader picture and multi-faceted benefits that do not correspond to the zero-sum nature of water-sharing. These can potentially benefit from the recent progress in Turkish-Syrian relations and the developments in Iraq and the imminent return of Iraq to the international community as a fully functioning state.

The objective, program, and the activities of a recently established riparian Track 2 initiative, ETIC, or the Euphrates-Tigris Initiative for Cooperation, of which the author is a founder, are described in the final section. The initiative is unlike other, earlier unofficial initiatives in that it comes from inside the basin, does not focus on water, and is not prescriptive. It has, in its first year of existence, already catalyzed tri-lateral gatherings of unofficial nature, conducted multi-riparian training programs, and established linkages in the riparian countries of the basin. ETIC has benefited from partnership with UNESCO and cooperation protocols are pending with international and U.N. organizations.

Customary Water Governance - a neglected approach to benefit sharing in transboundary river basins

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Keywords: customary water governance, transboundary river basins, weak states, civil society, sub-Saharan Africa

In many regions of the South, Integrated Water Resources Management (IWRM) in transboundary river basins faces great difficulties when it comes to applying the concept on the ground. One of the main reasons for this is a too narrow approach that confines IWRM to formal institutions. Only too often, formal institutions are weak agents of implementation. On the other hand, at the same time informal traditional institutions of water management can be found on the local level in many places. Up to now little attention has been paid to these traditional actors and institutions by state authorities, international organisations and donor agencies dealing with modern transboundary IWRM. This paper posits that their inclusion can considerably contribute to the promotion of benefit sharing, not only with regard to water-related issues, but also in a more general political context 'beyond the river'.

This paper will present an assessment of the relationship between modern formal and customary informal institutions of water governance in southern Africa. It will demonstrate that traditional actors and institutions, customary law and indigenous knowledge with regard to water management have shown considerable resilience in southern Africa despite the modernising influences of colonialism and post-colonial state building. They were subject to modernising influences, of course, and hence have been re/de-formed and modified to a certain extent. Nevertheless, customary law and traditional societal structures – extended families, clans, religious brotherhoods, village communities and the like - and traditional authorities – such as village elders, headmen, clan chiefs, healers, religious leaders etc. – determine the everyday social reality of large parts of the population in southern Africa even today, in particular in the rural areas. They co-exist with state institutions. State structures in southern Africa are still relatively weak, and hence a state-centric approach to water governance has to be overcome and a variety of non-state actors – from the sphere of modern civil society as well as from the traditional sphere - have to be taken into account as well. The neglect of civil society and customary institutions and actors may lead to the failure of IWRM and to water-related conflicts.

To design formal institutions – from Water User Associations to River Basin Organisations – is no doubt important, but nowhere near sufficient in order to implement transboundary IWRM and to achieve benefits from collaboration in regions of weak statal and other formal institutions. Instead, attempts should be made to positively accomodate formal modern and informal customary approaches to water governance.

This is particularly important in transboundary settings as traditional societal structures are not confined by modern state boundaries. Rather they transcend borders that were drawn in colonial times and inherited by the newly independent states. Communities often settle on both sides of the border and form transboundary social networks. This permeability of boundaries, which is a characteristic feature of weak states, should not be seen primarily as a negative fact, but one should explore the positive potential of this given fact with regard to options of benefit sharing. Local governance in such a setting is at the same time transboundary governance, relatively independent from the government structures of the states in question. The question how transfluvial and at the same time cross-border customary institutions of water management and conflict resolution can be combined with structures of state-based international water management needs further attention if one wants to foster benefit sharing.

The paper will conclude that experience from various southern African transboundary river basins amply demonstrates that the various levels of hydropolitics – from the local to the global – are closely interwoven. Not only governmental agencies are hydropolitical players, but also the private sector and local communities and other stakeholders from within a given international river basin. Furthermore, also actors from outside, e.g. international organizations, donor agencies and international NGOs play a role. Thus hydropolitics today cannot be confined to the local or national level any longer.

Therefore transboundary water governance in international river basins cannot be but multi-level, multi-actor, multi-institutional, and it will only work if informal institutions, custom, customary law, indigenous knowledge, local governance structures are included, and a state-centric approach is overcome.

One may expect that the development of such non-state centric modes of water governance can contribute not only to the prevention of water-related conflicts and to the promotion of water-related benefit sharing, but also to conflict prevention and benefit sharing in general, as ‘good (transboundary) water governance’ will positively influence the stability of societies, will strengthen societal and last but not least also state and international institutions and enhance their legitimacy.

Benefit Sharing and Interdependency in Developing International River Basins: A Comparative Study

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Keywords: bilateral cooperation, interdependency structure, sovereignty, Treaty on the Lesotho Highland, Mahakali Treaty

Though states seldom experience open conflict over the development of international rivers, negotiations often end in stalemate where the optimal development scheme is not adopted. Optimal solutions imply that all basin states reap benefits from cooperating at the basin-level; "win-win" situations are created. As holistic management of rivers becomes emphasized, there is a need to understand how independent states act in the face of balancing domestic and basin-wide water demands. How do states perceive cooperative river development? What are the factors that induce states to share benefits? The paper aims to highlight the specific benefits of bilateral cooperation and conditions in which they are achieved. The paper hypothesizes that cooperation creates a certain structure of interdependency in the basin. From comparative analysis of the negotiations concerning bilateral agreements in the Orange River and Ganges River, it is stressed that this riparian interdependency determines the potential benefits.

Between upstream Lesotho and downstream South Africa of the Orange River, a bilateral treaty of the Lesotho Highlands Water Project allows for diversion of river flow in Lesotho territory to South Africa. In addition, it makes possible Lesotho to generate hydropower by partially using the project's South African financed infrastructure such as storage dams. The negotiations for this project took thirty years during a time when the two states were politically opposed over apartheid and Cold War issues. Hence, water negotiations were often susceptible to political climate. The focus of the negotiations concentrated on how the benefits derived from cooperation would enhance or sustain sovereignty. For example, South Africa insisted that its benefit should be the securing of stable water supply since the water would sustain its economic heartland. Lesotho benefiting hydropower generation and royalty revenue of transferred water reflects its appeal as an independent country in control of utilizing its own water resources for economic development.

The Mahakali Treaty signed in 1996, clarified water utilization agreements between upstream Nepal and downstream India for an integrated approach in developing the Mahakali River, a tributary of the Ganges. It mainly determines respective quantities of water withdrawal for irrigation as well as collaborative implementation of a multipurpose dam project, Pancheswar Multipurpose Project. Nepal and India have had a history of negative sentiment over previous water agreements. They are continually still at odds over the benefits claimed in the treaty. The geopolitics and power relations of Nepal and India resemble that of Lesotho and South Africa. Both upstream countries are landlocked, economically and politically weaker while the downstream countries are the "hegemons" of the river basin. However, the main factors that impede benefit sharing in the Ganges basin are the quantitative issues of inequality concerning water utilization and cost burden. Since neither country is able to provide uncontestable data to support its claims for water consumption, they are in deadlock over how much benefit one can gain from cooperation. For the basin state, the interdependency structure created by the Mahakali Treaty is conceived as eroding the sovereignty of the country since it cannot achieve equal benefits.

The two case studies show how cooperation creates an interdependency structure in implementing development work on shared rivers. This structure makes it essential for the basin states to retain their sovereignty through their respective share of benefits. Though interdependency and sovereignty seem like incompatible concepts, there must be consideration given to the interdependent relations for successful benefit sharing. In addition, it can be said that quantitative understanding of benefit sharing limits the potential points for mutual agreement.

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Which Conflict Management Factors can be identified in order to promote Cooperation on Shared River Basins? Current Hungarian & German Approaches

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Key Words: shared river basins, transboundary cooperation, conflict management factors, water resources management, water policy tools

Background/ Analysis of the Issue:
It is a well-known fact that water does not stick to man-made, political borders. Moreover, in river basins the effects of the various e.g. political and environmental systems that operate within them are integrated. Taking these premises into account it is obvious that i) local, regional as well as national administrative boundaries often may not comply with "basin boundaries" and thus ii) be in direct or indirect inconsistency with the integrative nature of the river basin. Therefore the joint and/or transboundary management of water resources requires the development of institutional frameworks, which might be considerably different from more traditional approaches like economic collaboration.

Facing this challenge, nowadays a growing effort to promote institutionalised behaviour via so called international-regimes like the establishment of different river basin commissions and bi-national agreements can be noted. Major stakeholders are not solely "states", but as well specific groups like sectoral government bureaucracies, regional and local governments electricity companies, etc. Some of them may be involved in the international negotiations themselves, or they are supporting the development of politically feasible environments for example on the regional level.

Water management regimes of common, transboundary river basins and water bodies in Europe have got new qualities with the introduction of the EU-Water Framework Directive (WFD, 2000/60/EC) in December 2000.

But even though many of the countries sharing the River Basin e.g. of the River Danube or the River Rhine are EU member states and therefore subject to WFD implementation principles, their perceptions of what constitutes a benefit with regard to for instance water uses may be distinct from one another. Furthermore some riparian states not being within the European Union territory underlay other, independent water management determinants.
The causes for possible conflicts in joint river basin management are therefore numerous on all administrative and political levels as well as with regard to different cultural backgrounds and historical relationships and often almost "presaged".

A deeper understanding of the different dimensions of current water-related cooperation and conflicts is necessary to i) identify factors causing current shortcomings of cooperation and ii) elaborate strategies for conflict resolution and conflict prevention in order to smooth the way towards a sustainable management of water.

Procedure:
We analysed several existing agreements on transboundary cooperation of Hungary, Germany and their neighbouring states, respectively, as well as joint cooperation on regional and local level within the two countries. Our main focus was:
to analyse transboundary cooperation taking place on different levels and scales:

i. river basin commission level (focus on the River Danube and River Rhine)
ii. bi-national level (e.g. Hungary-Serbia, Hungary-Croatia, Germany-Austria)

- to investigate cooperation in water resources management on regional and local administrative level (in Hungary and Germany)
- to identify policy, legal and institutional set-ups, best-practices and constraints
- to elaborate which agreements, memoranda of understanding etc. and settings are successful and why
- to check whether specific demonstration projects on e.g. stress on small transboundary water courses are able to function as initiators of cooperation
- to investigate the current involvement of different stakeholders within the policy-making process as well as the level of fulfilment of WFD-Public Participation obligations
- to survey possible benefits of transboundary cooperation
- to examine what benefit-sharing might imply in a local, regional and national development context
- to identify political tools required for successful river basin and transboundary water management

With these undertakings we aimed to develop recommendations providing substantive support to the discussion process among water experts, scientific institutions and decision-makers worldwide about current and future conflict management factors promoting cooperation on shared river basins and thus transboundary water governance.

Results and Findings:
Very first interim-results of our study indicate that cooperation on transboundary waters should not be handled separately from other national and international tasks of authorities being responsible for water management. Further findings suggest that water management agreements are most efficient when defining clear duties of the signing parties with regard to e.g. unilaterally planned water utilisation, procedures of transboundary environmental impact assessment and responsibilities in case of floods, drought or emergency situations. Moreover agreements should consist of consultation arrangements and clear operational mechanisms to prevent, control and reduce impacts originating from pollution sources or water abstractions that are effective on joint river basins and waterbodies. This is of special importance for countries like Hungary, which receive most of its total water resources from neighbouring countries. Cooperation should aim to harmonize national water policies, and especially the norms and standards for chemical and ecological water status assessment. Comparability of status assessment does not only depend on comparable assessment methods (see the so-called

"Intercalibration-Exercise" within the WFD provisions) but as well on harmonized ways to implement comprehensible and somewhat coherent monitoring-programme designs. The latter aspect is obviously a crucial precondition in the achievement of common management objectives.

Frame Agreement for Territorial Development, River Contract of Olona-Bozzente-Lura Basin

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Keywords: river basin management, agreement, governance tool, local development, water policy

Because of their nature and localization rivers - like most water resources - are often shared between several authorities, at national to regional and local: levels each of these exerts a control and has specific competences with regard to the management of this natural resource. This territorial "government" fragmentation causes several drawbacks in the river basin management, such us:

Overlapping of political decisions
Lack of coordination/prioritization of interventions
Inefficient use of public/private resources

As a result most river basin suffer from a low quality management, that leads to economical, political and environmental inefficiency. To change this analyzed state of the art related to the Lambro-Seveso-Olona basin, Lombardy Region decides in 2002 to start a regulated and organized management process for the basin area as a whole, in order to plan interventions, coordinate actions, share costs and monitor activities in a win-win solutions for all interested parties. In compliance with directive 2000/60/CE, a "River Contract" is planned and implemented: an agreement between public and private stakeholders located in the basin area that draws the framework for the definition of strategies and actions to be undertaken, high lightening urges and defining key players and relative responsibilities.

This "River Contract" enables all basin stakeholders to contribute with their own competences/resources to a global and strategic design that maximizes single efforts and overdraws the impact of each shared planned action. Through this governance tools Lombardy Region (that presides the "River Contract" Coordination Committee) links its policies with all subscribers contributions, i.e. local authorities, enterprise representatives, environmental bodies, etc.

In order to test the efficiency of this "governance tool", Lombardy Region selected the "Lambro – Seveso – Olona" basin, an "environmental risk area" strongly jeopardized by an overpowering industrial activity, intensive water use and damaging natural floods and droughts events.

The signature of a frame agreement to jointly face the challenges linked to the recover of this area took place in 2004. The high number of involved subjects demonstrates the success of this new "governance tool":

- Lombardy Region
- 78 Local authorities - municipalities
- 3 Provinces (Como, Milan, Varese)
- 3 ATO - "Territorial Optimal Domain" to manage integrated water cycles at local level (Como, Milan, Varese)
- ARPA – "Lombardy Region Environmental Agency"
- AdbPo – "Basin Authority of the Po River"
- AIPO – "Interregional Agency of the Po River"
- Lombardy Region Regional Scholar Office

The signature of the "River Contract" implies the engagement of each subject in contributing with own resources to the implementation of jointly planned works and initiatives. To manage this engagement a "Coordination Committee" has been created, where a representatives of each under signer contributes to the strategic planning: it guarantees the coordination of all interventions and the synchronicity of all efforts. By now several different activities has been planned and implemented (i.e. infrastructural / urban / security / environmental planning, regulation, environmental recovery and valorization, cultural promotion).

- The "River Contract" signature allowed by now:
- The immediate start of activities related to the management of basin emergencies
- The complete and integrated analysis of the problems to be considered within the basin framework: a strategic scenery has been studied and laid out to link all initiatives, plan adequate technical tools, evaluate the coherence of the actions and plan policies
- The promotion of a communication / training plan to disseminate the results of the actions, involve local actors in the definition of new targets and diffuse among the basin population a sustainable water culture

- The implementation of such a "governance tool" gives an important added value to the local development since:
- It permits to concentrate on different experimental/structural initiatives, binding them in an integrated strategic vision
- It permits to share the costs of such interventions, combining complementarities of resources and maximizing single efforts
- It gives value to a bottom-up approach, that involves urges at every local level
- It offers a "conceptual model" of working, that can be translated in different context or referred to resources shared between regions/nations

Thin or thick institutionalisation in Transboundary River Basins: Hydrological Regionalism along the Mekong and the Nile

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Keywords: River Basin Organizations, Mekong, Nile, Conflict and Cooperation, Water Governance

Recently, 261 transboundary river basins have been identified, covering 45% of the global land mass, hosting 40% of the world population. 145 countries lie within such a basin, 33 of them with more than 95 percent of their respective territory. 17 international watercourses (including two lakes) flow through five or more countries. Some of these rivers have been and still are subject to multilateral cooperation, reconciling the demands and expectations of all parties – typically in regions with a high degree of political institutionalization and advanced regional cooperation in other fields – as it is the case for the Rhine and the Danube rivers. A considerable number or transboundary rivers however, the majority in fact, drain regions characterized by a low level of economic development, fragile arrangement of institutions, parlous political power equation, asymetrical power distribution, subliminal animosities or even open enmities. Since the world´s water is getting scarcer in the light of growing population and an increasing per capita demand, particularly in these very regions, river basin institution building is a key to secure future water supply and to prevent the rise of interstate water conflicts.

Contributing to the Workshop Political Tools for Benefit Sharing in Transboundary Settings I would like to present a comparison of the institutional arrangements of river basin cooperation in the Mekong and the Nile Basin. Drawing from the first-hand research I conducted for my PhD thesis I want to systematically display limits and opportunities for institutionalised transboundary cooperation in complex hydropolitical settings. Against this background the Mekong and the Nile basin cooperation processes share some contextual features, but differ in their approach of politically tackling the underlying problems.

Both river basins, with the Mekong traversing 6 and the Nile draining 10 countries, comprise conflict prone regions and poor, often unstable nations, characterized by cultural and political diversity. Hydrologically, both basins are shaped by an upstream-downstream situation, but also contain sub-basins (such as the lower Mekong basin and the Equatorial lakes region) that resemble a common-pool constellation, leading to a concomitance of conflict and cooperation over water resources. Finally, the riparian states of both basins recently installed an international body to guide and spur collaboration on such diverse issues as water supply, hydropower, transport, fisheries, flood prevention and tourism, embodied in the Mekong River Commission (MRC, est. in 1995) and the Nile Basin Initiative (NBI, est. in 1999).

Against this similar hydropolitical background, and guided by similar motivations, however, distinctive river basin regimes are emerging. Whereas the NBI stands out in that it gathers all 10 riparian states (MRC only 4 out of 6), depicts the clear intention to move to implementation as soon as possible, following an ambitious vision, the MRC performs as the more cohesive, realistic and pragmatic actor, lacking the wide array of envisaged projects of the NBI and focusing on the doable rather than the imaginable. In a comparative, schematic perspective the main differences appear as follows

NBI		MRC
Inclusiveness	vs.	Cohesion
From Planning to Action	vs.	Epistemic Community
Ownership	vs.	International Expertise
Imaginable	vs.	Doable

Since these two prototypes of hydrological regionalism belong to the most developed river basin regimes in developing regions, there performance is indicative potential imitators. Although it is too early for a final assessment, preliminary findings indicate that both institutions constitute a breakthrough in the Hydropolitics of the respective region. Furthermore, both adhere to an underlying concept of regionalism that distinguishes African from Asian approaches towards transboundary institution building, with the former favouring thick, comprehensive and inclusive institutionalisation and the latter preferring thin, focused and cohesive institutionalisation. Both are viable approaches, but have to learn and adapt from each other, in order to establish a balance between reality and vision that is conducive to tangible cooperation rather than talk-shop or wish-list regionalism.

My presentation will proceed in the following fashion:

1. Introduction and Background
2. Transboundary River Basins
3. The Mekong river basin and the Mekong River Commission
4. The Nile river basin and the Nile Basin Initiative
5. Two approaches of Hydrological Regionalism
6. Conclusion and Recommendations

European funds as a Tool for Strengthening Transnational Cooperation in the Field of Water Management in the Scheldt River Basin District

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Keywords: Scaldit, Water Framework Direcive, Scheldt river basin district, Interreg IIIB NWE programme, Transnational cooperation

On 22 December 2000, Directive 2000/60/EC, better known as the Water Framework Directive (WFD), came into force in the European Union. The objective of this directive is achieving a good surface water and groundwater status in all European waters by the end of 2015. The Water Framework Directive incites the EU Member States to manage their waters and to draw up management plans at the scale of river basins and no longer at the scale of administrative borders. This implies that for international river basins, the Member States that share the river basin have to ensure an appropriate coordination.

The Scheldt river basin district is one of these international river basins in which a coordination between the riparian states (France, Belgium and the Netherlands) has to be ensured. Since 1995, the Scheldt riparian states and regions have been working together officially within the International Scheldt Commission (ISC). However, in order to ensure a full and effective transnational coordination of the WFD-obligations in the Scheldt river basin district, there was a need for additional financial resources. Therefore, the Scheldt riparian states submitted a project named 'Scaldit' for financing by the European Regional Development Funds programme Interreg IIIB North-West-Europe. A budget of 6,5 million Euro was granted to the project, of which half is funded by Interreg.

The name Scaldit is made up of 'Scaldis', the Latin name for the river Scheldt, and 'Integrated Testing', which refers to the testing of the European guidance documents for the WFD. Scaldit is a pilot project that constitutes a first step in the implementation of the WFD in the Scheldt river basin district. The project got off on January 1st 2003 and will end on December 31st 2006. The project is being carried out within the framework of the International Scheldt Commission (ISC). This offers the opportunity to work within a structure where the work of experts is being endorsed by political decision-makers.

One of the first obligations of the WFD was to carry out an in-depth analysis of the existing water status in each river basin district. This analysis is also referred to as the 'art. 5 analyses'. The project partners, which represent the different riparian states and regions of the Scheldt (The Netherlands, Flemish Region, Walloon Region, Brussels Capital Region, France) joined their forces to execute the art. 5 analyses of the WFD on a transnational scale. Furthermore, while executing these analyses, the European guidance documents, which were developed within the Common Implementation Strategy for the WFD, were tested. Within the framework of the so-called Pilot River Basin exercise, these testing experiences as well as the benefits and challenges of transnational cooperation were reported to the European Commission and the Joint Research Centre. The analyses comprise a characterisation of the river basin district (for both surface and groundwater), a review of the impact of human activity on the status of surface waters and on groundwater and an economic analysis of water use. The results of these analyses were brought together in the Scaldit report. By publishing these results, the riparian states conformed with the co-ordination obligations for international river basin districts, as prescribed by article 3 of the WFD.

The Scaldit project also devotes attention to the interaction between water management and spatial planning and to the flood risks in the Scheldt river basin district. With regard to this, a report was published in January 2006.

The results of the Scaldit project form the basis for the development of an international river basin management plan for the Scheldt river basin district, which has to be elaborated by 2009. The Scaldit-partners are initiating the preparation of this plan in the last phase of the project, among others by defining a number of significant water management issues. These issues are the main issues to be dealt with during the coming years in order to be able to achieve a good surface and groundwater status in all the waters of the district. Following issues are concerned: 1. Surface water quality, hydromorphological alterations and sediments; 2. Groundwater vulnerability; 3. Scheldt specific pollutants; 4. Economic analysis; 5. Prevention of floods and droughts; 6. Proper management; 7. Data, measuring and assessment methods.

Although transnational cooperation offers some clear advantages (sharing of experiences and knowledge, better mutual understanding, possibility of solving cross-border problems, strengthening of the integrated character of the water management) it remains a difficult exercise in which a balance has to be sought between the subsidiarity principle and the need for coordinated decisions and approaches in order to be able to pursue a truly integrated management of the water resources within an international river basin district. And this is what Scaldit is about.

Issues, Challenges and Prospects for Shared Water Resources Management in Africa

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Keywords: shared water resources, management: governance, stakeholders, North Africa; Mechanism of consultation

During the past decade, the OSS has undertaken to develop, as part of its "Large Aquifer Basins" programme, a process of scientific and technical dialogue between the countries sharing water resources. The objective is to promote a "basin awareness".

The concerted management of these resources aims, above all, at safeguarding and protecting them against both alteration and depletion with a view to ensuring both a sustainable and an equitable use of them for the benefit of the "neighbouring" countries. This, in turn, requires involving all the stakeholders and partners for whom were granted priority order.

This priority status is necessary to enable a rational and long-lasting exploitation of these scarce resources. Towards this regard, scientific and technical concerted action is a preliminary step in allowing for better knowledge of the state of the resources, the conditions of their exploitation as well as in setting up management mechanisms, thus, building a spirit of partnership among the technicians and boosting their solidarity in theface of risks.

However, such solidarity and technical partnership need to be further strengthened by a political will to cooperate within the framework of a common vision. Appropriate concerted action mechanisms must be set up in order to channel the efforts of all stakeholders towards the implementation of such a vision.

Indeed, the action of optimising a concerted management of the shared water resources requires certain compromises and needs to be founded on dialogue mechanisms and instruments which would make it possible :

- maintain the management tools developed, the circulation and exchange of data and information, as well as quality control of the data;
- define consensual plans granting each State equitable use of the shared water resources;
- to ensure involvement and appropriation by all stakeholders, especially the local populations and their representatives, based in particular on information, sensitisation and education programmes;
- to establish appropriate legal, institutional and administrative frameworks which specify the rights, duties and prerogatives of each and everyone, as well as the procedures and means conducive to good governance of the shared water resources;
- to promote joint international initiatives likely to ensure a sustainable management of these resources.

This approach for the consultation mechanism enabled a technical/scientific begining that ended with political support. This has been clearly demonstrated by the SASS project which was initiated in 1999 and ended in 2005.

The north- Western Sahara Aquifer System [NWSAS], shared by Algeria, Tunisia and Libya, consists of water reserves that cannot be totally exploited and are only very partially renewed. The NWSAS stretches over a million km2 and is composed of two major water-bearing layers, the Continental Intercalary and the Terminal Complex. Over the last thirty years, abstraction by drilling has risen from 0.6 to 2.5 billin m3/yr. This rate of abstraction involves many risks : strong impact on neighbouring countries, salinisation, elimination of artesianism, drying up of outlets, etc .

The hydraulic results were analysed using socio economic and environmental analysis. The outcome of which raised the awareness of stakeholders on the necessity of a common approach to managing the shared water resources. The three countries have now adopted a permanent management structure for the sustainable management of shared water resources.This consultation structure was jointly adapted with the signing of an agreement between the three countries during the synthesis regional workshop in Rome 2002.

The consultation mechanism structures comprises of a steering committee composal of national structures; a coordination unit managed and hosted by the OSS and an ad hoc scientific committee for evaluation and scientific orientation.

Benefits Beyond boundaries? A Critical Account of Benefit Sharing in the Orange River Basin

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Keywords: Securitization, Desecuritization, International rivers, Benefits beyond boundaries, Depoliticization

Introduction

During the last decades the academic discipline of international relations has witnessed an unprecedented increase in debates centred on the concept of security. While some have argued of an expansion of the traditional concept by referring to such notions as economic security, environmental security, global security and even ultimate security; others have defended the traditional approach where security was linked to the state, defending itself from its enemies by military means. The Copenhagen School of International Relations has attempted to overcome this dilemma by focussing on how issues become securitized and, consequently, has sparked debates over the conditions for desecuritization. However, conditions for the un-making of security has received limited attention in the overall framework.

Following the assumption that the securitization of water resources in international river basins is an undesirable outcome of increased perceptions of resource scarcity and crisis (Turton 2003), it becomes important to delineate the mechanisms at play for desecuritization to take place. In this regard, Sadoff and Grey (2002) have put forward a general framework for benefit sharing in international rivers where increased cooperation can provide benefits to the river, from the river, because of the river and, ultimately, beyond the river. The Orange River Basin shared by Lesotho, South Africa, Botswana and Namibia has previously been defined as a "basin at risk" with a potential for political stress and conflict (Wolf et al 2003). By focussing on benefit sharing as a method of desecuritization, perceived threats and crisis induced rhetoric can be transformed into mutual trust and cooperation. Bilateral benefit sharing arrangements between the basin states are in place and have yielded results and these are now increasingly complemented with a multilateral focus under the heading of the Orange-Senqu River Commission (ORASECOM), which was established in 2000.

Findings and Empirical Analysis

The Lesotho Highlands Water Project has generated benefits to and from the river, these being reaped by both Lesotho and South Africa and has, according to some actors, created an optimal "win-win solution" for both countries.

The establishment of the Ai-Ais/Richtersveld Transfrontier Park (ARTP) between South Africa and Namibia on the Lower Orange in 2001 has created benefits in the area of conservation as well as facilitated the creation of new border posts to increase cross border tourism. While the project is still in its initial stage, the eradication of "political fences" in the interest of environmental management and conservation has the potential of creating benefits that go beyond the river.

Subsequently, South Africa and Namibia are jointly conducting the Lower Orange River Management Study (LORMS) which, among other effects, has led to investigations with regards to building a new dam to ensure stability of water supply. This comes in addition to data sharing, joint research and hydrological analysis benefiting, for instance, irrigation schemes on both sides of the common border.

Even though ORASECOM had a slow start, future projects are increasingly discussed within the Commission and its multilateral character has contributed to trust among the hydropolitical elite in all basin countries.

By unpacking the concept of benefit sharing, its desecuritization potential becomes evident. The basin states have gone further than just merely sharing water, but are increasingly sharing the benefits of increased cooperation not only confined to the river itself.

The Orange River Basin is by some described as a technically closed basin. By unpacking and contextualising the concept of benefit sharing, an additional closure politically where the concept becomes stripped of any contentious political clout, is avoided. The “win-win” perceptions in the case of the LHWP have a depoliticizing effect as they conceal the fact that the benefits and costs of the project are not equally divided between the people of the basin. In the ARTP it is clear that some communities on the South African side will benefit from increased cooperation, but to what extent and in what way these benefits will include communities on the Namibian side is more uncertain. Nevertheless, the opening of new border posts can counteract the fact that the demarcation of the border between the two countries is a bone of contention. That Namibia and South Africa work together with the LORMS, shows that cooperation and benefit sharing can take place even in a situation where the border has initially been “closed”. At this stage, the benefits of ORASECOM appear to be confined to the creation of trust, donor confidence together with data and information sharing and it remains to see whether such will evolve into actual projects in the future.

Conclusion and Recommendations

Dynamics and mechanisms contributing to the desecuritization of international rivers have received scant attention. Benefit sharing among the basin states in the Orange River can be a valuable tool in this regard, as long as the concept is unpacked in order to reveal who benefit what and at what costs. Benefit sharing as a principle can be promoted on a political level, but benefit sharing mechanisms are highly context dependent. Benefit sharing beyond boundaries appears to be easiest to realize when economic benefits are clear, such as in the LHWP, and more difficult where the actual benefits to be derived are more ambiguous which is often the case in multilateral settings. Hence, benefit sharing in the Orange River Basin has traditionally appeared on a bilateral basis, usually as infrastructure projects or joint studies. However, with a basin-wide commission established, benefits derived from bilateral projects are increasingly used for the benefits of all basin states.

Cooperation for Development: Emerging Frameworks for Sharing Benefits in The Euphrates-Tigris River Basin

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Keywords: Euphrates-Tigris, transboundary basin, sharing benefits, development, cooperation

In the Euphrates-Tigris river system, the water question emerged on the regional agenda in the 1960s when the three major riparians, namely Turkey, Syria and Iraq initiated major development projects. The uncoordinated nature of these supply-led developments as well as ineffective demand management practices within the framework of national water policy and management of the co-riparians continue to be the principal causes of water disputes in the region. On the other hand, since the early 1960s there were attempts to foster dialogue and information exchange in the region through a series of technical water negotiations. Yet, one could observe that the riparians had adhered to stringent positions, which did hardly change during the course of the negotiations in three decades' time until the suspension of the negotiations in the early 1990s.

Hence, futile negotiation processes over water allocation and related disputes over water rights in the Euphrates-Tigris river basin demonstrate that there is a need to create new cooperative frameworks that enable links between cooperation and development. Discussions concerning water needs would better take place within a broadened agenda whereby equitable usage could be determined along with the handling of water related multisectoral development issues such as infrastructure (energy, telecommunication, transport), agriculture, trade, industry, and health and environmental issues.

Introductory discussions present the limitations and shortcomings of existing water allocation mechanisms while more workable solution of "sharing the benefits rather than sharing the water itself" constitute the main research question of the paper.

Relations between Turkey and Syria have considerably improved since the signing of the Adana Security Agreement in 1998, and new and promising initiatives have been undertaken. To name a few, in 2001, the Southeastern Anatolia Project (GAP) Regional Development Administration, Turkey initiated contact with Syria by sending a delegation on the invitation of the General Organisation for Land Development (GOLD), Ministry of Irrigation, Syria. As a result, a Joint Communiqué was signed between the GOLD and GAP administrations on 23 August 2001. Its overall goal as perceived by their initiators is to provide sustainable utilisation of the region's land and water resources.

Furthermore, the paper scrutinizes the development of political and economic relations among the riparians since late 1990s as they produce fruitful impacts on the water based development in the region. In this respect, the significant improvement in the economic relations of Syria and Turkey is studied with specific references to the developments in the major sectors of sustainable development such as agriculture, energy, health and other water-related development sectors. A series of government, private sector and civil society delegations paid numerous mutual visits reaching fruitful understandings and agreements on trade and economic matters. These culminated in the signing of the Free Trade Agreement in 2004, a real breakthrough in the advancement of bilateral economic relations.

The paper will reflect this growing positive atmosphere in Turkish-Syrian bilateral relations at large, however the analyses will particularly focus on the productive dialogue in the water related development sectors, namely agriculture, energy, health and environment. Thus, the years 2003 and 2004 witnessed the signing of two framework cooperation agreements on health and agriculture, respectively. Both agreements underline the importance of enhancing cooperation and fostering development in two neighboring countries and comprise, among other things, issues on water related development fields such as combat against water related infectious diseases and soil and water conservation in agricultural practices.

Moreover, Syria, Iraq and Turkey are partners of an energy cooperation project, that is, the project on the interconnection of power grids of seven Middle Eastern countries. Lebanon, Jordan, Syria, Egypt, Libya, Turkey, and Iraq are coming closer toward linking up their power grids and creating a regional network that will save significant amounts in combined energy costs. The project expands to include eight or nine nations in near future as more countries hook up to the grid, which will eventually link up with countries as far a field as the Gulf Cooperation Council, North Africa, Mediterranean region (MEDRING project) and the 15-nation European Union.

Another significant development in the region is the foundation of the Euphrates-Tigris Initiative for Cooperation, ETIC by a group of scholars and professionals from the three major riparian countries in May 2005. ETIC adopts a holistic, development focused, multi-sectoral approach as opposed to one aiming at sharing the river flow. The latter has proven to be divisive and unproductive. ETIC does not promote a certain model of cooperation or a formula of water sharing. It envisages to be a facilitating platform. In this respect, since its very recent establishment, ETIC has proven to be a dedicated convenor of a conference sessions among the concerned authorities in the region and also the innovative creator of training program among the water engineers of the region. ETIC will be introduced in the paper with its vision and subsequent initiatives.

Based on the status of the relations between the riparians of the Euphrates-Tigris system and the recent rapprochement between Turkey and Syria, along with projections with respect to Iraq in the new era, one can predict better cooperation and more productive conditions for transboundary water coordination in the region. Hence, the authors suggest that cooperation in the region needs to be based on wider development concepts; cooperative processes need to be geared to specific goals of development, and poverty reduction related to wider socioeconomic development.

Politics, Economics, Stakeholder Benefits, and Transboundary Ground Water: Lessons from North America

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Keywords: transboundary ground water, stakeholders, economics, political institutions, benfits

Introduction

Transboundary ground water issues in the North American countries of Canada, the United States of America, and Mexico are truly dynamic. Institutions such as the International Boundary and Water Commission (IBWC) of Mexico and the USA and the International Joint Commission (IJC) of Canada and the USA were originally established to consider surface water issues. However, they have been adapted to consider ground water. The North American Free Trade Agreement (NAFTA), a treaty signed by all three countries and implemented in 1994, has proven to be applicable to ground water, although in some cases may eventually prove inimical to the interests of border regions as the three countries attempt to develop and manage their transboundary ground water. Interesting issues can arise through NAFTA, as transboundary economic considerations may influence water resources located entirely within one country. These three institutions – IJC, IBWC, and NAFTA - coupled with the ad hoc approach of individual stakeholder groups, illustrate that transboundary ground water management is generally functioning well in North America and that benefits for some stakeholders are being realized. Five case studies, involving water quality, quantity, and waste disposal, illustrate our premise: the Abbotsford-Sumas aquifer (Canada-USA); Hueco Bolson and Mesilla Bolson aquifers (Mexico-USA); Hermosillo aquifer (Mexico-USA); Sierra Blanca nuclear waste disposal site (Mexico-USA); and the San Pedro River basin (Mexico-USA).

Political Institutions

The IJC and the IBWC are both products of bilateral treaties between the USA and Canada, and the USA and Mexico, respectively, but have different roles and powers over transboundary water resources. The IJC has limited power because it cannot become involved in disputes until both countries refer the matter to the Commission. The IJC's jurisdiction is also limited to surface water, but has bypassed this limitation in specific cases where the surface water problem was directly related to ground water resources. The actions of both Commissions require consent by the two sovereign governments which constrain their effectiveness as an institutional entity. The IBWC, in contrast, is not just a mediator, but also an active participant in the apportionment and utilization of the transboundary water resources. The decisions of each Commission are not binding. NAFTA also shown that it, too, can treat ground water, although in the USA, NAFTA's approach to ground water as an economic good may jeopardize the use of scientific processes.

Case Studies

The majority of the examples presented demonstrate cooperation between two countries, the success of the political institutions, and the stakeholder groups. The countries are voluntarily collaborating and using the institutions available to them in that region as well as creating new institutions to deal with specific problems and to work together more effectively to maximize benefits. A task force was created for the Abbotsford-Sumas aquifer to address water quality issues impacting both Canada and the USA. The San Pedro River basin, on the USA-Mexico border, is the subject of a multi-national study to determine the effects of ground water pumping on the riparian corridor and devise a way to protect the migratory bird corridor. Mexico and the USA, through the IBWC, are also cooperating over the Hueco Bolson-Mesilla Bolson aquifers.

NAFTA has created tension over the Hermosillo aquifer in Mexico. Although not a transboundary aquifer, the Hermosillo aquifer produces water to grow many agricultural products that are in high demand due to the easing of trade restrictions. This increased demand has created internal conflict over the rights and use of the Hermosillo aquifer. In this case, the people must decide between the benefits of exporting high-valued agricultural products over the use of water for other local purposes, such as commercial and industrial development. The future is unclear at this point.

The Sierra Blanca nuclear waste facility illustrates that the siting of a nuclear waste facility is a water quality issue that has the ability to strain relations between both countries if not handled carefully. Siting a facility near the USA-Mexico border is difficult because the largest surface water bodies (Colorado River and Rio Grande) in the southwestern USA flow into Mexico.

The majority of the examples from North America demonstrate that there are existing political institutions and stakeholder organizations to resolve transboundary ground water issues. Both environmental and economic benefits have been realized.

Conclusions and Recommendations

- The IJC and IBWC generally function adequately whenever ground water is an issue, thus effecting transboundary ground water management, if on an ad hoc basis
- NAFTA's "economic good" focus may jeopardize the use of scientific processes
- NAFTA considerations, which are inherently transboundary, may complicate the management of water resources located wholly within one country, thus "creating" transboundary issues where there were none.
- Radioactive waste disposal sites and their impacts on transboundary water resources present contentious issues.
- More attention needs to be paid to ground water and its unique characteristics and not try to "fit" ground water into existing surface water compacts and agreements.

We recommend the modification of the IBWC and IJC agreements to deal specifically with ground water. The implications of NAFTA on ground water and related issues should also be clearly delineated.

Laying the basis for a future transboundary management of the Volta Basin in West Africa – the Case of the Volta Water Governance Project

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Keywords: Dialogue, Code of Conduct, Local Transboundary Committee, River banks restoration, Volta Basin Authority

Background

The Volta River Basin in West Africa is the ninth largest basin in Sub-Sahara Africa and shared by six countries (Benin, Burkina Faso, Côte d'Ivoire, Ghana, Mali, and Togo). The largest part (85%) is shared between Burkina Faso and Ghana. The Basin is the home to some 14 millions people who depend directly or indirectly on the resources of the river. With a population growth rate of about 2.5% per year, the River Volta and its resources is continually becoming stressed as a result of human activities.

The Volta River Basin however, remains one of the few major transboundary river basins in Africa with no formal institutional arrangements for coordinated management of its water resources.

Absence of a coordination mechanism and legal framework as well as lack of reliable management information and data for information sharing constitutes institutional problems that underpin all the water resources management problems associated to the basin. Viewed from the perspective of increasing competition among the various uses of water, recurring rainfall deficiency due to climate change, environmental degradation, potential risks of conflicts between Ghana and Burkina Faso become apparent. There also seem to be increasing misconception regarding the causes of water deficits, the responsibilities of riparian countries during devastating floods, the proliferation of aquatic weeds and problems of water pollution in the basin.

The IUCN project for Improving Water Governance in the Volta River Basin, commonly known by its French acronym PAGEV (Projet d'Amélioration de la Gouvernance de l'Eau dans le Bassin de la Volta), responds to this need for transboundary coordination and cooperation regarding the management of the Volta Basin waters.

PAGEV aims at strengthening the bilateral cooperation between Burkina Faso and Ghana towards a more equitable and sustainable management of the Volta basin. It is being implemented in partnership with the Direction Générale de l'Inventaire des Ressources Hydrauliques (DGIRH) of Burkina Faso and the Water Resources Commission (WRC) of Ghana. Both institutions are in charge of developing, implementing and monitoring water policy in their respective countries.

The three-year project is funded by Sida and DGIS of the Netherlands through IUCN's Water and Nature Initiative (WANI)

PAGEV interventions and outputs
PAGEV is implementing activities based on IWRM principles whose outcomes would be replicated throughout the basin. These interventions including the following;

- Development of a set of management principles or “code of conduct” that will be shared by the two countries.

- A water audit and gap analysis is being conducted and water availability and use scenarios will be developed. These will form the basis for future dialogues on use of water resources in the basin.

- Implementing pilot IWRM interventions with local communities on both sides of the border to demonstrate transboundary cooperation. Some ongoing activities include the formation of local, national and transboundary water committees, reforestation of river banks, rehabilitation of small reservoirs, joint monitoring of water quantity and quality into Ghana from downstream of the Bagré dam in Burkina Faso.

Some outputs from PAGEV activities so far include; a) the establishment of the Joint Technical Committee on IWRM (JTC-IWRM), b) the formulation of a draft Code of Conduct on the use of shared water resources of the two countries, c) the establishment of a local transboundary committee. A key outcome of the meeting establishing the Local Transboundary Committee was the ability for people to meet face to face for the first time and discuss concrete activities together. This transboundary meeting also brought to the fore the difficulty of working in multilingual environments as French, English and Moré (the local language).

Impacts of PAGEV intervention
Some of the impacts this stage includes;

- The establishment of relationship and trust of strategic partners.
  Breaking of the language barriers which may hinder cooperation
- Empowerment of communities for natural resources governance and conflict resolution.
- A change of attitude brought about by educating the communities on the potential benefits in the activities of river bank restoration through the option of growing commercial fruit trees along the river banks to be liberated by farmers. The communities have thus given up part of the farmlands on the river banks for the conservation of the river banks.

This presentation is intended to share some of the lessons learnt in the implementation of PAGEV, and solicit recommendations for further improvement of the project.

Planning in transboundary water basins as a tool for sustainable water management

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Key Words: transboundary waters, water management plans, water policy, EU WFD , Peipsi/Chudskoe lake

Transboundary water basins, shared by two and more countries, very often face more challenges regarding water management comparing with national water basins. Thus, coordinated water protection measures on the basin level require efforts from all countries, sharing the basin. In order to agree on such measures, development of the joint Management Plans/Programmes seems to be the most appropriate tool to set up the priorities and main directions of the joint activities. These documents are mainly based on the national Plans or Programmes and cover transboundary aspects of protection and use of water resources.

Currently the EU is bordering with a number of third states, and the boundaries are either crossing water bodies, or going along with them, or dividing the water basin into several parts. Taking into account such facts, the EU Water Framework Directive recommends joint agreed actions for all parties (even for the third states) in the process of development and implementation of the Water Management Plans. National requirements in this sphere very often differ from the ones of the EU WFD so agreement among the parties and harmonization of the legal provisions are essential for the joint water management and planning.

The EU Water Initiative is also requiring to establish national water resources management plans by 2005, so such national plans, having common denominator and relevant aims and objectives, could be integrated into international Plans or Programmes being applied to the transboundary water basins, which also demand coordinated water management efforts not only on the national level.

In case of the EU and Russian Federation borders, national provisions do not have serious and principal differences with the EU WFD requirements, so in the process of developing joint Water Management Plans it seems possible to integrate both European and Russian requirements while having agreed positions and adapting such Plans to the transboundary situation.

UNDP/GEF Project "Development and Implementation of the lake Peipsi/Chudskoe Basin Management Programme", to be finalized in 2006, has drafted such Joint Basin Management Programme for the Lake Peipsi/Chudskoe basin as a tool to organize joint water management in the transboundary basin due to the urgent need to develop a priority list of common environmental objectives for the whole transboundary lake water basin, that should coordinate national environmental objectives and develop a common denominator acceptable by the two governments that is to be addressed by cooperative efforts of the governments of Estonia and Russia with coordination provided by the Estonian – Russian joint transboundary Water Commission.

This Programme was prepared taking into account both national legislation and EU Water Framework Directive since the lake is located on the external EU borders. It is based on the several key documents such as Transboundary Diagnostic Analysis, defining environmental objectives and a strategy for the transboundary Lake Peipsi/Chudskoe Basin Management Program (TDA); Estonian and Russian Lake Peipsi/Chudskoe Nutrient Load Reduction Plans prepared by UNDP/GEF, EU LIFE and EU TACIS projects; Water Management Plans and other relevant documents worked out by UNDP/GEF, EU LIFE and EU TACIS projects; Public Participation Plan developed under the UNDP/GEF project and two Feasibility studies on ecological and water tourism around the lake and on eco-farming also carried out under the UNDP/GEF Project.

Joint Basin Management Programme for the Lake Peipsi/Chudskoe basin was actively discussed with different stakeholders in the basin and presented to the key organizations responsible for the water management in the region. The process of the official consideration and approval on the highest level is on the way in both countries due to the need to integrate this Programme into other national strategies and policies for effective implementation of the required measures and monitoring of th performed activities.

Towards Hydropolitical Cooperation in the Nile Basin: Win-Win Projects between Sudan and Ethiopia to Transform Conflicts

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Key Words: Hydropolitical, Conflicts, Win-Win Projects, Ethiopia, Sudan

Water is increasingly becoming a source of conflict not only in the Nile region but also in many other parts of the world. Water conflicts are found in many different setting locally, some pastoralists and farmers compete over scarce drinking water and water for their livestock. Conflicts can appear between upstream countries or between downstream countries or between both upstream and downstream countries, due to lack of water, increase demand due to population growth, and other natural resources. Ethiopia and Sudan need more water for their future projects. If Ethiopia and Sudan take water unilaterally, then tension will rise which may lead to conflict between the two countries. To avoid this tension three ways are identified.

We have proposed in this paper three different types of questionnaire, the first one focus one the possibility of cooperation between Sudan and Ethiopia, where the second questionnaire focus on the benefits of the integrated win-win projects on water resources between the two countries, the final questionnaire focused on the risks (likelihood of significant damage to the project and or affected economic, social and environmental systems) of the integrated projects on water resources also between the two countries.

The paper recommends cooperation through step-by-step projects shared between the two countries, where it regard Ethiopia as the main provider for hydropower, and Sudan was regarded as the main provider for agriculture and marketing.

Finally the paper highlights five advantages and paths of cooperation between the two countries, so as to peacefully transform conflicts before they reach an unmanageable stage. Benefits and risks of the integrated projects are illustrated in the paper.

Zambezi Action Plan Project 6, Phase II (Zacpro 6.2): Creating an Enabling Environment for Benefit Sharing in a Transboundary Setting

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Keywords: Integrated water resources management; transboundary; enabling environment; equitable; benefit sharing

The Zambezi River, with its tributaries, is probably the most important source of water in the Southern African Development Community (SADC). From its source in north-western Zambia to the Indian Ocean, the main river has a length of about 2700-km. The Zambezi River Basin stretches out over 1,36 million km2 and occupies parts or the whole of eight countries: Angola, Botswana, Malawi, Mozambique, Namibia, Tanzania, Zambia and Zimbabwe. The population living in the basin is estimated at around 40 million people (year 2000).

The potential of the shared water resources of the Zambezi River Basin to contribute significantly to the economic development of Southern Africa is recognized within and outside the region. Conscious of this fact, the Riparian States of the Basin agreed that the water resources of the Basin could only be managed effectively, efficiently, equitably and sustainably by embracing integrated water resources management with the entire Basin as the geographic unit of management.

In 1987, the then Southern African Development Coordination Conference (SADCC), now the Southern African Development Community (SADC), adopted the Zambezi River Action Plan (ZACPLAN) in the framework of economic integration, cooperation and development of southern African countries. The objective of ZACPLAN is to achieve environmentally sound planning and management of water and related resources in the Zambezi river basin. Through the ZACPLAN, a number of projects have been undertaken.

The ZACPRO 6, Phase II Project is a follow up and complement to the ZACPRO 6, Phase I Project. Together, Phase I and Phase II constitute the ZACPRO 6 Project, which is a core project of the Zambezi River Action Plan (ZACPLAN) which consists of 19 Projects, which are intended to support regional cooperation on environmentally sound management of water resources of the common Zambezi River watercourse and to strengthen regional cooperation for sustainable development. The ZACPRO 6 Project focuses on establishing an enabling environment to support the realization of the goals of ZACPLAN and on the development of an Integrated Water Resources Management Strategy for the Zambezi River Basin. It is premised upon the vision that the eight riparian states of the Zambezi River Basin will achieve a higher and sustainable socio-economic development for all, through equitable and sustainable utilization of the shared water resources of the Zambezi River Basin.

In this regard, the Riparian States agreed to establish the Zambezi Watercourse Commission (ZAMCOM). The Agreement was formally signed on 13th July 2004.

The key lessons learnt from the Zambezi process are that the creation and consolidation of the enabling institutional environment should precede the development of the management systems, tools and plans for the development and utilization of the water resources and that ownership and leadership of the process must rest with the Riparian States. Mechanisms should be put in place to build mutual trust and confidence amongst the Riparians. The need for a paradigm shift from equitably sharing water to equitably sharing benefits should be underscored and this requires political commitment and guidance at the highest possible level. Shifting focus from sharing water to sharing benefits derived from its use provides far greater flexibility even though it is perhaps the most difficult and sensitive challenge in cooperative management of the shared basin.

The Disputed Silala River Basin: A Catalyst for Cooperation?

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Keywords: Silala River, Transboundary waters, Water conflict and cooperation, Bolivia, Chile

An acute water conflict that exists in our world today is not even known to most practitioners in the field of transboundary waters. The dispute consists of little more than a stream that flows from southwestern Bolivia, in the alti-plano, to northern Chile. The two countries have entrenched themselves so deeply since the issue arose in 1997 that neither nation has been willing to move from their original positions.

The Silala River represents much more than just a small amount of water that travels between the two countries. There are issues of sovereignty that date back more than a century to the War of the Pacific, when Bolivia lost its access to the sea, that still play a role in the matter. Bolivia and Chile, since 1978, only have consular relations and have been in intermittent talks over the past six years specifically with regards to the Silala River. If the issue is to be solved, many aspects of the problem have to be taken into consideration before a comprehensive solution is to be found and the nations can move forward towards improved diplomatic relations.

The basis of the dispute is that the two countries are at odds with whether the Silala River is an international river or an international transfer of water. According to Bolivia, the Silala River emerges from a set of springs on the Bolivian side of the border and, in 1908, after a water concession was given to a Chilean railroad company to use for its steam engines, an aqueduct was constructed carrying the water from the Bolivian side of the border to the Chilean. As steam engines are no longer used, Bolivia considers the original water concession void and sold another concession to a Bolivian firm, DUCTEC. Through DUCTEC, Bolivia believes it has a right to charge Chile for the use of those waters. Chile contends that the Silala River is a natural flowing body of water that was never diverted from springs, but was always present, which falls under the norms of international water law with regards to “equitable utilization”. Under these widely-recognized norms, Chile would then have a right to use the waters of the Silala River without worry of having to pay for the water flowing from Bolivia or whether Bolivia could cut the water off.

The current situation is one that brings to the forefront many of the issues that are beleaguering the two nations. With newly elected presidents in both countries, the Silala dispute has already been discussed in the early months of both of their terms. The Silala does not sit by itself, however, in the agenda and that is where the problems arise. Bolivia, after more than 120 years without a sovereign port for exportation of its goods is still demanding Chile give them a sovereign port. Without a port, Bolivia has found it difficult to export its large natural gas reserves. At the same time, Chile is in need of energy. Both nations are attempting to normalize relations with one another to help with regional integration. All of these factors provide room for negotiation.

This presentation will examine how cooperation over the Silala River waters could be used as a catalyst for more far-reaching collaboration between the two countries, a “Water for Peace” concept. Whereas the dispute could potentially be resolved by knowing whether the Silala is an international river or an international transfer of water, this would incur large losses for one side or the other, not an ideal situation for either country. The dispute can be looked at as a win-win proposition for both sides in looking at how coming to an agreement may include not only other elements of cooperation besides water through “expanding the pie”, but also to try to avoid leaving “value on the table”. An application of Pareto's "Possibilities Frontier" will examine how adding value to the issue can improve the chances of success within the negotiation process and a sustainable outcome. Both Bolivia and Chile can benefit on a greater scale by opening up the debate rather than having an arbiter decide the Silala case based on the science.

An Appraisal of the On-Going Strategic Management Framework in the Transboundary Niger Basin of the Sub-Saharan Africa for Sustainable Development

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Keywords: transboundary Niger basin, sharing benefits not resources, reversing degradation trends, healthy environment and peace, sustainable development

The River Niger, straddling the West and Central Sub-Saharan Africa, is the longest river in Africa and 7th in the world. The active hydrological basin of the river cuts across nine countries of different climatic zones. The land and water resources of the basin have been noted to have great potentials for socio- economic development of the entire region.

But despite the vast resources in the basin and the un-matched favourable conditions for development, the basin is still found to be adversely affected by poverty and diseases. This poor condition in the basin is attributable to unilateral and un-coordinated development of the resources coupled with the negative impacts of the activities on the environment.

The Niger Basin Authority (NBA) formed in 1964, as a regional cooperation body for management and development of the transboundary basin, had only to its credit a network of telemetric hydrological monitoring system and a forecasting tool that failed to produce any meaningful predictions to avert hazards in the basin.

But by late1990s, the regional body has initiated a lot of programmes and projects starting with activities to improve the hydrological data collection system and services for proper monitoring and assessment of water resources potentials in the basin.

This was followed by initiating project on consultative framework on 'Shared Vision Process'. The management process is to engineer a collaborative administration of the resources in the basin for integrated development. The Process is also to prepare a Maser Plan for integrated development of the resources in the basin with all the expected benefits of the resources to be shared in a just and equitable manner.

The Global Environment Facility (GEF) project on reversing the degradation trends in the land and water resources of the basin that started some few years ago has reached the last phase of its implementation plan and some pilot projects tagged environment management projects are to be executed..

All these and other projects and programmes in the Niger basin for introduction of management strategy for the purpose of achieving sustainable development in the basin are at various stages of completion and not yet fully realized. But, it is worthy to note that the overall achievement to date has a lot to show that the basin is on the path and direction of having meaningful and sustainable development, healthy environment, clean waters, peace and cooperation in the basin and in the entire region.

Reducing the Transboundary Degradation of Kura-Aras River Basin in South Caucasus

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Keywords: transboundary , IWRM, policy , legislation , institution

The Kura-Aras river system is the most significant international river system in the South Caucasus. Seriously degraded water quality and quantity constraints may increasingly lead to disputes or in worst case to conflicts amongst water users within and across riparian countries. As the experience showed single sector oriented management of water resources confined to national level did not solve the problems and deterioration of water resources and aquatic environment continued. The countries realised that only multi-objective, integrated planning and management of water resources at river basin scale could adequately address the environmental and social-economic needs. The riparian South Caucasian countries (Armenia, Azerbaijan and Georgia) in the Kura-Aras Basin recognized the importance of Integrated Water Resources and Basin Management Approaches in the River Basin and demonstrated their interests in application of new approaches in their state water policy. On the other hand, the present economic situation of these countries and political tensions between some of them retard practical application of above approaches.

The Sida having recognised the needs and funded through UNDP Georgian Office a two-year long project with participation of Armenia, Azerbaijan and Georgia for the purpose to identify legal, institutional and policy needs for Integrated River Basin Planning and Management (IRBP&M); to develop Kura-Aras National Action Plans (NAPs); to identify institutional options for trans-boundary Integrated River Basin Planning and Management (IRBP&M); to build national capacities for IRBP&M activities.

Further co-funding was provided by the UNDP Regional Environmental Governance Programme of the UNDP Regional support Centre for Europe and CIS based in Bratislava. This fund was used to establish an NGO forum; support development of public involvement plan, including pilot projects, to ensure public involvement in the design of the demonstration projects; and to create and support a regional stakeholder group to provide input into the trans-boundary analysis/strategical action programme (TDA-SAP) process. More specifically: (1) establishment of regional and national institutional management and support mechanisms; (2) undertaking a stakeholder analysis in the basin; (3) carrying out a trans-boundary diagnostic analysis (TDA), including a causal change analysis; (4) preparation of a regional Strategic Action Programme (SAP) and component National Action Plans (NAP; (5) organisation of a donors conference; (6) preparation for submission of results to GEF, which continues the work after the Sida funds were finished.

Deliveries of the project were task reports on national policy, legal and institutional needs for IWRM; cursory gender study in water resources management; background analyses of the

Kura-Aras River Basin for Armenia, Azerbaijan and Georgia; national objectives for IRBP&M have been identified and prioritized through national consultations incl. stakeholders groups; national priority issues identified through root-cause analyses and national reports produced; National Action Plans prepared for Armenia, Azerbaijan and Georgia; study of optimal institutional model for the transboundary river basin management; national and regional GIS maps; studies on identification of existing data bases, data collection and management techniques, monitoring and standards; trainings of representatives of water-related agencies database management and GIS.

The project was able to strengthen and further develop the regional network of technical experts and mid-level officials who really care about the River Basin environment and readily enter into dialogue around the sustainable water resource management issues. It was a complicated issue to engage in the dialogue high-level officials due to the known political tensions between two South Caucasus countries. Sida provided sufficient assistance to continue the technical dialogue of transboundary water management, which fact was able to prepare the platform to raise a political profile of transboundary IWRM dialogue. Thus the conflict resolution (synergy) effect of the co-operation in water sector was significant.

The current paper is going to present the project execution and achievements in a complicated geopolitical environment. The authors obtained lot of experiences on how to facilitate development in transboundary settings emphasising the potential of “sharing the benefits” rather than simply “sharing the water.” Benefits of environmental, socio-economic interventions and regional economic integration will be presented. Furthermore, options of agreements in transboundary water context will be also highlighted for strengthening the development initiatives and collaboration. As the authors see, in turn, these factors stimulate investments in water sector and pave the way for increased stability in the region.

The authors will address issues such as benefits from collaboration in transboundary settings; benefits of public involvement in a regional, national and local development context; responsibility to ensure a fair distribution; formulation of legislation, policy and institutional needs to ground the transboundary development.

Workshop 2:

Water and Trade: Matching International Water Availability and Local Needs

Various ways of estimating the Virtual Water Trade for various purposes

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The concept of "virtual water trade" has been developed to explain how physical water scarcity in countries in arid and semiarid regions is relaxed by importing water-intensive commodities (Allan, 1998). The original idea of virtual water trade is therefore, "importing food is as if importing water"; namely, food trade is virtually the trade of water because importing countries can use their own water resources for other purposes such as domestic water use.

Today the perhaps more straightforward and easier to understand concept of "virtual water content"—the water used to produce the commodity (Hoekstra & Hung, 2002)—is used. In this case, "virtual water content" is the same as the external cost of water for agricultural and livestock production processes and it has recently been called a "water footprint" (Chapagain & Hoekstra, 2004). However, the amount that was used to make the product does not necessarily reflect the amount of water which can be saved by the virtual water import. Utilizing the concept of "virtual water trade" for water resources assessment, the amount that should be estimated is the quantity of water needed if the same amount of imported goods were produced in the importing country. In this case, there will be a difference between the amount of water actually used during the production process in the exporting country, and the imported amount of virtual water. The difference explains the comparative advantage of food production and can illustrate how much water usage is saved globally (Oki & Kanae, 2004).
The confusion between these two definitions of "virtual water" most likely started from a misunderstanding in which some people regarded the trade of food as the "trade of virtual water". Instead, originally, the food trade was regarded as the "virtual trade of water." Since "virtual water content" is really the external cost of water usage to the environment, it may be more appropriate to call it "environmental virtual water" (Allan, 2004, personal communication).

The "virtual water" defined as "virtually required water" in its original sense is useful to see how virtual water trade save the water scarcity. According to the classical view of world water resources assessment, 22 countries were identified as "seriously stressed" because less than 1000 m3/y/c of water resource is available in the statistics in year 2000. However, if the virtual water trade, including livestock production and the major crops, is considered for these countries, only five countries are categorized as "seriously stressed" (Oki et al., 2004). Furthermore, richer countries with available water resources exceeding 2000 m3/y/c may even be classified as "slightly stressed" if virtual water flow is considered. This result clearly indicates the importance of considering human aspects in world water resources assessment, and the strong relationship between economic poverty and water shortages.

Generally crop yields and water efficiencies in exporting countries are higher than in importing countries. Consequently, "real water," the water used in the exporting countries, tends to be smaller than "virtual water" in importing countries. For example, 1 kg of soy bean corresponds to 1.7 t of "real water" in the USA and 2.5 t of "virtual water" in Japan. In this sense, the virtual water trade of 1 kg of soy bean from the USA to Japan saves 0.8 t of global water resources. The total virtual water trade (imported virtual water) for commodities in

2000 was estimated to be approximately 1140 km3/y. However, this corresponds to only 680km3/y of real water suggesting a water saving of 460 km3/y (Oki & Kanae, 2004). While the virtual water trade will not increase the total water resource, “saved” water in the importing country can be allocated to other purposes, such as municipal and environmental uses. However, one should be careful when interpreting these results since the idea of virtual water does not consider social, cultural, and environmental implications or limiting factors other than water.

Considering “environmental virtual water” is also useful to illustrate how consumption of goods put environmental load to other regions and countries. One major advantage of quantifying the virtual water trade is to appeal to ordinary people how their daily lives are related world water usage through the trade of goods particularly food. For this purpose, water self-sufficiency ratio, which can be defined as the ratio of the domestic water usage to the sum of domestic water usage and imported virtual water, could be also appealing. For this purpose, “virtual water trade” in its original definition will suit.

Virtual water trade is a conceptual tool that can be used to consider the inter-relationship and trade-offs among water, food, land, and energy. Further quantification and detailed investigations of virtual water trade, such as the differentiation of virtual water into categories, for example: non-sustainable water resources and rain-fed products, is required and would have various implications.

Free Trade Agreements and Water

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Keywords: Free Trade, International Policies, Water Services, International Law, WTO

What do we know about the relationship between the varied array of current free trade agreements and the process for negotiating water resources? What are the links between water and multilateral trade agreements of the World Trade Organization, Bilateral Investment Treaties and free trade agreements such as NAFTA, CAFTA and the Andean Free trade Agreements?. What would be the possible implications of liberalization of a sensitive resource as water? The paper presents some answers and advances made by 9 researchers from Canada, Chile, Bolivia, Argentina, Peru, Colombia and Ecuador.

Due the complexity of water management and the diversity of treaties, there isn't a single direct link between water and free trade agreements, rather a number of links which overlap and inter-link based on the different uses of water. As a result, this natural resource appears as a theme that traverses the whole global agenda of free trade. Decisions on water have ended up influencing both the creation and elimination of laws and institutions regulating investments as well as determining the rights of public and private agents.

The agenda of free trade involves water resources en three areas: market access, services and investments. It applies to at least eleven uses of water including bottles water, exports, drinking water services, environmental services, hydroelectric power, use of water by mines, gas and oil companies, tourism, agriculture and transport ass well as water rights.

Market Access: Bottled water and water exports
The "harmonized tariff schedules" of GATT includes water as a "commodity" in a rather confusing way in its tariff heading 2201: "Other types of water, including natural, artificial or mineral water or aerated water which doesn't contain sugar or artificial sweeteners; ice and snow." Initially, it seems to refer to bottled water, but then it talks of ice and snow which makes the definition much broader.

Clause 2501 starts by talking about salt and sodium chloride and ends up including "sea water". Clause 2851 includes "distilled water or water of similar purity".

The trade across frontiers of bottled water is one of the world's biggest expanding industries. From an annual trade of 900 million liters in the 1970s, we now have an annual trade above 24 billion liters.

As for bulk export of water, it is worth remembering the words of Mickey Kantar, the US Trade Representative who in 1993 said: "When water is traded, it is a good and therefore all the provisions of trade treaties must apply". In other words, once water is exported, its commercialization can´t be prohibited except temporarily on the basis of internal scarcity

(GATT, art XI-2(a)) or for environmental reasons but only if these provisions are also applied to national producers o consumers. (GATT. Art.XX(g)).

Services: Different ways which involve water

Drinking Water and sanitation services are those which are obviously highlighted in research into water and the General Agreement on Trade in Services (GATS). Nevertheless are also included in environmental services, in tourism services, in distribution services, in transport by water or pipes and in "other services" which includes hydroelectric power (art 11).

GATS and the services chapters within Free Trade Agreements in general have the following core rules: a) Most Favored Nation, all countries must be treated equally; b) Market Access, once a sector is opened to foreign competition, a country can't no longer impose restrictions on services such as changes in pricing, duration, legal framework (art 16); c) National Treatment, foreign companies must be given the same treatment as national companies (art 17); d) Compensation for changes, allows to ask for compensation, if a State has overturned or revoked a commitment in a particular sector. (art 16).

Investments: a very wide coverage

Investment is defined widely, within the investments chapters of NAFTA and many BITs, to include rights to water, licenses, authority and permissions granted in the areas of mining, tourism, oil and gas industry, hydroelectrics, transport of water, drinking water services, environment, agriculture, fishing, etc.

If for whatever reason, a country revokes, modifies or limits these rights or access, then this can be a reason for demanding indemnities or compensation based on the argument of "indirect expropriation"

The possible implications

Free trade agreements could tie the hands of governments and put restrictions on public policies which regulate the use and access to water resources. For example, they could obstruct the application of rules and policies that prevent the over-explotation of water resources; they could put into question the application of domestic regulations that protect water such as restrictions in use, or monitoring of environmental impacts.

They could limit the power of governments to change licenses, permissions, technical regulations or standards. They could make it difficult to introduce environmental controls at the same time of issuing licenses and end up shaping the financial aspects of each contract.

Finally they could prevent the granting to local providers (companies or communities) of subsidies, transfers, low-interest loans, debt guarantees or debt cancellation.

Limits of Virtual Water Trade, and Alternatives

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Keywords: water, security for food, virtual water trade

Water is a renewable but finite resource. Against the background of increasing population, growing food requirements, industrialization and urbanization, the competing claims of agriculture, industry and household water consumption need to be mediated. There are other claimants too on this precious resource. These include hydropower (other power generation methods are part of industrial sector), navigation, recreation and the environment. Another challenge is the spatial distribution of water; while some regions and countries have plentiful water supply others tend to be water scarce.

Under these circumstances a water-scarce region/country pursuing food self-sufficiency tend seek water diversion from other regions/countries.

An increasingly favoured view is that 'if water becomes the scarce factor, it may be more sensible to 'import' it embodied in food, especially if food is available on favorable trade terms'. Proponents of this argument point out that Egypt, a water-scarce country, regularly imports food (Allan, 1992) and that California obtains 73 percent of its daily water input by importing food, though it also 'exports' water by selling cotton, fruit and vegetables (Comeau, 1993). They suggest that the twin problems of water scarcity and hunger can be addressed by increased agricultural production in water abundant countries, and by then supplying these products to water scarce countries on favourable trade terms.

This paper raises some concerns about this approach of addressing water security [for food security] through international trade in commodity crops.

I do this, first, by examining the concept of water abundance. In thinking about water abundance, I suggest, we need to investigate other crucial factors such as availability of land and other inputs for export oriented production, the environmental cost of export oriented production (including the question of food-miles) as well as social implications of export oriented production.

Second, using the example of commodity trading in the US, I shall show that overproduction not only results in lowering of prices locally but also internationally. In the world market, it results in the phenomenon of dumping, or the selling the commodities at below the cost of production, [known as dumping amongst trade experts]. A reduction in international commodity price is likely to be attractive to the importing water scarce regions; however, the impact it has on family farmers around the world are devastating.

Both in the producing and importing countries, overproduction and associated dumping pushes over the edge those farmers who are unable to recover their cost of production. In developed countries this results in impoverishment of rural areas and further consolidation of agro business, and in developing countries this results in farmers suicides and/or increased migration to cities.

Third, I suggest that the main beneficiary of such international commodity trade will be the US and EU based multinational agro-business companies. With the ongoing agricultural liberalisation process in developing countries, these multinationals now operate in most countries and do business in a vertically integrated manner, converting many independent farmers into contract farmers.

This is a gloomy scenario for international water community that is striving to help governments and citizens achieve universal access to water and sanitation and help meet other water challenges.

In conclusion I propose that development of multifunctional landscapes, with locally available resources may provide a better answer for addressing the food security issue.

A New Dimension to the Concept of Virtual Water Trade and Water Footprints of Nations with Special Reference to India

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Keywords: Virtual Water, Footprint, Business Outsourcing, India, Trade

The concept of 'virtual water' was introduced by Allan (1993). Water used to produce a commodity is called the 'virtual water' contained in the product. Virtual water is the water embedded in a product in a virtual sense. If 1000 kg of water is needed to produce 1 kg of grain and if 1000 kg of this grain is exported from one country to another, in a way, one million kg of water is being exported.

To compute virtual water content of products, a distinction is made between primary products (e.g., vegetables), processed products (sugar), and transformed products (cheese). Some processes may yield multiple products and in this case, total quantity of water used is allocated amongst these. Further, not all products require water and for such items, virtual water is nil. The virtual water content of a product is an indicator of the environmental impact of consuming the product.

There can be two different ways to look at the concept of virtual water. From the view point of the producer, virtual water content of a product is the quantity of water that is consumed to produce that commodity. This quantity depends upon the technology and conditions of production. There can be considerable difference in the quantity consumed depending upon these factors. Considerable saving of water is possible if water efficient technology is employed to produce, say, steel. Further, more water is needed to produce each unit of a crop in arid climates as compared to humid areas. This view point is helpful when a country or region is involved in large-scale exports of a commodity. If the country is facing shortage of water, it may be worthwhile to review the export policy.

From the view point of the consumer, virtual water content of a product is the amount of water that would be needed if the commodity is to be produced at the place of consumption. This quantity will also depend upon the technology and conditions of production. This view point can be helpful in taking a decision if the country is facing a shortage of water and plans to import certain goods that require large quantity of water.

Related to the concept of virtual water is notion of water footprint. Water footprint of a nation is defined as the total volume of freshwater used to produce the goods and services used by that nation. In a similar way, this concept can be defined for an individual.

Some countries of the world do not have adequate water to meet their current and projected water need while in some other countries, available water is much more compared to the demands. Further, in big countries, there are regions of surplus or deficient water availability. A possible approach to overcome this spatial mis-match between water availability and demands is to transport water from surplus regions to deficient regions. Due to the involvement of large distances and associated infrastructure and other costs, transportation of real water between water-rich and water-poor countries may be very difficult. Therefore, a viable option for water-scarce countries could be to import water-intensive products rather than produce them domestically. At the same time, water-rich countries could reap benefits from their abundant water resources by producing and exporting products that consume large quantities of water. Of course, in reality things are no so simple and additional questions of food security, energy security, employment, etc. enter in the picture.

In the present work we have looked at an unexplored dimension of the concept of virtual water. In the field of information and communication, two important changes have taken places during the past decade. With the advent of Internet, it has become extremely simple and efficient to transfer data across the world. The physical location of the two parties involved in data transfer is immaterial and large volumes of data can also be shared without much difficulty. A natural fall out of this development is that if it is expensive to analyze data at the place where it is being generated or is to be used, the data could be transferred to places where it is cheaper to analyze it. This has led to a revolutionary concept of business process outsourcing (BPO). In this concept, an organization transfers or out-sources some non-core activities to places where it is cheaper to complete them. BPO is a boon to multi-national companies since it helps them in cutting costs and improving profit margins. These days, the tendency of companies to set-up their production base or R & D centers in different parts of the world is increasing. Although the multi-national companies rarely consider water consumption while relocating jobs, BPO has a virtual water dimension also. When an employee, located in a particular country is providing services to clients located in another country, his host country is exporting some virtual water. This virtual water export is equal to the water consumption by the employee and his family.

Using the current, historical, and projected data about the employees associated with BPO jobs in some countries, this study has computed the virtual water exchange for this sector. The results have been used to revise water footprints of selected countries. It is observed that the BPO factor is important in estimating water footprints. As the trends show, the number of employees involved in BPO jobs in many countries is slated to sharply rise with time. Consequently, this aspect is likely to become more important with the passage of time.

Managing Dynamic Resource Externalities with Trade Implications: The Case of Virtual Water

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Keywords: Natural Resource Management, Groundwater, Agricultural Trade, Dynamic Economics, Externalities

Virtual Water Trade has received increasing attention in the recent water resources management literature, from both researchers seeking to understand the implications that international trade patterns in both agricultural and non-agricultural goods have for water resource consumption. In his seminal work, Allen (1998, 2001) has promoted the idea of virtual water trade as a way of relieving the stress of agricultural production for self-sufficiency in water-scarce countries. While much of the literature that has followed has focused on the best means of accounting for the virtual content of water that is embodied in every unit of good trade in international agricultural markets, few have contributed towards building a better understanding of the policy implications for natural resource management.

The tenor of much of this literature is reminiscent of discussions that have taken place, in the past, over the natural resource impacts of agricultural trade in terms of soil degradation, pesticide use or other localized externalities. Many of the policy insights that have been gained from the study of those problems have not translated well into the current discussion surrounding virtual water trade, and the implications that it has for natural resource management.

In this paper we place the discussion of virtual water firmly within the context of natural resource management, and examine the implications that localized policies for water resource pricing and use have on the implicit water content of agricultural commodity trade flows between countries. Using a simplified analytical framework, for clarity of exposition and to better illustrate the principles involved, we place our analysis within the context of dynamic water resource usage, as it is the best context in which to examine the externalities that arise from non-cooperative water resource extraction. As much of the recent literature on water resource management has shown, non-cooperative behavior is the prevailing paradigm that characterizes the use of water for agricultural production, in many regions of the world.

The Natural Resource Economics literature on Common Property externalities in groundwater extraction is both rich in theoretical and empirical treatments, beginning with the article of Gisser and Sanchez (1980) which examined the loss of efficiency that occurs when a groundwater aquifer moves from a sole-owner extraction regime to one in which there is competition in pumping. Various other authors have addressed the efficiency problems that arise under competitive in groundwater pumping, but Negri's 1989 article placed the problem squarely in the realm of applied differential game theory, and described the strategic externality that arises from the dynamic gaming of the competing agents pumping from a common aquifer. It is within the context of this vast literature, that the basic resource problem of the paper will be set up.

In this paper, we link the water use and agricultural production behavior to a simplified bilateral trade model, in order to illustrate the impacts that localized water resource management policies have on the resulting trade flows of agricultural goods. Following standard methods for solving dynamic games, and standard numerical procedures for solving stochastic dynamic programming problems, we construct a calibrated and robust dynamic game model of water usage and agricultural production, and introduce trade linkages through a simple spatial equilibrium model. Using this framework, we are able to clearly distinguish between the effects of distorting trade policies on agricultural production, trade and water resource usage, and the effects of distorting water resource policies on agricultural production, trade and overall welfare. This distinction is crucial in identifying the appropriate policy instruments to apply, and has significant implications for welfare – especially in cases where the nature of the externality is mis-diagnosed and mis-handled by policy action.

By illustrating the policy problem in this way, the paper contributes to the current literature on virtual water trade by providing a better conceptual framework in which the current proponents of virtual water trade can apply their analysis. By doing so, we hope to better clarify the theoretical underpinnings of natural resource management problems, as they relate to international agricultural trade, and provide guidance to researchers and policy makers on where they can best apply their efforts.

References

Allan, J.A. (2001): "Virtual Water – Economically Invisible and Politically Silent: A Way to Solve Strategic Water Problems." International Water and Irrigation Journal , November.

Allen, J.A. (1998): "Virtual Water: A Strategic Resource: Global Solutions to Regional Deficits." Groundwater, 36(4):546.

Chapagain, A.K., A.Y. Hoekstra. and H.H.G. Savenije (2005): "Saving Water Through Global Trade." Research Report Series No. 17, Institute for Water Education, UNESCO-IHE, Delft, The Netherlands.

Gisser, M. and D.A. Sanchez (1980): "Competition versus Optimal Control in Groundwater Pumping." Water Resources Research, 16:638-642.

Negri, D.H. (1989): "The Common Property Aquifer as a Differential Game." Water Resources Research, 29: 9-15.

Ogg, C.W. and D. Sutton (1988): "Linkages Between Soil Conservation Policy and Trade Policy." In Agricultural Trade and Natural Resources: Discovering the Critical Linkages (D. Sutton, ed.), Lynne Reinner Publishers.

The Concept of Virtual Water Trade – an Environmental Research Perspective

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Keywords: Virtual Water Trade (VWT), Agriculture, Global Land Use Accounting (GLUA, Environmental Impacts

The concept of Virtual Water Trade (VWT) has lately attracted major attention as a new development strategy. VWT aims at reducing water intensive production processes in water scarce regions. Water scarce developing countries should no longer produce, but import, especially, agricultural products which demand irrigation (70 percent of world's freshwater use). A kilo of wheat, for example, 'contains' 1000 litres of 'virtual' irrigation water. In a precautonary sense, it is argued that these water savings are beneficiary to the environment.
The assessment of 'virtual' resources is not new to environmental research. Indeed, resources are used, polluted and destroyed as side-effects of production processes. They have also been considered by different environmental accounting schemes e.g. ecological footprint and ecological rucksack. The problem of VWT is that it only focuses on water and blends out other ecological impacts, which are connected to the water-intensive biomass production.
In our presentation, we show that the empirical method of Global Land Use Accounting (GLUA) could therefore make a significant contribution to VWT debate. GLUA is an empirical method accounting direct and indirect land-use for the production of agricultural commodities. GLUA usually focuses on a national economy. It considers all land use inside and outside a country caused by domestic consumption.

From an environmental research perspective, VWT shows some deficits. The combination of a normative promotion of (virtual water) trade in combination with lacking consideration of other environmental factors beyond water might lead to adverse ecological impacts. Importing instead of producing agricultural products might reduce the water volume used in the particular country, but does not necessarily imply an absolute reduction of worldwide material flows. Indeed, it is probable to cause a burden shifting to water rich countries which, in consequence, would have to intensify their agricultural production and thus the environmental pressure connected to it. Therefore, the debate on VWT should take into account direct and indirect effects on land-use.

International Trade and Water Flows in Colombian Agriculture: Analysis for the Period 1961-2004

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Keywords: Virtual Water, International Trade and the Environment; Agricultural Dynamics and Water Use; Water Footprint; Globalisation and Local Impact

One of the central concerns in current water policy globally is related to the local action that must be undertaken in order to meet the Millennium Development Goals in 2015. However, there are few analyses that attempt to trace the effect of global policies on water resource use at either the national or the local level. In particular, little research has been carried out on the effect of international economic policies, such as economic aperture and external consumption patterns, on the intensity of water use for various purposes and their implications for integrated water resource management. As in most of the rest of the world, the evolution of the agricultural sector in Colombia has been traditionally studied from an economic, historical and political perspective. Little research has been directed at examining the environmental impact caused by dynamics in the agricultural sector and structural changes within this sector, in terms of use and exhaustion of natural resources in general and water resources in particular. These gaps could be related to the lack of emphasis on environmental studies within academia and public policy study. This in part explains the fact that there are few instruments to estimate the quantity of natural resources involved in economic activity, which would make it possible to integrate socioeconomic analysis with environmental studies. The objective of this article is to evaluate the impact of water use in agriculture as it relates to the changes in the Colombian economy's development models between 1961 and 2004. Special emphasis will be made on the role that international trade has played in driving this water use. For the analysis, the concepts of "water footprint" and "virtual water" will be used. These powerful tools for economic and environmental planning are able to measure the evolution of economic activity in relation to water use in a country or region.

This research found that water demand for agricultural use is very sensitive to changes in the external conditions of Colombia's main export products (coffee, bananas, sugar cane, African oil palms). This has created a large body of evidence that affirms that globalisation and internationalisation of the economy has a negative effect on governance in individual countries and territories, specifically as regards tackling environmental pressure and implementing Integrated Water Resource Management policies. In addition, the biophysical virtual water balance (imports minus exports) is showing a growing deficit in the quantity of water that leaves Colombian territory on its way to the rest of the world, as a result of the process of specialisation in 'water-intensive' agricultural goods. This creates ecologically unequal exchange, as Colombia absorbs greater environmental costs due to higher water resource use (opportunity cost), along with the respective pollution. In this sense, the economic policy of trade aperture can affect the Millennium Development Goals being met, due to increased pressure on and conflicts relating to water use, as the demand for water intensifies to feed production specialised in 'water-intensive' goods. This research shows that international trade is a new vector (along with air and water) that spreads environmental pollution and impact with no regard for national borders.

Fresh Water Sharing in the Trans-boundary River to meet the Local Needs in Regional Context

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Keywords: Transboundary river, Fresh water, Sharing, Equitable, Flood-drought cycle

In this paper availability, needs and sharing issues/strategy of fresh water in the trans-boundary River systems along Indo-Bangladesh boarders will be discussed. Fresh water sharing of common rivers or water bodies like like/reservoir among the concerned countries are always a critical issue worldwide and requires rigorous information based analysis and great attention resolving it satisfactorily and to reach a common and acceptable agreement. In context of trans-boundary river, situation of Bangladesh is unique. Being a small country (Area about 143000 sq km) it contains 57 trans-boundary rivers out of which 54 are along the Indian border and rest 3 are flowing along Myanmar border. Most part of the fresh water flow in all major rivers is coming from the contribution of watersheds lying out side of Bangladesh border.

The Ganges, the Brahmaputra-Jamuna, the Teesta, the Dharla, the Barak etc. are the significant trans-boundary rivers with Indian Territory and the Matamuhuri, the Sangu and the Naf with Myanmar territory. The Ganges and the Brahmaputra-Jamuna are flowing through the multiple countries and are the most important rivers because of their magnitude of flow-sediment carrying capacity, role on flood plain and delta building and flood-drought cycle in the lower riparian areas. Fresh water flow in the trans-boundary rivers vary greatly from almost zero in dry season to about 80000 cumecs in monsoon. During monsoon tremendous amount of fresh water passes over the country on the contrary during dry season flow is very insignificant, at some locations almost no fresh water flow exists that causes recurrent flood-drought cycle, depletion of groundwater table, contamination of groundwater, saline water ingress, sedimentation in the tide influenced rivers resulting reduction/damage to agricultural and fisheries productivity, choking of the distributaries and tidal rivers, water logging and drainage congestion, environmental degradation, loss of domestic animals, trees and plants, health hazard and loss of livelihoods. Reduction of fresh water supply in the dry season causes chronic economic, social and environmental hazards in the lower riparian region which results indescribable distress to the people.

Fresh water which usually flows in the rivers either local or trans-boundary is invaluable for the livelihoods and development of riparian people and locality. It means there is a great demand for fresh water in the rivers and other water bodies. River has an origin and an outfall, fresh water flows from upstream to towards the outfall and usually volume of flow increase with the distance from the origin. Flow of the rivers can be diverted for utilization in agricultural, industrial, navigational and fisheries purposes at any point along the reach. It must be kept in mind that need for fresh water and right to fresh water are equally distributed all along the river reach. By any means right of other region can not be underestimated or ignored. Especially if the river or other water body is trans-boundary more attention must be given to this point. Need may vary locality to locality transitionally, but right remains equal all along. For the time being relatively more water can be utilized in certain locality but it must be mutually agreed and with the honor to human right. Canada and USA sharing the fresh water of their great lakes, like many other countries India and Pakistan also sharing the fresh water of a number of trans-boundary rivers equitably through mutual agreement. Hence, in case of Bangladesh-India-Myanmar there must be an acceptable way of sharing the water of their trans-boundary rivers. The mechanism is important and it must be innovative and politically and socially well acceptable.

Transboundary Water Problems in the Kura-Araz Basin

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Keywords: River, water consumption, pollution, ecological condition, regional security

Kura is the largest river of the South Caucasus, its source is in Turkey (area Ardagan) at the altitude 2740 m., and estuary in Azerbaijan on -27м. Length of Kur makes 1515 kms, and the drainage basin 188 thousand км2 and is arranged in territories of 5 states. It is arranged as follows: Azerbaijan - 52,9 thousand км2, Iran - 40 thousand км2, Georgia - 36,4 thousand км2, Armenia - 29,8 thousand км2, Turkey - 28,9 thousand kм2. The basic part of flowing is formed on the territory of Georgia (37,7%), Armenia (23,4%) and Azerbaijan (21,5%) as well as 13,6% in the territory of Turkey and 3,8% in Iran.

The long term average volume of water resources of basin of the river Kura is 26,6 км3. Total amount of water use in countries of basin of the river makes about 23 км3, i.e. 86 % of water resources are used for needs of population and economics. At the basin of the river lives about 20 million persons. Such use of water exhausts the rivers of basin and decreases the flow on it estuary par.

The analysis of water consumption structure in countries situated in the Kura river basin is approximately following: irrigation – 68%, heat-power engineering – 11,0%, industry – 6,9%, communal economy – 6,3%, agricultural water-supply – 5,2%, forestry – 2,6%. Water consumption increase is observed in Azerbaijan for the last 30 years (7,0%), East Georgia (7,0%), Armenia (8,5%), Iran (4,1%).

The existing condition in last years even is more aggravated with reduction of the natural flow in basins of the rivers, in connection with climatic changes. For the last 6 years (1995-2001) the natural flowing diminished by 25-30%, in alpine regions the solid precipitations diminished, the seasonal snow-line rose by 500-800 m. above than usual. Thus, it is necessary to mark, especialy that in 2003 in Kura water was much more than long-term norm and it has flooded large territories in the southern flow. Kura this year in Azerbaijan has created many social and ecological problems. Has suffered about 31 administrative regions, where live 1,5 million.

The resources of river waters of Azerbaijan are made 980 м3/sec., or 30,9 км3. The considerable portion of flow in Azerbaijan goes from contiguous territories by the transit rivers. The volume of this influx for mean on liquid water content of year makes 652 м3/sec or 20,6 км3. The flow being formed of the river directly reshaped within the limits of country (local flow) is 328 м3/sec or 10,3 км3, as a whole from the local resources of fluvial waters the portion of surface flow is made 58 %, and underground 42 %. The resources of fluvial waters of country for multiwater year are equal 735 м3/sec, or 23,2 км3, and for little water 228 м3/sec or 7,2 км3. It is necessary to mark that 80 % of water resources of country is made by water basin of the river Kura and its inflow, 70 % which one is reshaped in terrains of neighboring states. The water resources of the republic are limited extremely and as contrasted to neighboring states their specific weight per unit of territory and per capita less according to Georgia 7.7 and 8.3 times, and with Armenia 2.2 and 1.7 times.

Ecological condition and regional security. The problem of rational use and protection of water resources is very actual for the region countries. Up to 1990 the water use and control over the water resources quality is realized on the base of legislative acts of the former USSR and agreements between the USSR and Turkey, Iran. At the same time the state system of regular observations, water quality control and sewage and drainage waters cleaning (thought not fully) and draining system were acted. The scientific-research organizations of the country conducted the scientific-research and engineer-prospecting activities for rational use of water resources.

However, for the last 25-30 years no one seriously fundamental investigation on assessment of water quality forming and transformation, and the natural facilities of self-cleaning and renewal of water quality characteristics was not studied in order to develop the scientific-based measures on transboundary rivers quality management. Due to economic difficulties and the lack of programs and acts between countries on water resources rational use as well as the lack of understanding the water capacity and quality formation regularities, water resources consumption and distribution at present confuse the situation in the region. Also the lack of regional data collection exchange system in last 10-12 years makes impossible for administrative bodies to make timely and objectively decisions. There is no regional system of beforehand water capacity and quality prevention.

So, in order to evaluate completely the existing situation and find way out of crisis it is necessary to carry out a comprehensive work on reveling the sources of pollution, the regularities of formation the quality of pollution, transportation of pollutants along the length of rivers, determination the capability of self-refining of rivers, reservoirs and all storage pools, working out the scientific bases to prevent pollution, the control and management of quality of water resources of the basin of the Kur river.

It is impossible to carry out these works within the limits of one country taken apart, even within the limits of countries of the region-Azerbaijan, Armenia and Georgia. Besides the unification of efforts of scientists and specialists of corresponding organizations of these countries it is necessary to drow in the advanced experience of developed countries and efforts of international organizations.

Water Scarcity and Economic Policy in Yemen

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Keywords: Yemen, water poverty, water scarcity, economic policy, water resources management

Yemen is both one of the poorest and one of the most water scarce countries in the world. It ranks 151 out of 177 countries in the Human Development Index 2005. The average per capita share of renewable water resources is 125 m3 per year, according to government estimates, compared to a world average of 7,500 m3, and 1,250 m3 in the Middle East. Particularly in rural areas, the population lives at the minimum health impact threshold of 20 l/c/d. Water resources are depleting rapidly, and it is estimated that by 2022, the country may run out of water. The high population growth – fourth highest in the world, according to UNICEF – only compounds the challenge. Yemen's National Water Sector Strategy and Investment Program 2005-2009 (NWSSIP) states that "sustainability is no longer attainable in the overexploited areas".

The importance of water for development is unquestionable. But the importance of socio-economic development to remedy water scarcity has not yet received the political and societal support required to achieve an efficient and equitable water resources management in Yemen. The challenge is to match water policy to the critical reality of scarce resources.

The government has well recognized the need for better allocation and preservation of the resource for sustainability. Water is one of the topmost priorities of the country. NWSSIP is a strategy, action plan and investment program that covers all aspects of the water and sanitation sector, including water resource management, urban and rural water supply and sanitation, irrigation and the environment. For 2005-2009, NWSSIP envisions a $1.5 billion investment program, with a particular focus on rural water. Wide-ranging legal, institutional and organizational reforms are foreseen.

Yet, a central challenge remains largely untouched: 90% of water in Yemen is used for agricultural purposes and only 7% for drinking water (3% industrial consumption). In and around the capital Sana'a, there are 425 wells, most of which are not used for drinking water purposes. The underground aquifers have been drying up at a fast rate.

Agriculture's share in GDP has been declining from 21.4% in 1993 to 15% in 2004. But agriculture still represents 54.1% of total employment in 2004, and supports 2/3 of rural livelihood. With such a large percentage of the population living off agriculture, in a country where 15.7% are below the $1 a day poverty line and 45.2% below the $ 2 a day poverty line (Human Development Report 2005), and where the unemployment rate stands around 35%, the agricultural sector is vital to the economy and the most important generator of rural income. Accordingly, change is immensely difficult to attain.

Still, it is here that water-saving schemes must be implemented, contributing both to socio-economic development and the desirable diversification of the economy. The agricultural sector is undergoing a concentration process of land holdings: while small marginal farmers are crowded out, the holdings of few large farmers are continuously growing, thereby contributing substantially to food insecurity of the rural population. Furthermore, while labor productivity has remained largely constant in the 1990s, land productivity increased by over 50%, mainly due to increasing irrigation practices: The share of directly rain-fed cultivated area (today still at 55%) has gone down by about a third since 1975. Groundwater irrigation, on the other hand, has exploded from 5% to 45%, while its efficiency remains low (<40%). Traditional water management practices, contributing to a careful and efficient use of water, are in steep decline – the sector gives only little or no support. Increasing costs for pumping water again favor larger holdings to the detriment of marginal farmers.

In addition, as water is extracted from the country's wells at virtually no cost to the well owners, the incentive to shift to more profitable, water-intensive crops, is enormous. Cereal production still covers 50% of cultivated land, but its share has been declining at a rate of 2.4% per year since 1995. Meanwhile, 80% of cereals are imported. At the same time, aggregate citrus production increased 20% p.a. between 1991 and 2003. Qat, the popular national crop, today accounts for 25% of the agricultural labor force and generates value added equivalent to 25% of GDP. The consequence is the continued, even increasing over-exploitation of water resources: qat is estimated to consume 30-35% of the country's irrigation water, and for each kilo of bananas produced, Yemen exports 24 liters of virtual water.

In conclusion, Yemen is right in urgently targeting the urban and rural water and sanitation sectors to boost socio-economic development and decrease poverty. But as long as the economic policy does not tackle water use adequately, water scarcity cannot effectively be dealt with. What is needed is an economic policy for water that covers not only the full operating costs of water, but the full economic price of water, which includes the opportunity costs of exploiting water as well as the negative externalities exploitation produces. A policy constructed in this way, within a water resources management framework, would promote water conservation and socio-economic development.

Workshop 3:

Economic Instruments

The Potential Role of Economic Instruments in River Basin Management

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Keywords: economic instruments, river basin model, water use efficiency, water conservation, irrigation sector

Improved water use efficiency, particularly in irrigated agriculture, but also for domestic and industrial uses, is key to meeting future growth in demand for water. Economic incentives for water management, including prices, taxes, subsidies, quotas, and use or ownership rights, when implemented appropriately, can affect the decision-making process of water users and motivate them to conserve and use water more efficiently in irrigation and other uses. Administrative water prices generally work well for municipal and industrial water usage, particularly if subsidies are targeted toward poor domestic users, and revenues generated through water charges are invested into expanding water supply services to lower-income areas. Designing a water pricing system for agriculture that does not hurt farm incomes is more challenging, however. Administrative water prices are generally less effective in saving significant quantities of irrigation water, particularly in developing countries where farmers have limited control over water supply reliability, and large systems serve many small farmers, making measuring and monitoring deliveries for volumetric charges costly. Analyses have shown that increases in direct water tariffs only release small quantities of water from agriculture for other uses, at a high cost to the irrigation sector as farm incomes drop significantly. In addition, in existing irrigation systems, prevailing (formal or informal) water rights significantly increase the value of irrigated land. Water rights holders perceive the imposition of water prices, or an increase in existing prices, as expropriation of those rights, reducing the value of land in established irrigation farms. Attempts to establish or increase water prices are thus met with strong opposition from irrigators. A series of river basin analyses using economic-hydrologic river basin models for the Brantas, Dong Nai, Mekong, and Maipo river basins located in Southeast Asia and Latin America, respectively, support these observations. Increased irrigation service fees would impose a substantial burden on farm economic welfare, while water savings would be relatively modest. Other economic instruments, including rationing, a water brokerage or clearing house mechanism, and informal or formal water marketing, on the other hand, can induce conservation of water while maintaining farmer incomes. The Indonesian case study shows that de facto rationing that occurs under a properly administered water rights regime more effectively induces agricultural water use conservation than do volumetric tariffs, and provides strong incentives for increased efficiency. The Vietnamese case study shows the advantages of a brokerage mechanism, where farmers have the option to buy and/or sell water at fixed prices from a bulk water manager, which helps protect the economic interests of individual irrigation systems. Issues to contemplate during the implementation of a brokerage mechanism include: 1) third-party effects including impacts on the quantity or quality of return flows or reduced economic activity in the water-supplying region, 2) the difficulty of trading water over long distances, 3) the potential for monopoly control over water resources, and 4) the danger of over-exploitation of open-access water resources such as groundwater. Model results for the Maipo basin in Chile show that water trading can allow water to move into higher valued domestic and industrial uses without adversely affecting farm incomes. In fact, net farm incomes can increase substantially if water rights trading is allowed, compared to a case where water rights are fixed. When water rights are traded, declines in agricultural production are small, while the economic efficiency of water use increases. The Mekong case study shows that alternative water sharing mechanisms can help increase water use efficiency as well. In particular, the changes in overall profits under the scenarios for proportional water sharing give an indication that alternative institutions can significantly influence the relative cost/benefit situation in the basin countries and regions. Moreover, to achieve both equitable and optimal benefits from water use across countries and sectors, the optimal strategy would be to strive for the largest basin water use benefits and then to redistribute these benefits instead of the water resource. However, to date, there are few examples of effective compensation mechanisms in a river basin context. Despite the beneficial outcomes for the irrigation sector and the overall basin economies based on the modeling results for these four case studies, economic incentive approaches outside of irrigation service fee payments have seldom been implemented. Such implementation would require a) strong water use rights systems; b) careful fitting of instruments to the particular water use and development situation; and c) pilot testing at a smaller scale before attempting large-scale implementation.

Assessing Benefits and Costs for Sustainable Water Management: The Case of Spain

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The high demand of water resources for irrigation purposes is the cause of significant water quantity and quality problems in Mediterranean countries. The reliance of the Water Framework Directive on water pricing may fail in these countries, since water pricing is quite complex to implement in irrigated agriculture, efficiency of water pricing is questionable, and its political acceptability remains to be seen. This calls for alternative Directive instruments, such as the re-allocation of water from off-stream use by agricultural, urban and industrial users to environmental uses both in aquifers and streams, and also in the coastal wetlands. Pollution control instruments such as ambient quality standards and pollution emission limits are also needed.

The heated policy debate that has been taking place in Spain over ways to solve water scarcity and resource degradation highlights the difficulties involved in achieving sustainable management of water resources, because of the conflicting interests of diverse stakeholders, such as regions, economic sectors and political and environmental groups. Two examples analyzing the benefits and costs of sustainable water management policies are presented. The first evaluates alternatives to overcome water scarcity in Southeastern Spain, and the second ranks abatement measures to control agricultural nonpoint pollution in the Ebro basin, located in Northeastern Spain.

These empirical results question water pricing as an efficient or even feasible instrument to allocate irrigation water or to curb pollution. Government water authorities, environmental NGOs and international organizations, should look carefully at the implications of sound empirical research that takes into account the underlying biophysical processes and the complex spatial, dynamic and social issues involved in the design of water policies. Water and pollution markets, while difficult to implement, appear to be a much more efficient and feasible policy approach than water pricing. Even the current command and control water policies that most countries have in place, seem to be more appropriate for irrigation management than water pricing.

Rational Pricing of Water as an Instrument of Improving Water Use Efficiency in the Agricultural Sector: A Case Study in Gujarat, India

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Keywords: Economic instrument, water use efficiency, equity, pricing, agriculture

Presentation of Topic and Analysis of the Issue:
Agricultural sector in India accounts for over 85 % of the total water used for various purposes in the country. But the water use efficiency in agriculture is very low – about 40 % in the case of surface irrigation and about 60 % in the case of groundwater irrigation. Part of the reason for the low efficiency is the highly subsidised price of irrigation water that encourages excessive application of water to crops and leads to low investment in the maintenance of irrigation infrastructure, resulting in high seepage and conveyance losses. Several on-farm studies have shown that an increase of 20-30 % in water use efficiency is possible if water saving micro irrigation technologies such as drips and sprinklers were used. But under the prevailing flat (fixed) rate system of canal water pricing, farmers do not have any incentives to use the water saving irrigation technologies. So the main issue involved is how to motivate the farmers to use water saving irrigation technologies so as to increase water use efficiency and save water for other more valuable uses. Rationalising the existing water prices seems to be one of the possible alternatives to do that. Theoretically speaking, price as an instrument of public policy changes the attitude and behaviour of consumers and motivates them to act in socially desirable ways. This paper attempts to illustrate the effectiveness of rational pricing of canal irrigation water in improving water use efficiency and equity through a case study.

Discussion of Results / Findings:
The case study was conducted in the command area of an irrigation canal in Central Gujarat, the Mahi Right Bank Canal (MRBC). The command area of the canal is 212,694 hectares (ha). Due to several reasons including adverse political fall out, irrigation charges in the command area, as also in other command areas in the state, were very low relative to the real resource cost of supply as well as the net value added due to irrigation. Besides, the water charges were not revised over the last two decades, 1981-2001, despite the steep increase in the cost of operation and maintenance of the canal system. It was in the year 2002 that the Government of Gujarat (GoG) took a bold decision and increased the water charges substantially, ranging from 200 % to 300 %, depending on the type of crops irrigated. For example, the water charges for paddy (rice) crop were raised from Indian Rupees (INR) 110 per ha to INR 360 per ha, for wheat from INR 110 per ha to INR 240 per ha and for sugarcane from INR 830 per ha to INR 2280 per ha. But as expected, farmers adjusted their crop pattern by diverting land from water-intensive crops such as sugarcane and banana to less water - intensive crops such as wheat. As a result, the demand for water went down, especially in head reach of the canal, and those farmers who had their fields in the tail end of the canal got more water. Thus, the increase in water prices led to more efficient and equitable use of canal water. Another important point worth noting is that the recovery of water charges was not affected adversely due to the increase in water charges. This shows that even at the increased water charges the consumer's (irrigator's) surplus was high enough to motivate the irrigators to continue to use the canal water. On the supply side, the increased water charges covered

only 60-70% of the normal operation and maintenance (O&M) cost of the canal system. This shows that there is justification for further increase in water charges from both demand and supply sides. In fact the GoG has decided to increase water charges further by 25 % very year for sugarcane and paddy, and by 15 % every year for other crops until the water charges fully cover the O&M costs. However, bowing down to the protests from farmers, the GoG has reduced the proposed rate of increase in water charges for sugarcane and paddy from 25 % to 15%.

Conclusions and Recommendations

The failure to price water rationally at its full resource cost in India has encouraged its wastage, and misuse. Rational pricing of water would lead to increased efficiency and equity in the use of water, besides reduction in public expenditure on irrigation subsidies. Experience in Gujarat shows that, despite the fact that raising of water charges is a politically sensitive and hazardous decision, the GoG has gone ahead and increased the water charges substantially for canal irrigation and the irrigators are paying the increased water charges voluntarily. In view of this, what is needed in India is an all-party consensus on the need to price water rationally for all uses and do away with all kinds of direct and hidden subsidies in a phased manner.

Meeting Human and Environmental Water Needs: Groundwater Mitigation Banking in the Deschutes Basin, Oregon, United States.

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Keywords: groundwater, mitigation, banking, instream, restoration

Growing populations in the western United States have led to increased pressure on water resources. Deschutes County, Oregon is one of the fastest growing regions in the United States. As the region has grown, outdoor recreation has surpassed agriculture in economic importance and small-scale hobby farms have replaced large-scale agriculture as the primary water users in the basin. In Oregon, the state allocates the right to use water to individuals. Surface water in Oregon's upper Deschutes Basin has been fully allocated for human uses, primarily irrigation, since the 1940s. As a result, streams in this high desert basin are often severely depleted during the summer irrigation season. Low summer flows reduce the amount and quality of habitat available for threatened and endangered fish populations. To prevent further degradation and to prevent injury to existing water rights, the Deschutes Basin has been closed to new surface water development. New water users in this rapidly developing basin well need to transfer water from existing surface water uses or to acquire new groundwater permits.

A comprehensive study by the United States Geological Survey has demonstrated the connections between surface water and groundwater in the Basin. Groundwater development in the upper Basin has potential impacts on surface water, particularly to the legally protected lower Deschutes River. Oregon's Deschutes Basin Mitigation Program (the Program), developed subsequent to this study, requires new groundwater users in the upper Deschutes Basin to acquire groundwater mitigation credits before using their water. The Deschutes River Conservancy's Groundwater Mitigation Bank (the Bank) has brokered the majority of these mitigation credits and serves as a voluntary, market-based tool for meeting human and environmental water needs in the Deschutes Basin.

Mitigation credits offset the impacts of groundwater development on surface water in the Basin. Existing surface water right holders have developed credits by transferring existing surface water rights to instream uses. Each credit represents 1.8 acre-feet of water, approximating the consumptive water use of 1.0 acre of irrigated agricultural land in the Basin. Groundwater users can acquire permanent credits from surface water right holders who permanently transfer their water right instream, or they can acquire temporary credits on an annual basis from instream leases held by the Deschutes River Conservancy's Groundwater Mitigation Bank (the Bank). These instream leases and transfers protect instream flows in the upper Deschutes Basin during the summer irrigation season, and they mitigate for any decrease in groundwater discharge to the lower Deschutes River.

The majority of new groundwater users acquire temporary credits through the Bank.

In 2005, the third year of the Bank's operation, temporary credits sold for US$70/credit. The purchase price for each allocated credit encompasses the administrative costs of running the Bank, the leasing cost associated with the allocated credit, the leasing cost associated the matching reserve credit, and a small restoration surcharge that supports other instream water acquisitions in the Basin. Permanent credits range from US$4,000 to US$6,000 per acre and are less available for purchase than are temporary credits. Temporary credits offered by the Bank provide a flexible, low-cost alternative to permanent credits.

The Bank has demonstrated its utility as a tool for instream flow restoration. Instream leases funded through the Bank in 2005 protected up to 16.2 cfs instream. The Bank exists within the framework of a larger instream leasing program that protected up to 89 cfs instream annually during the same period. Temporary leases funded by the Bank restored up to 3,448 acre-feet of water to streams in the upper Deschutes Basin 2005.

The Bank provided water for development in the basin while restoring flow to important fish habitat. 21 clients purchased a total of 338.4 temporary credits from the Bank in 2005. These temporary credits mitigated for the consumptive use of 609 acre-feet of water. In contrast, 6 groundwater users held a total of 224.9 permanent credits in 2005. These permanent credits mitigated for the consumptive use of 404.8 acre-feet of water.

Under its state charter, the Bank needs to hold one credit in reserve for every credit that it allocates to a customer. Reserve credits are supported by instream leases but not allocated to any consumptive use. These reserves, combined with other factors related to instream transfers that are specific to Oregon water law, allowed the Bank to restore 5.7 times more water instream than it provided for consumptive use in 2005. New groundwater development in the basin provides water for instream use that that far exceeds the consumptive water uses associated with that development.

Both the Bank and the Program have demonstrated their efficacy at balancing human and environmental needs in the Deschutes Basin. However, some questions remain about long-term impacts on both surface water and groundwater resources. First, new groundwater development in the upper Basin may not affect groundwater discharge in the lower Deschutes River for several years. Second, many instream transfers are based on irrigation water rights and provide instream flows only during the summer irrigation season. In contrast, the new groundwater rights that these transfers mitigate for may be used throughout the year. These questions suggest that Oregon should develop and implement a comprehensive water resources monitoring regime that will allow it to adaptively manage the Groundwater Mitigation Program in the future.

Linking Tariff Structure Changes To Improved Utility Performance: The Case of NWSC

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Keywords: Tariff Structure, Water Utilities, Performance, Efficiency gains, benchmarking

The design and implementation of an efficient equitable and sustainable tariff system remains a high priority and a great challenge for public and privately operated water utilities in developing countries. Typical of many developing countries, the National Water and Sewerage Corporation Tariff was faced with a number of inherent weaknesses that hindered optimal performance of the Corporation. For example, from 1994 to 2002, the NWSC tariff remained unchanged and was therefore eroded over time by factors such as inflation and depreciation of the shilling against the dollar. This erosion impaired the ability of the Corporation to effectively provide water and sewerage services.

This article attempts to show the different tariff changes that were adopted by the NWSC since 1998. Of significance is the fact that improvements in financial health and performance can be achieved without necessarily increasing the tariff level, but by instituting specific tariff changes, which address the inherent weaknesses of the tariff structure. For Uganda, this was possible given the adequacy of the average tariff to cover what was considered (or benchmarked) to be an acceptable efficiency level.

In summary, the tariff reforms undertaken have included

a) The reduction of the connection and reconnection fees,
b) The indexation of the tariff,
c) The re-balancing of the tariff and
d) The introduction of a new connection policy.

The implementation of the above tariff changes have on one hand shown that cost reductions have implicit efficiency gains which can lead to the improved financial health of a company.

With the implementation of the above specific and systematic tariff changes, the NWSC now operates on an improved financial basis. Secondly, and of importance, the presentation shows that although tariff changes and amendments are usually associated with the involvement of the private sector, a purely public enterprise can implement tariff changes given the right environment and Government policy.

Indeed the tariff experiences of the NWSC could be a benchmark for other utilities and there is a lot to learn on how the policies were adopted, implemented and their resultant effects.

Strategies for Improving Performance of Water Resources Schemes – An Experience of Maharashtra State – India

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Keywords: Entitlement, Volumetric supply, Users' participation, Regulatory authority, Water audit

Presentation of topic and analysis of issue: The total surface potential created in Maharashta state (India) is about 3.9 Mha, however utilization of irrigation potential has remained between 42 to 50 percent. Reasons for under utilisation could be attributed to poor system efficiency (25 to 30 % as against design efficiency 40 to 45%), non participation of users and inadequate maintenance of irrigation delivery system. As irrigation alone consumes 75 to 80 % of total water quantum, any saving in its use could result in increased water availability for other sectors or may bring additional area under irrigation. With the pressure of growing population and increasing water scarcity, need for efficient water use is practical necessity. Therefore Government of Maharashtra (GoM) has initiated many path-braking reforms to improve performance in water sector.

GoM has taken policy decision in 2003 to supply irrigation water in bulk on volumetric basis and that too only through Water Users Associations (WUAs). The water is supplied on the demand basis. Water use entitlement is provided to WUA and WUA have freedom of cropping pattern within their entitlement. Conjunctive use of water will be encouraged by providing right to collect water charges on ground water use within their area of operation. Bulk volumetric water supply is encouraged by providing cash back of 20% of paid water charges. This has resulted in increased users' participation in irrigation management and paved way for switching over from inefficient method of supply of water on crop-area basis to bulk volumetric water supply.

Adequate legal support to WUAs is being provided through enacting Maharashtra Management of Irrigation System by Farmers (MMISF) Act 2005. The Act provides enabling provisions for efficient use of water and penalty for misuse or overuse.

Timely and adequate maintenance of irrigation system is vital for efficient operation as well as better service delivery. Many times for want of funds, maintenance is deferred. Therefore, it is necessary that at least O & M expenses shall be met through water charges. To achieve this objective water rates are enhanced by 2 to 2.5 times of those prevailed in 2001, with built in provision of 15% increase in water rates every year (up to year 2004).

Saving of water is as good as creating additional water resources. Therefore, a comprehensive 'water auditing' method is devised for maintaining complete water accounts at scheme level. An independent organisation has been established for water auditing under the control of a Chief Engineer for effective implementation. Simultaneously, 'benchmarking of irrigation schemes' is carried out to evaluate performance of irrigation schemes and to adopt best practices to improve overall performance of irrigation schemes. Report of benchmarking and water auditing is published annually.

The state has taken revolutionary decision to provide water use entitlements to users entity in each sub-sector and regulate it through independent regulatory authority. The state has gone ahead with enactment of Maharashtra Water Resources Regulatory Authority (MWRRA) Act 2005. The MWRRA has been established in August 2005. MWRRA will monitor and regulate water resources within the State, which will facilitate and ensure judicious, equitable and sustainable management, allocation and utilization of water resources. MWRRA will also decide water rates through public hearing for diverse water uses viz. agriculture, industrial drinking and other purposes. It will also ensure preservation of quality of surface and sub-surface water. It will work on the principle of 'Polluters to pay'. It will also lay down criteria for trading of water so as to maximize the efficiency of water use. With legislative support and new arrangements in place, there will be an efficient water management at locally as well as at river basin levels.

Discussion of results - With application of various ranges of incentives and sanctions as well as management tools, State has improved the performance of water resources schemes in both system and financial aspects. In 1999-2000, water use efficiency in irrigation was just 80 ha/Mm3, which is improved to 119 ha/Mm3 in 2004-05. Since last three years, the State is able to carry out O & M of the water resources schemes through water charges collected. Maharashtra is the first State in India to achieve it and maintain it. This is an important step in the directions of sustainable development in irrigation sector.

Conclusions - Demand oriented water supply, bulk water supply on volumetric basis and water-pricing measures have shown remarkable improvement in management of irrigation schemes. Maharashtra's example demonstrates that it is possible to increase water use efficiency and make irrigation schemes self-sustainable through sustained efforts. Reforms like providing water use entitlement as well as effective implementation of 'polluters to pay' principle through MWRRA, will supplement State efforts in making efficient water quantity and quality management. The reforms and actions are more prominent on the backdrop of water sector scenario prevailing in developing countries.

Decoupling the subsidy for water pumping: the Mexican case

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Keywords: aquifers, water pumping, subsidy, distribution , electric energy

One of the biggest environmental problems in Mexico is the non sustainable use of freshwater. As a result of such mismanagement, the stock of both, ground and surface water is being polluted and depleted. Water is wasted in a number of ways, for instance, through leakages in the pipeline system; by the spill of highly polluting substances that inflict enormous casualties in terms of biodiversity; by the misuse that takes place in homes, industry and agriculture.

This presentation deals with the non sustainable use of water in agriculture, a sector that consumes around 80% of the available freshwater. The non sustainable use of water is fostered by the direct subsidy to this resource and from the indirect subsidy to electric power used for pumping groundwater.

The work presented here analyzes the impact of a possible increase in the price of electric power used for agricultural pumping. Data is obtained from a national survey to irrigation farmers, as well as from the national electric provider (Comisión Federal de Electricidad). The approach entails a linear model that controls for type of crop, irrigation technology choice, and other physical variables such as precipitation, temperature, type of soil. We also include roads in kilometers to closest towns and cities, number of users of each well, how overexploited the aquifer is and other variables which were not statistically significant.

The model yields a price elasticity of demand for water of -0.16 (i.e., water demand falls by 16% when price rises 100%). An implication of this result is that if the subsidy to pump water is substituted by an equivalent income transfer to the farmers, groundwater extraction would be reduced by 3,234 millions of liters per year, production may increase, the incentives will promote a slow but steady shift to more efficient irrigation technologies, and towards crops less intensive in the use of water.

Nowadays the distribution of the subsidy is quite uneven: among irrigation farmers, the Gini coefficient is about 0.91 (where 0 denotes equality and 1 means one person receives the whole subsidy). Only 30% of all farmers in Mexico have any type of irrigation system which implies that more than 70% of all campesinos (peasants) receive none from this subsidy which in 2004 was a total of 670 million US dollars.

The main recommendation derived from the study is the need to make a reengineering of the subsidy for pumping groundwater. The subsidy should instead be a direct income transfer. This way, farmers have the incentive to make a rational use of water and electricity while irrigation technology, crops, and the entire production process is not affected by artificial effects that deter resources from more efficient uses.

Derived from this result, we propose several policy alternatives. The first "decoupling" option is to refund to each farmer the average subsidy. This alternative is beneficial for small, possibly poor, farmers while the big farms would loose. We believe that the negotiation of this alternative would be difficult since the most powerful interest groups tend to have greater extensions of land, bigger concessions and higher electricity bills.

The second policy alternative is to refund the subsidy according to the historical consumption. This alternative would continue giving substantial benefits to those who receive a large share of the subsidy and a smaller one to those who have currently a small subsidy. Large producers would not suffer from a reduction in their incomes and the subsidy would be more transparent.

The third alternative is to refund the subsidy only to water concession holders. Many of the irrigation farmers do not have an official concession to use groundwater. This alternative would have the effect of stimulating a more efficient and legal use of water and electricity. It could also generate a market for concessions and therefore, fostering the regularization of groundwater concessions. It would be difficult, however, to have an overall support for this alternative.

A fourth option is to refund the subsidy as a payment per hectare. The subsidy then would depend on the number of cultivated hectares that each farmer holds. Similarly to former alternatives, all users could be benefited or just the ones holding a concession. We would not recommend however to pay according to the type of crop because further distortions could be generated (i.e., it could affect the production choices for the following cycles).

In all the described cases, the subsidy to the use of electricity for water pumping is progressively eliminated. The subsidy should instead be decoupled and target the original policy objectives directly. In other words, it would be more effective to foster productivity and support to the poor through debit cards, micro-credits, coupons, etc. rather than imposing a price control to electricity

WaterAid - The Empty Glass Campaign

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Keywords: WaterAid, Campaign, EUWI, EUWF, Euopean Union

WaterAid's calls for a total reform of the European Union Water Initiative and to scrap the European Unions Water Facility.

The EU Water Initiative (EUWI) was set up in 2002 but to date not a single person has received more water and sanitation because of it. Its aim was to be the "main contribution to the achievement of the Millennium Development Goal for drinking water and sanitation". The objectives of the Initiative were to reinforce political commitment to action; to raise the profile of water and sanitation issues in the context of poverty reduction and sustainable development; to promote better governance arrangements; and to catalyse additional funding. But after endless rounds of meetings in Brussels, London and other European Cities there has been no progress on any of these.

To make matters worse, six months after the EUWI was set up, the EU proposed a Water Facility - a separate €500 million funding pot. Far from providing the necessary funding for the Millennium Development Goals, the EUWF has had a negative effect by distracting hard pressed officials into making bulky applications to the Facility. The vast majority of these applications will never be successful since the sums applied for are 15 times greater than the funds available.

With both these issues in mind WaterAid has launched the Empty Glass campaign to demand change. Using Tearfund and WaterAid's latest research the poster will demonstrate the main problems with the EUWI and suggest changes that will ensure water and toilets for all.

FEASIBLE - A Tool to Improve Environmental Financing

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Keywords: Economic instruments, WSS, Financing strategy, FEASIBLE, Good governance

What is FEASIBLE? How may this model serve as a tool for the preparation of solid environmental financing strategies? What are the lessons learned? These are the questions that this paper aims at answering. In doing so we will draw upon lessons learned in the past 7 years with the preparation of environmental financing strategies, foremost in the EECCA countries. Most of these strategies have been prepared by COWI under the supervision of the EAP Task Force Secretariat at the OECD. They build upon the model FEASIBLE, which has been developed by COWI in cooperation with the EAP Task Force Secretariat at the OECD with financial support from, among others, DANCEE.

The paper will consist of three sections. Section 1 presents the concept of an environmental financing strategy and FEASIBLE. Section 2 provides a case study assessing the results on the use of FEASIBLE for the preparation of an environmental financing strategy within the urban water sector. Section 3 contains an attempt to wrap-up lessons learned, both positive and negative, with regard to FEASIBLE.

Environmental Financing Strategy and FEASIBLE

An environmental financing strategy is a methodological framework for medium- to long-term strategic balancing of environmental and infrastructure service targets with available financing. It is applicable in the environmental sectors that require investment-heavy environmental infrastructure. Thus, the basic idea behind the environmental financing strategy concept is quite simple. There should always be a balance between the money needed to meet the target and the money available to do so.

Environmental financing strategies can be used by transition and developing countries as well as western market economies, including EU Member States and EU Accession Countries:

- To assess total investment needs of alternative policy targets.
- To bring about practical implementation programmes taking into considerations what the economy and households can afford.
- To identify investment projects and build short- to medium-term project pipelines.
- To identify the policies and measures which are necessary to ensure effective financing of the project pipelines.
- To support claims of environment and other ministries responsible for municipal services on the public budget.
- To support transition country requests for donor and IFI financing.
- To measure and report on the progress in the implementation of programmes and policies.

A computerised decision support tool has been developed to support the practical implementation of the methodological framework. The tool, called FEASIBLE, facilitates an iterative process of matching the expenditures required to meet given targets with available finance. The key feature of FEASIBLE is the use of generic cost functions, which allow easy estimation of the costs of alternative service and environmental targets with a limited data collection effort.

Case Study: Armenia; In 2005, an environmental financing strategy was prepared for the water sector in Armenia. Two scenarios were developed:

- Baseline scenario. It anticipates the implementation of the ongoing programme on WSS rehabilitation in Yerevan, and maintaining the service level and condition of infrastructure at the base year level in the other urban areas. If the pre-2003 financial trend continues over the entire 2003-2015 period, the annual cash flow gap would amount to AMD 29 billion. However, a package of policy measures (see below) would gradually bridge the annual cash flow gap.

- Development scenario. Since it seemed possible to bridge the financial gap in the baseline scenario, more ambitious targets have been considered for the rehabilitation and development of the urban sanitation infrastructure. The resulting development scenario was elaborated, following discussions with representatives of the ministries and agencies in Armenia.

FEASIBLE model simulations have shown that, in principle, it is feasible to reach the development scenario targets by 2015. The scenario would require substantial capital investments in WSS in the urban areas under consideration, amounting to a total AMD 176.2 billion over 2002-2015 (AMD 12.6 billion per year). However, the following policy package could fully cover the operation and capital expenditures, amounting to some AMD 689.4 billion (equivalent of USD 1.2 billion) over the 2002-2015 period:

- To improve user charges collection rate up to 94% by 2006 (from some 70% in 2003).
- To increase the water bill for households to the affordability threshold (4% of the average household income) by 2006 and to increase the tariffs for other consumers by 150% by 2007.
- To undertake energy and cost saving measures.
- To allocate public funds and international loans to WSS amounting to 2.2% of public expenditure budget for the 2005-2011 period, then gradually decreasing to 1% by 2016.

This package entails, however, some pitfalls. In particular, maintaining the water bill at the level of 4% of average household income - over 2006-2015, and allocating public funds and international loans amounting to 2.2% of the public expenditure budget in 2005-2011 are challenging targets. These pitfalls are being addressed in Armenia. Much attention is paid to a meter-based tariff system. It is a difficult task. Mainly because all individual policy measures in the package are substitutes, so if there is a problem in utilization of one of them to its full capacity, more ambitious targets could be considered for the other policies.

Lessons Learned: Lessons learned are plenty. Some are positive. FEASIBLE has proven to be a useful tool to force decision makers to set SMART (Specific, Measurable, Attainable, Realistic and Time-bound) targets, even though it necessitates some difficult choices. Others are negative. Most important is that it is still difficult for many users to run the model, which is public available (see www.cowi.com).

Cost-benefit analysis: Economic instrument for establishing benefits and responsibilities in water management based on examples from Argentina

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Keywords: Economic, Instruments, Policy, Cost-benefit, Responsibilites

Cost-benefit analysis (CBA) is a set of techniques that have been used as tools for making decisions (in general about proposed investment or infrastructure projects) as well as, in a general sense, to compare the advantages and disadvantages of alternative policies to be adopted. Increasingly this type of tools and related economic instruments are being used incorporating environmental variables as well as other issues which have not been characteristically part of mainstream market economics.

The presentation proposed will draw upon cost – benefit analysis carried out in Argentina following different environment related policies. The presentation will acquaint with general principles for this instrument, in particular as applied and applicable to developing countries' situations, data availability and circumstances in water and water-related management issues in these nations. The presentation will follow general notions of cost-benefit analysis as applicable to environmental water related issues and will touch upon general issues as directly relevant to the subjects being discussed (such as, economic instruments in general, international – local interactions, and benefits and responsibilities of water-related policies).

The exercise and research carried out (and put forth here for presentation) for determining cost benefit analysis for water – related issues have fallen under two basic scenarios:

i. the factual scenario which implies the identification and quantification of actual benefits and costs of the recent policies and evolution of the sector; and,
ii. the 'optimum-policies' scenario which would identify and quantify the costs and benefits of a sustainable policies.

The comparison of the net benefits of both scenarios shows the costs of adopting the wrong policies for control and management. As a minimum, for the studies carried out, this sort of analysis indicates that policies which incorporate not only the benefits but also the environmental costs (albeit in the long – term) are more sustainable and more equitable in the long run

The identification of costs and benefits

Once a given impact in the society is classified as a cost or a benefit, a basic question is implicitly posed, i.e. for whom? Actually, from an economic point of view, CBA is undertaken assuming that there is a social function of utility which is affected positively (i.e. benefits) and/or negatively (i.e. costs) according to the different identified impacts of a given project and/or policy. In the case studied, the 'society' could be defined as the Argentine economy, but this definition could conceivably be expanded to more broad definitions of 'society', given the fact that many natural resources do not have finite explanations regarding ownership and ownership rights.

In fact, it is possible to find that some benefits for a given country are, in fact, costs for another nation or even the whole world. In addition, the estimate of benefits and costs is usually done as aggregate economic flows while there is still the question of the different social and economic groups that are differently affected by benefits and costs. For example, for businesses, the salaries are costs but for the workers, the salaries are benefits. In areas of conflicting use of water resources, what is beneficial for an industry (for example), is detrimental to another user(s). These sorts of considerations are generally the new incorporations analyzed in novel cost – benefit analyses. In this exercise, a matrix of beneficiaries is estimated in order to show the most relevant impacts on the different categories of economic agents and social groups.

Conclusions

From the point of view of classical cost benefit analysis, the main benefits are supposed to be the net increases in value added for the economy. However, new tendencies in this sort of analysis tend to incorporate other issues, such as environmental damage costs in the long run. Another point which is further explored, and also different from classical cost – benefit exercises, is the issue of who benefits and who "pays" for environmental and water related policies.

In conclusion, the adoption of a consistent and strong environmentally - oriented water management policy would tend to have net economic benefits for the economy as a whole as well as for societies. Nevertheless, for this to happen inter sectional society considerations as well as time factors need to be incorporated in cost benefit analysis that do also incorporate environmental variables.

Bibliography:

Villalobos, Ruy de., "Notes on the valuation of renewable natural resources", manuscript, 1999.

UNEP/CEDEA, "Integrated Assessment of Trade Liberalization and Trade-Related Policies: A Country Study on the Fisheries Sector in Argentina "UN Publications, New York and Geneva, 2002.

Event-driven indexed drought insurance instruments for poor farmers

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Keywords: water productivity, insurance, drought , risk, Nicaragua

Agricultural water productivity must increase to meet future global demands more food while satisfying competing demands from non-agricultural users. From the observations of Rockstrom (2003) and others, substantial improvement of so-called 'green' water productivity of rainfed crops is achievable in sub-humid to semi-arid areas, if farmers could correct nutrient deficiencies while managing climatic uncertainty. This uncertainty presents a major constraint to improvement because farmers with minimal resources cannot risk investments in fertilizer and other factors that may be necessary to raise crop yield.

Drought insurance is a financial instrument that can support sound decisions under climatic uncertainty. Reliable insurance policies, which can indemnify farmers through periods of financial stress, puts them in a better position to take reasonable risks, such as applying fertilizer, using new seed or developing water management infrastructure. In the long-term, sound investments such as these increase productivity and enable farmers to accumulate financial and biological to lead them out of poverty. Repeated evidence exists to show that, without such investment, farmers face a downward spiral of declining value of production and deepening poverty. A potential implementation pathway is to use insurance to enable micro finance institutes (MFIs) to lend to farmers who might otherwise be considered too risky.

This paper describes the development and application of insurance products to enable poor farmers in drought prone regions to improve profitability and water productivity.

Potential for an insurance products in developing countries

Insurance has been used for centuries in Europe. Insurance works by 'packaging' the best available science and economics in a single number – the insurance premium – that can be communicated easily to those who face the risk and to insurers who can help protect against it. Farmers in developing countries lack access to such instruments and this places them at a considerable disadvantage. Some early insurance schemes have been tried and, while these drew strong interest from farmers themselves, most have failed because of serious administrative and technical inadequacies. Government-run insurance schemes are often unsound for these reasons. In almost all cases insurance has failed not because of the principle but because of its poor implementation, in schemes which are costly or badly designed. Most, if not all of these pitfalls can be avoided through index-based rainfall insurance scheme, based on sound scientific methods, to provide a cost-effective but accurate level of insurance to potential risk-takers.

How to develop a robust insurance scheme for developing countries

The basic requirements of an effective insurance scheme are:

1. The scheme must be secure yet cheap to administer.

2. The premiums must correspond accurately to indemnity payments to avoid problems of moral hazard and adverse selection.

Weather index-based insurance schemes can help meet these conditions. A limited number of weather index-based crop insurance schemes have already been trialed around the world (e.g. Canada, India, Mexico and Argentina). Most rely on good historical data that is likely to be very rare or unavailable for many (if not most) places in the developing world. We demonstrate a complementary method that can develop site-specific rainfall-indices for regions where little or no data are available, by using statistical models to generate daily rainfall data, and by coupling these to crop simulation models to relate rainfall and crop yield. Results below show the outline of a robust methodology as applied in Nicaragua.

To be robust, the drought insurance product must minimize basis risk for all locations, and should minimize the information asymmetry between the insurer and insured. Our methods develop a rainfall index that maximizes the correlations between crop loss and the rainfall index. As demonstrated in the case study, premiums must be specific to a given site and, if possible, soil since these variables influence crop loss significantly.

Case Study. Drybeans in Central America

Drought is a common problem for farmers in Central America. Farmers in the region are caught in a downward spiral of declining yields and soil fertility. Farmers understood the value of insurance and local insurers desired a low-cost drought insurance method to satisfy demand. The staple crop in the area is drybeans. Extensive crop yield data does not exist for the area. Even where it is available, it is suspected of being unrepresentative of the condition being insured. It is also known that climate varies significantly over relatively short distances within the area, so even where climate data existed, it seemed unfit to provide comprehensive coverage at the detail required. With the back-up of locally-experienced agronomists, we deployed MARKSIM (Jones and Thornton, 2000) to generate 100-year climate data-sets for each 18 x 18 km grid cell. These data were coupled to the DSSAT crop simulation model (Hoogenboom et al., 2004) to provide for each grid-cell a comprehensive data-set of daily climate and bean yield for different soil types and principal crop varieties, on sloping and flat land.

This data-set was analyzed to generate weather indices that correlated best with crop loss, from which premiums could be estimated for specific locations and conditions. Perhaps the most striking feature is the variation of risk for different soils and locations, reflecting the degree of information asymmetry which remains if spatial variation and specific agronomic effects are not included. Acceptability and transparency were validated through workshops in the area with MFIs and farmer groups. Discussions are on-going to take these methods further into the domain of local insurers and to expand methods to include a broader range of specific crop types.

Poverty Reduction through Attitudinal Change

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A case study of an irrigation group facilitated by the Agriculture Support Programme – ASP in Zambia.

Since time immemorial farmers in Zambia have relayed on rain-fed agriculture. Almost all agricultural activities are concentrated in the 5 months when the rains fall. The remaining seven months are rarely utilized for productive work but instead regarded as a time for leisure. This is one of several inherent attitudes which are important factors consigning the majority of the rural population at subsistence level and seemingly unable to come out of the poverty trap. This situation has been further worsened by a rapidly increasing population, unsustainable utilization of the natural resource base as well as the entrenchment of the dependency syndrome. Farmers have been able to improve their livelihoods during years of good rains but eventual gains have been pulled back during the frequent bad years. The threat of negative consequences of global warming has made rain-fed farming even more vulnerable.

Zambia has an enormous potential of untapped water resources, in fact the largest in Southern Africa. To productively use this resource, requires a drastic change in attitudes and mindset among farmers to perceive and appreciate water as a valuable and productive resource rather than a free good with little value. Three main water sources are exploited by small scale farmers namely: streams, shallow wells and dambos (wetlands). Generally methods for abstracting/uplifting the water are not sustainable and commensurate with the benefits accrued there from. Though improved small scale irrigation techniques/technologies are available, there use is rather limited due to a number of factors including limited availability of the technologies on the market, cost and inadequate extension coverage (knowledge).

The Agriculture Support Programme - ASP is actively working with 44,000 targeted farmers in 4 provinces of Zambia, aiming at improving household food security and increased incomes among the target group. The programme core thrust is to commercialise agriculture from subsistence levels to viable entrepreneurs. The ASP interacts with targeted farmers over a three year period through a methodological approach,-"the facilitation cycle". Using the facilitation cycle farmers are facilitated to identify local opportunities which could translate into viable agricultural enterprises. Through the facilitation process, a consciousness creation and evaluation process is initiated which ultimately translates into an action plan outlining activities to be implemented or necessary to be undertaken by the farmer(s) and other service providers (collaborators, support entities and ASP) in order to exploit the identified opportunity/enterprise. Critical to the action plan is setting of the vision which will focus the farmers' development process out of poverty .The implementation of the action plan is supported by the program in various ways according to identified needs.

The Chankalamo Savings and Irrigation Group is a commodity interest group among the more than 2600 interest groups closely working with the ASP. The group comprising 20 members (10 FHH 10MHH) has successfully tapped the potential of a small stream for commercial production of irrigated vegetables. Through the production and sale pf assorted vegetables each member household is able to generate on average US$ 200 per week. Besides the direct benefits to each household from increased income the group has significantly contributed to improving money circulation in the local economy. The group is now a model of management practices and hosts several exposure visits from other ASP facilitated interest groups which has translated into adoption of improved irrigation and management practices and increased production. Other farmer groups in the area are also benefiting from the Chankalamo group marketing linkages.

This poster will show how focus on attitudinal change can make farmers appreciate the benefits of using improved irrigation practices. This in turn makes them improve their livelihood and become more willing to take responsibility for their own development process as well as the conservation of the water resource. While the poster will focus be the evolution, present status and anticipated future of the Chankalamo group it will also provide an overview of the ASP facilitation process and experiences.

Workshop 4:

Benefits and Responsibilities of Decentralised and Centralised Approaches for Management of Water and Wastewater

Livable Pra-sae River; 5 Strategic Actions to Enhance Benefits in Water and Wastewater management

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Keywords: Partnership, networking, conservation,, income generation , local government

Eastern territory of Thailand consist of 4 provinces: Chanthaburi, Chonburi, Trat and Rayong. This part of the country plays an important role in Thai economy as it is a resource rich region with many rivers start from moutains in Thai-Combodian border and run through fertile plain land. Prasae River is one interesting eco-system that flows through Klaeng District and at end it drainsout to the Gulf of Thailand at Klaeng Municipality. It is a 36km-long river having a catchment area of about 2,100 km2. Klong Prasae and Klong Phao are the major tributaries of the river.

Prasae River has a long history. It was the primary mode of transportation by water in the region and a food source for people. However, since year 1874, the importance of the river has changed due to the development of road network, moreover, waste water was discharged into the river. It was left out nearly 30years as a polluted river.

According to the Kingdom of Thailand's Constitution of 1997, people's participation is promoted both at local and national level, in the governance under a democratic system. Under the new constitutional power all local government organizations enjoy autonomy in laying down policies and bylaws for their governance, development, personnel and area administration and finance. With the new status, municipalities have called for more active participation from the public in administering their townships.

Moreover, Section 30 of the Decentralization Act lays down definition, plans, process and 18 general principles of decentralization with 6 categories of missions to be completed within 4 years (2001-2004) and no later than 2010. Mission-5 is the management, administration and conservation of natural resources and the environment.

The Mayor of Kleang Municipality elected by the local people since 2001 has been working closely with Thailand Environment Institute for many years on various projects mostly related to mission-5 of the Decentralized Act. He has announced the energy and environment policy of Kleang Municipality under which it was indicated to conserve and rehabilitate Prasae River in order to bring its original life back. Project implementation has been strategized by 5 action components:

Strategic Action I : Promote partnerships and participation.

- Establish River Prasae Conservation Group consist of all stakeholders in the city
- Set up many meetings among members of the group to discuss problems and how to solve them as well as add the activities into municipality's 3 year development plan to provide budget.

Strategy Action II: Use media and develop various activities to raise awareness of the local people.

- Produce pamphlet called "Rak Nam Prasae" (We love Prasae River) and distribute to people every month.
- Establish a community radio channel to give information to the people
- Set up activities for each stakeholder group to educate and raise awareness on river and water:
  - youth camp and river spy campaign for youth group,
  - boat trip to investigate the problem along the river for community and private sector,
  - training, mangrove trees planting campaign for community .
- Revive previous customs and traditions related to the river to make the people aware about benefits of water in the river.

Strategy Action III: Promote income generation activities along with river conservation

- Promote eco-tourism program in Pra-sae River ; boat trip, fire flies watching, home stay
- Give the permission to some fishermen for floating basket for keeping live fish in water and enable them to play the role of River Watchers.
- Promote grease trap among restaurants as primary water treatment. Collected grease from the trap is sold (150 Baht per 20 litres) as the raw material of animal food and soap.
- Promote waste separation in schools: municipality gives 1 Baht per 1kg of separated waste back to school.

Strategic Action IV: Apply appropriate technologies to address water pollution issue and for water quality monitoring

- Promote grease traps in restaurants and households as primary treatment method of waste water instead of investment for mega water treatment facility
- Use liquid Effective Micro-organisms (EM) produced from organic waste to reduce odor and treat wastewater before discharge into the river.
- School children are mobilized to apply biological testing methods to identify organisms, plants and insects under "River Spy Campaign" to monitor the water quality along the river

Strategic Action V: Establish networking among local authorities and private sector

- Join and share with other local authorities which are located along Prasae River to for a network for river conservation
- Collaborate with private sector business companies and factories in the area to carry out environmental activities together

During the last four years the condition of Prasae River has improved tremendously. It has again become a major mode of transportation in the region. Quality of water has improved to the acceptable level. More and more organisms, plants and insect are growing in the river water. People have established their livelihoods based on the river. River is again a source of income for people from fishing, transportation and eco-tourism. Political leadership of the municipality has brought all stakeholders together to make Prasae River a livable place for Klaeng people. In addition, this river nowadays becomes the identity of Klaeng City as well.

When Communication Counts – Sharing Tasks and Changing Roles in Dondo, Mozambique

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Keywords: Decentralization, Democratization, Networking, Communication, Coverage

Introduction

Dondo Municipality is located 30 kilometers West of Beira, along the Beira corridor in Mozambique's Sofala province. Its population in 2005 was estimated at just more than 90,000 inhabitants. An urban elite lives in the centre and have access to communal basic services while 70 percent of the population lives in peri-urban areas with no or limited access to basic services such as health care, education, electricity, water supply and sanitation.

Dondo has been one of the most successful municipalities in Mozambique since the first municipal elections took place in June 1998, six years after the civil war ended. Improvements in water supply services are one of the factors that have contributed to its successful development.

Records show that in 1998 only 6 out of 54 existing water sources were operational and the majority of the peri-urban population was then served by unprotected wells. Many hand pumps had broken down and there were no funds to repair them. Most of the water sources[1] were constructed during the civil war to serve the refugees and were constructed within a supply-side context without giving due consideration to the demand first.

By February 2006, 54 percent of the population had adequate water supply and 94 hand pumps were serving the peri-urban areas[2]. The breakdown rate is currently around two percent while repairs are done within 24 hours after the breakdown is reported.

Actions taken

In 1999 the 'Program for Rural Water Supply and Sanitation in Sofala' (PAARSS), which is funded by the Austrian Development Cooperation and the 'Provincial Directorate of Public Works and Housing of Sofala' (DPOPHS) entered into a partnership with the municipality to support its water and sanitation sector. Together these organizations identified the following necessary actions:

- Implement the National Water Policy (NWP 1995)
- Design and put in practice a multi-level communication strategy to create a common understanding of the NWP among the private sector, government, communities, CBOs, and NGOs operating within the municipality.

[1] By water source we mean a protected well or a borehole equipped with a hand pump.
[2] The national standards define adequate coverage as a water source serving 500 people in a maximum distance of 500 meters from each household.

- Stop the political demands so as to focus on community needs..
- Launch of a municipal enterprise to provide water and sanitation services peri-urban communities.
- Enable civil servants to manage water supply and demand.
- Train local activists to oversee pump management, maintenance and hygiene.
- Support the establishment of Water Users Committees and water sources caretakers.
- Support the implementation of viable mechanisms of water tariff collection to meet operation and maintenance needs.

Results

Today, water supply and sanitation coverage in Dondo is more than 60 percent while the average coverage for Mozambican cities is 36 percent. The growing population in the peri-urban areas is served by 84 out of 86 hand pumps. As a result, the municipality has not been severely affected by cholera outbreaks since 1999.

Local communities have formed Water User Committees and all families, with the exception of the poorest, contribute 5,000 Mts (twenty US$ cents) for access to potable water from hand pumps or communal sites. When a pump breaks down, the committees buy spare parts and local technical expertise is sought if needed and in less than 24 hours it's repaired. The main task for politicians and technical staff in Dondo now is to plan, coordinate and mobilize funds for the network's expansion instead of looking for funds to repair the pumps.

Conclusions

- Water services are provided in a sustainable manner, within the framework of the NWP.
- Following the implementation of a demand driven water policy, the municipality is also supporting communities in local planning, and decision-making. This policy is one way of introducing participatory community planning and grassroots level democratisation.
- By maintaining technical expertise for the water and sanitation sector, the municipality can provide residents with a safe and healthy environment thus guaranteeing sustainable access to potable water at an affordable price.
- Due to the better coverage, Dondo municipality now has the capacity to promote social and economic development.
- Water and sanitation coverage has been increased in Dondo thus bringing benefits to water consumers and increasing coverage to other areas.
- Local residents are now able to manage the infrastructure leaving the municipality to concentrate on the network's expansion.
- Though cholera outbreaks continue to be reported in neighbouring districts, Dondo municipality has managed to prevent outbreaks by communicating with consumers through a network of water users committees.

Recommendations

- Dondo experience should be spread to other parts of Mozambique, making use of community radios and Television;
- The National government should give more support to Dondo authority on its efforts of building capacity for sustained water and sanitation services provision and bring this experience to scale.

WATER IMPROVE: Building responsible citizenship in metropolitan Caracas

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Keywords: water, citizenship, periurban inferface, metropolitan areas, Venezuela

Water and Sanitation System:The catchment area includes two basins, the basin of the rivers Tuy and Guárico. The CMR is located in the basin of the river Tuy and represents about 50% of the water of the metropolitan aqueduct. All the water intakes are in the PUI-Tuy. One of the main problems is that they are at 200 meters above sea level and the water must be pumped up to 1.500 m.a.s.l. The metropolitan WSS is public, it is made up of six subsystems and is technically and functionally very complex.

The problems of the WSS range from technical, economic, and environmental to social: lack of frequency in the supply, low billing and high unaccounted for water, low quality of water, lack of disposition of served waters, and socially differentiated coverage.

In the poor communities the service is still in large part informal or illegal. Some are supplied by cistern trucks that are both formal and informal and other types of supply include water that is given or sold by neighbors. Existing networks were constructed by parts without taking technical criteria into account. At the beginning of 2000, 60% of the network of the aqueduct of the Caracas Metropolitan Region was informal and there were no plans of it.

The new regulatory framework: The new reality of the WSS is directly related with the new regulatory framework.Two postulates of the new Constitution of 1999 have a close relationship with the WSS:The definition of water as a “good of the public domain” which implies that it CANNOT be privatizad, and The principles of participatory and active democracy that stimulates community participation.

Putting the news principles in practice has given rise to important changes in the WSS that can be summed up in two large projects:Expansion of the service with greater equity and Incorporation of community participation in the management of the service

Within these proccesses the new vision of the company (service with social equity), the new organizational culture that includes the creation of the Department of Community Affairs and a new relationship between engineers and technicians with the population of the communities where technical and popular knowledge are shared to improve the service and quality of life of these communities stand out.

Community organization and technical water boards
Water is an individual problem of households since it affects daily life, family expenses and health and the environment. Daily life is organized around water with a more intensive impact on women than on men. Nevertheless, water is above all a collective problem and the solution of the problems of water takes a fundamentally collective form through community

organizations called Water Forum where the participation of the woman is fundamental and of a majority nature.

Water Forms are a type of community organization based on the principle of joint responsibility between Community and State that leads to improving the quality of life of the poor sectors and the construction of citizenry.

In the whole country more there are more than 2200 and in the VTMs close to 150 are active. Among their principal functions are community diagnosis (cadastre, census and WSS plan), preparation of projects, supervision and control thereof and an educational function regarding water. That is, it is not a type of instrumental participation but an effective participation in the design of policies and management of the service

- The positive aspects of this new form of community participation can be summed up in five large points:
- Expansion of the service and improvement of the frequency of supply to the poor sectors.
- Strengthening of the community fabric.
- Building social citizenry.
- Building a new institutionalism (new network of Community-State relationships).
- Building a new culture of water.

The limitations in the Institutions are the persistence of bureaucratic and patronage features and in the Communities the persistence of the culture of urgency, individualism, patronage and traditional leaderships.

Achievements

The principal contribution of the Caracas case study is concentrated on the contributions of community participation in the management of the systems of water and hygiene and in the importance of a regulatory framework with the decisive participation of the State, that is, a participative governance of water.

In this process, it has been possible to:

-Initiate the transit from a culture of needs to another of rights and obligations, where the community not only demands the right to a service, but also assumes concrete responsibilities in the management of the systems in the maintenance of the networks, the payment of the service, the care of the use of the water and, in synthesis, the creation of a culture of water that makes the systems sustainable.

-Improve access to the WSS that has allowed achieving the Goals of the Millennium in reducing by one-half the persons without access to water 10 years ahead of time according to what the government has said as endorsed by the PNUD.

These achievements must be connected closely not only with community participation and the commitment of the public hydrological companies but also with the great availability of financial resources from petroleum income that are being directly used in improving the quality of life of the poorest. As an example of this, it is observed that currently there are U$60,000,000 for 400 water and hygiene projects (an average of U$150,000) that were prepared by these communities in an exercise of direct and participative democracy.

A Discussion on Water Planning and Policy Related to Rural Water Supply in China

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Keywords: planning and policy, rural water supply, water management, countermeasure, sustainable development

The paper presents an overview of the current situation of rural water supply in China and provides a brief of discussion on water planning and policy in relation to water management, countermeasures and future challenges in practice.

According to official figures, China has 73 percent of its population living in rural areas. Water supply is a critical factor in Chinese economic growth. The development of appropriate tools for assessment of the effectiveness of water provision is essential for water management for rural water supply. The Chinese government has paid high attention to rural water supply in terms of operation at different levels (central, provincial, regional and city and local). It can be seen that China has adopted different techniques of rural water management in terms of different periods. These include three stages. (1) China's water policy and planning supported the application of decentralised water management for rural water supply from 1949 to 1980 to encourage agricultural development and improve rural sanitary conditions and the quality of drinking water. (2) From the 1980s to 2000 China made great efforts to formulate water standards and planning and policy for rural water management in order to promote implementation and development of integrated management for rural water supply, in relation to the Ninth Five Year National Plan to increase investment, create water projects and programmes, provide technology and co-operate with global organizations for improvement of drinking water supply. (3) The current policy is to provide safe access to drinking water in rural areas and the implementation of sustainable development of water supply to meet the challenges of rural water conditions and global concerns of the Millennium Development Goals 2005 (UN, 2005) as a whole to involve technology, sanitary standards, infrastructure and sustainable development of water supply.

The paper is intended to identify effective integrated management of water resources by environmental institutions to tackle water planning in terms of relations between central and local level and how to combine this with environmental tools and policy for rural water supply. It also explores environmental tools for dealing with the improvement of implementation of water planning in practice and how to improve water institutions for rural water supply.

The issues that the paper considers are the situation of rural water supply in relation to water planning, policy and water management systems at local level in the different periods to analyse how they can connect with the planning and policy of today's China and also evaluate the advantages and disadvantages of the three stages, and reflect on what should be improved in water management in rural China.

The paper answers the research question regarding what roles the considerations of the government and the public play in rural water supply in relation to the functions of water policy and planning, and how to deliver water planning and policy for water management systems and theirs implementation at local level.

The development and application of the research has involved collection and evaluation of relevant and original information based on government documents related to water policy and planning, and case studies undertaken in rural China. The study provides concrete examples of planning related to drinking water supply.

Discussion of outcomes: safety of drinking water supply in rural areas of China has been influenced by several factors: un-suitable water planning and policy between regions; overlapping local departments of water authorities, installation of water constructions; unsustainable funding provided by government; diversification of local government management leading to lack of integration and dis-organization; lack of techniques and awareness of sanitary operation in practice of rural water supply.

The paper suggests that the way of improvement of water resources management should be for central government to devolve powers to regional or sub-regional level which would then have more effective access to and control of implementation by local agencies and be more representative of all stakeholders. It may be suggested that water supply and control could be privatised at the sub-regional level to increase the perceived value of this public resource while overall control and co-ordination remains with central government in the public interest.

Management of Wastewater and Storm Water Drainage Systems in Kolkata – Problems and Recent Measures Taken

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Keywords: Drainage in Kolkata, Earlier Works, Problems, Environmental Management Plan, Recent Measures Taken

Situated between the tidal river Ganges (Hugli) on the west, the overflowing swamps on the east, and having tidal creeks surrounding, Kolkata suffered chronically from drainage congestion and water logging, especially during monsoon period with large run-off. Grown during the last three centuries, the municipal boundary of the city presently contains 141 wards of a total area of 185 sq km. Forty one wards have been added to the city proper (with 100 wards) during the last twenty years only on the face of tremendous population increment and unprecedented urbanization.

The city proper has a combined sewer disposal system laid in west to east direction as per natural slope of the basin, and the drainage is disposed through channels and canals to eastern fringe area for natural sewage treatment through ecologically balanced wetland management system, and then to Bay of Bengal through the river Kulti. Rest of the quantity were drained and deposited directly to river Ganges and the canals connected to the river adding environmental pollution.

The added (fringe) areas of the city do not have any centralized sewer collection system provided by the municipality. Sewage management has been done by septic tank in each plot (house), surface drain, conduits laid underground for depositing to the local ponds and canals of the fringe areas resulting in pollution, mosquito and health hazards.

Tremendous rate of urbanization reclaiming land from agricultural land, rural areas, open spaces, water bodies, wetland areas, and constructing high rise buildings demolishing old smaller buildings has produced huge sewerage load for management, surface run-off and lack of water recharge to the underground water table. The local drainage congestion and inundation of areas at various parts of the city also contaminate sources of water (ponds, wells and tube wells) along with producing structural, physical and environmental damages. Practice of extraction of huge amount of water from underground by tube wells in large housing complexes and buildings and by the municipality resulted in depletion and lowering of underground water table, arsenic contamination and great health problem in vast areas of the city.

Works were done during 1950s and 1960s following recommendations of the World Health Organization by the State and Central Governments. Later, the works under the Ganges Action Plan with an objective of purifying water of river Ganges were done through a decade, though the results were not satisfactory. Meanwhile population and urbanization in the mega city has increased manifold and drainage management could not cope up with the demand.

Recently, the great awareness campaign and demand for protection of environment from pollution and degradation by a large section of people, media, NGOs and some government organizations helped taking some measures for safeguarding. The State government and the Kolkata Municipal Corporation have come forward with certain guidelines with regard to wastewater and storm water drainage of large housing and other projects at the fringe areas where central collection system is absent or not adequate enough as well as at the core city area. According to the new directive, the whole wastewater of a housing complex, other buildings or a factory has to be collected and treated in-house and the treated water is to be drained to the municipal sewer main where it exists or to the nearby canal or soak pit within the premise (in extreme cases). The storm water is to be drained separately to a collection chamber (in-house) from which the accumulated rainwater is recharged into the ground. Hence, rainwater harvesting and treatment of wastewater have become part of the architectural and construction management business, not only providing better environment and sustainability, but also economic generation to such consultants, labourers and other people. New directive by municipality for providing open spaces with green cover and tree plantation in all large plots schemed for housing and other development has been enforced. Rules regarding conservation and retention of water bodies have been framed and enforced with proper vigilance in the city area by the municipality. Solid waste management, wetland recovery, banning digging tube well in houses, increase of supply of purified water from Ganges, new measures for supply of arsenic-free water to people of affected areas, etc., are some positive integrated actions taken for better living and improvement of environment.

The students of architecture, civil engineering, environmental planning, etc. are to be taught the new measures and taken to the best practice sites for a practical, modern, holistic and integrated understanding. The young students are the users, decision makers and practitioners of tomorrow’s world. Proper emphasis is to be given on education, training, research for new measures and possibilities, capacity building and participatory programmes of stakeholders and public for broaden awareness, cooperation and appropriate practical activity in the management of environment towards sustainability.

Implementation of Decentralised Water and Wastewater Management in South Africa: Progress and Problems

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Keywords: decentralised management, catchment management, capacity building, training, implementation

South Africa is a relatively dry country with an annual average rainfall of 450 mm per year, which is well below the world average of 800 mm. In addition the rainfall is highly variable in the inland areas and occurs mostly in the form of thunderstorms during summer. The long river systems receive little runoff during the dry winter months, which means that a large fraction of base flow in winter derives from return purified effluent flows. The effect of this is that indirect reuse of water occurs generally in South Africa and that surface sources are subject to pollution and large variations in quality with a long-term trend of quality deterioration.

The management and control of water sources under the apartheid regime of South Africa was highly centralised and the Department of Water Affairs and Forestry had full responsibility for development and allocation of water resources and for pollution control. On the other hand, service provision was decentralised with local authorities having the responsibility for water supply and wastewater purification. This meant that service provision was at a high level in areas served by the well-established local authorities (mainly white areas). However, service provision in most rural areas and the rapidly developing informal settlements was very poor or non-existent.

The National Water Act promulgated in 1998 under the new democratic government set in motion a complete change of the highly centralised system in order to devolve management responsibility to the catchment level. The purpose of this act is to ensure inter alia, that the country's water resources are protected, used, developed, conserved, managed and controlled to meet basic human needs of present and future generations, to promote equitable access to water and to redress results of past racial and gender discrimination.

One of the key aspects of this process is the establishment of new water management institutions that will allow water users and interest groups to participate in the management of their water resources. The act aims to achieve these objectives through a variety of measures, including the establishment of Catchment Management Agencies (CMAs) that will have the responsibility for water and wastewater management at catchment level in so-called Water Management Areas (WMAs). South Africa is divided into 19 Water Management Areas and the long-term objective is that CMA's are to be established for each WMA.

One of the tools in the process of decentralising water management is through the development of a National Water Resource Strategy (NWRS). The first edition of the NWRS was published at the end of 2004 with the central objective to ensure that water resources are managed in such a manner that it supports equitable and sustainable social and economic transformation and development.

A vital element of the NWRS is the progressive decentralisation of the responsibility and authority for water resources management to CMAs and water user associations. These institutions, representative of water users and other stakeholders will facilitate effective participation in the management of water resources in their areas. It will also enable the Department to delegate its present roles as regulator, developer and operator to the CMA level and to focus on its role as policy maker, regulator and monitor.

The National Water Act makes provision that a CMA can be established on the initiative of the Minister of Water Affairs and Forestry or as a result of a proposal submitted by stakeholders in a WMA wishing to establish a CMA for the WMA (and approved by the Minister). However, the Department is taking the lead in establishing CMA,s for the 19 WMA's and is providing the majority of funding and expertise for this purpose. Funding from a number of donor organisations is also used for this purpose. The process of establishing a WMA on initiative of the Minister does, however, not mean that this is a 'top-down' process. A submission by stakeholders that is prepared through a proper process of public participation is still required for the process to proceed. Public participation in this process is very important since it determines the legitimacy of the institution that will be formed and builds a foundation for the institution to promote public involvement in water resource management. At this stage a total of 8 CMAs are in the process of being established.

Significant progress has been made in the process of decentralising water and wastewater management through the publication of the National Water Resources Strategy and in the steps taken to establish CMAs in some of the WMAs. However, many and significant problems remain to be solved before effective decentralised management will be a reality. The most significant of these is the lack of suitably trained staff to assume management and technical responsibilities. These problems can to some extent be alleviated through the transfer of staff from the Department to CMAs. The most severe problems being experienced at present are however, not on the senior management and technical levels, but at the level of service provision by municipalities and local and regional authorities. These service providers are to play an important role in decentralised management. There is a severe lack of skills at this level as is evidenced by numerous pollution incidents and occurrence of water-borne diseases in many areas. The solution to these problems requires training and capacity building over a wide spectrum to ensure that technical and management skills are available at the level where management, control and service provision has to take place.

Responsibility in processes. Stakeholders mobilize for IWRM in Northern Uplands, Vietnam

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Keywords: IWRM, stakeholder participatory, responsibility, informed decision-making, decentralisation

This study is based on the Second Red River Basin Sector Project. Its Phases 1 and 2 have concerned IWRM in Red River Basin, northern Vietnam and involved cross-cutting issues of institutional capacity building, public awareness, poverty alleviation, gender and stakeholder participation. This current study is on that part concerning poverty reduction through IWRM in the northern Uplands. It provides a success story with stakeholders at provincial levels taking the responsibility to support a decentralized process in the water sector towards poverty reduction. The accounted case concerns the use of small sub-basins in two districts in two targeted provinces as the basic planning and management units in IWRM and poverty. It describes the stakeholder process and its achievements in terms of shifting responsibility for project formulation and implementation towards the water users. The study also concludes on what needs to be done in order to enhance sustainable decentralization.

The stakeholder involvement is highlighted in the study with two stakeholder processes combined; province levels upwards initially and then province level downwards into local community involvement. Firstly, stakeholders have identified problems and solutions at province, sub-basin and national levels through a series of consensus building workshops. Secondly stakeholders have been deeply involved in a process of water sector planning in the priority four water sub-sectors from the first stakeholder process at small sub-basin level (irrigation & drainage, water supply & sanitation, flood control, and environment & pollution).

A process of water sector planning has been developed and implemented through interaction between three main streams of stakeholder involvement, aiming at informed decision-making. These are the (1) local authorities and (2) stakeholders at province, district and commune/village levels being the decision-makers and utilizing (3) technical experts providing specialized assessments. The final decision-makers, formed by (1) and (2), have succeeded in combining these three perspectives on water resource management, thus taking responsibility for an IWRM that targets poverty reduction. The three steps are as follows.

I. Local Authorities. The decision making process has been carried out step by step together with local authorities. Through the use of participatory methods a selection process has been formed, zooming gradually from selecting priority sub-basins with the magnitude 100 km2 to small catchments of an agreed-upon magnitude around 10 km2 in those of two sub-basins. The selection techniques for the last step have been based on firstly an inventory of all possible 10 km2 small catchments. Stakeholders from all of them have then agreed on two priority catchments for further planning. Earlier full coverage inventories by MARD of potential sub-projects have been revisited and provided for local community assessments as one contribution to the selection process.

II. Local Communities. Local communities have picked up the output from the authorities under (I), assessed and modified these proposals, and also added new ones. Two lines of action were taken. Technical experts interacted in a participatory manner in the process of assessment and modification. Also, a series of local community workshops was carried out with the involvement of 400 participants (one third of them female headed households) in 17 villages in five selected communes. These workshops were carried out in order to achieve informed decision-making to identify priority issues and possible solutions related to rural development in general and water development in particular. In this way, poverty reduction as viewed by local communities was given high priority. The goal to assist the local people to develop the participatory investment planning for IWRM could thereby be achieved in integration with the socio-economic development plan at community levels. The specific priorities and proposed solutions for rural development and water sectors have been lifted to the fore as one contribution to the synthesizing decision-making.

III. Technical Experts. One input mentioned under (II) is the participatory consultancy. Based on the local communities' assessments and selections, the technical experts have also established and assessed the priority sub-projects from five main criteria; water availability, irrigation performance, economic, environmental and water supply and sanitation/social/poverty. These have been combined into a systematic approach for internal technical ranking of the selected potential sub-projects. A formalized method to weigh the assessments carrie out by individual experts was developed in the project, and assessed and accepted by the stakeholders in a final evaluation workshop with informed consensus building based on all three contributions.

This synthesis workshop gave the final process output, a priority list of potential sub-projects. It was implemented with stakeholder participation from all three categories above. The result was consensus among the stakeholders of various levels and sectors about priority sub-projects where poverty reduction priority and technical feasibility were also considered.

In conclusion, the lessons from the study are (i) the developed and tested participatory investment planning process has the potential of scaling up into broad applications; (ii) subprojects are formulated at pre-feasibility level in two selected sub-basins in two districts, (iii) the selection of potential sub-projects, designed and agreed upon in cooperation with stakeholders, suggest a transparent method for shared responsibility, (iv) the selection process involves awareness raising and capacity building as a result of the informed decision-making process. Based on these observations the study forms the basis for follow-up studies on the implementation of IWRM for poverty reduction during next phase.

Central and Local governments engaging NGOs for testing and demonstrating new approaches to service delivery in water and sanitation in Uganda

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Keywords: software, rainwater, decentralisation, community, districts

The Government of Uganda (GoU), through the Directorate of Water Development (DWD), Ministry of Water, Lands and Environment, aims at significantly improving access to quality water and sanitation. It has recently been claimed that the target 77% of rural coverage by 2015, as stated in the Poverty Eradication Action Plan (PEAP), is not likely to be met - unless investments in the water and sanitation sector are considerably increased. The Water and Sanitation sector in Uganda is highly dynamic with various stakeholders including central and local governments, private sector organisations, donors, NGOs and CBOs. The GoU has adopted a rural water and sanitation sector reform process, aimed at ensuring that services are provided and managed with increased performance and cost effectiveness. In addition the rural water and sanitation sector aims at improving access to water and sanitation for rural communities. According to the principles of decentralisation and privatisation implementation has become the responsibility of Local Governments. In order to meet the high implementation targets for the Rural Water and Sanitation Sector up to 2015 (Sector Investment Plan 15) cooperation of all stakeholders has to be sought.

In line with this, Uganda Water and Sanitation NGO Network (UWASNET) signed a Memorandum of Understanding (MoU) with the Ministry of Water, Lands and Environment (MWLE) whose main objective was for UWASNET to consolidate the registered achievements and increase on the capacity of water sector NGOs and CBOs to complement MWLE in achieving universal access to safe water and improved sanitation. This among others includes "assisting Central and Local governments in identifying and engaging UWASNET members for testing and demonstrating new software and hardware approaches to service delivery in the water and sanitation sector including channelling funds to participating UWASNET members".

Subsequently, the Directorate of Water Development (DWD) sought cooperation from the non-government sector (NGOs and CBOs) through initiating the "Software and the Rain water pilot programmes" in selected districts of Uganda. The parties involved in the pilot programmes from the centre were; DWD, Ministry of Gender, Labour and Social Development (MGLSD), Uganda Water and Sanitation NGO Network (UWASNET) and Uganda Rain Water Association (URWA). While in the districts they included Sub county offices and district water offices, Water User Committees, Water and sanitation committees and the community.

The objective of the software pilot was to 'mobilise and sensitize the community on water and sanitation and to build and strengthen the community's capacity to choose the kind of water facility they need and to manage (operate and maintain) it in a sustainable way. It was implemented in five phases, these were; Preparatory Phase; Mobilization and Sensitization Phase; Capacity Building Phase; Construction and Launching Phase and finally the Post

Construction Phase. The software pilot was carried out by seven NGOs in Seven districts.

The objective of the rainwater pilot programme was to test the recommended Rain Water Harvesting (RWH) approaches that are community led before large-scale application. It was implemented in four phases, these were: Community mobilization and organization; Exposure visits; Technology demonstration (Hands on training) and finally RWH system production. The Rainwater pilot was implemented by two NGOs in two districts. the expected outputs were: RWH approach tested and results documented; Implementation of Government co-funded community water supply programmes through NGOs tested; and

Communities in pilot areas gain access to clean and safe water in the homes or nearby; beneficiary homes have improved sanitation (hygienic latrine coverage).

In formalising the cooperation with the selected NGOs and facilitating their employment, a number of documents were prepared, such as project proposals and budgets, tripartite Memoranda of Understanding (MoU), contracts, Terms of Reference (ToR) and various guidelines and formats were created and disseminated. The ToRs describe the tasks to be performed by the NGOs during the various phases.

This paper presents the initiation and development process of the pilot programmes. It spells out the different responsibilities of stakeholders at both central and district level. It also shares lessons learnt and recommendations to decision makers.

The River Basin Plan as a mechanism to consolidate an integrated approach

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Keywords: water services, management, river basin plan, integration, São Paulo

Nowadays we face many problems related to water – water shortage, floods, and pollution -; some of them have their origin in both the industrialization and urbanization processes.
Along the years, the trend has been treating the public services – water supply, sewerage treatment system, sanitation -, according to the sectorial approach and giving priority to the services that may contribute, in the short term, to the economic growth of a country or region.
Overlooking the importance to treat the water services as a whole and the inexistence of a link among them, have raised many conflicts between water uses and water users. Rather than a broad and efficient service, a bureaucratic structure was created for every service, with small or inexistent articulation and coordination between the structures.

In the 1970s, this process started changing, and in the late 1980s, a new paradigm was established: the sustainable development. In that context, the adopted patterns as well as the pros and cons of adopting a centralized and fragmented approach were questioned.
It's necessary to point out that such a discussion should be carried out considering that the guidelines to the planning and the management of such services are dependent on the existent legal and institutional frameworks, which determine the water's "dominion" and the entitlement to the water services.

In Brazil, we observe that, until the eighties, the decisions were taken by the central government, which had a fragmented vision of the problem and, therefore, the centralization didn't necessarily lead to integrated proposals. National Plans were proposed for sanitation and urban development; however, they were not articulated.

This scenario changed in the 1990s, after some constitutional changes. Since then the São Paulo State government and the municipalities have gained more autonomy and thus they could introduce new mechanisms to manage the public sector.

One of these innovations was the Law 7663, enacted in 1991, that created the Integrated Water Resources Management System in São Paulo State – a decentralized, integrated and participative management of the river basins.

The new System has adopted many instruments such as the River Basin Plan which has been contributing to transforming the way as the water resources are planned and managed. The River Basin Plan has become a mechanism to consolidate an integrated proposal, in the medium and long term, considering the basin as a whole and, depending on the case - water transfer for instance -, considering its relation with other basins.

The Alto Tietê River Basin Plan, e.g., contains a set of actions and works in terms of water supply, sewerage treatment system, both micro- and macro-drainage, pollution control, environment protection and conservation, etc.

The hindrances have been arising during the implementation of this integrated proposal:

- In São Paulo, the water resources management units (UGRHIs) were delimited considering the municipal districts whose area are totally settled in the river basin or whose urban area is totally settled in the river basin. This measure helps to adjust the conflicts between the river basin and the political-administrative limits. However, it should be pointed out that it is the municipal district that implements the actions.

- The plan's implementation demands financial investments and the plan should establish very clear**ly** the origin and the amount of those resources. In the case of the Alto Tietê River Basin, the Basin's Plan has pointed out the possible source of the financial resources: the São Paulo State budget; an agreement with the federal government; the Municipal districts budgets; the private sector; some State Companies such as SABESP; the Water Resource State Fund – FEHIDRO, and national or international loans;

- After adjusting the territorial units, establishing the necessary financial resources and the likely finance sources, there is a third hindrance to face: the entitlement to the services – water supply, sewerage system, etc. In São Paulo, these services have been accomplished mostly by the state Company SABESP or by the Municipal Companies. The challenge is to coordinate the integrated plan with the Companies' interests.

This brief presentation takes us to the following considerations:

- In São Paulo, the adoption of a centralized system, in the past, didn't necessarily result in integrated proposals. On the other hand, with the adoption of decentralized management it has been possible to have an integrated proposal as we can see in the River Basin Plan. The adoption of an integrated approach depends on the stakeholders' awareness of the benefits that can be obtained with such approach;

- The understanding that the integrated approach is necessary has, in a certain way, become consensus, especially among the technicians. Now, it is necessary to convince the other groups of its benefits;

- The adoption of this new approach requires an adjustment of the institutional arrangements, which were structured in a fragmented way, and also a struggle with the conservative sections that are inside those arrangements;

- With the adoption of the decentralized management, many integrated actions have been proposed and consolidated in the River Basin's Plan; the problems have been appearing during its implementation. Because of this, it becomes essential to increase the articulation among the stakeholders and the coordination among the actions to be implemented; it's also necessary to enlarge the stakeholders' awareness;

- The civil society participation will contribute to the follow-up of the Plan's implementation and to maintain its essential ideas.

Strategy for widespread implementation of numerous, independent, small scale Household Water Treatment programs

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Keywords: quality, training, household, education, decentralized

Voronezh is a river in the Central Chernozem Region of Russia, a left tributary of the Don River. The Voronezh River is 342 kilometres in length. The area of its basin is 21,600 square kilometres. It freezes up in the first half of December and stays under the ice until late March. The lower reaches of the river are navigable. The cities of Voronezh and Lipetsk are located on the Voronezh River. There are 28 tributaries of the Voronezh River in its basin (Ilovay, Stanovaya Rjasa, Matyra, Usman are the most significant). There are 488 surface water bodies in the Voronezh River Basin with the general length of river system of 4,645 kilometres.

Many countries continue putting into commission new chemical enterprises and expanding already working ones. This leads to the chemical pollution of the environment in the industrial zone and adjoining area by numerous toxic compounds. This is a particular in the Voronezh River Basin due to the pollution created by such large-scale industrial enterprises as Voronezhsynthezkauchuk, Novolipetsk Metallurgical Works, Rossosh Mineral Fertilizers Plant, Voronezh Tyres Plant. Within the Voronezh River Basin there are 29 chemical and petrochemical companies. In 2004, water pollution caused by these companies was observed in the city of Voronezh and in 15 districts of the Voronezh Region. In the Voronezh Region, 261.0 thousand people live in conditions of polluted water. The environmental degradation in the Voronezh River Basin has induced public instability, raised conflicts that can't be settled for a long time.

The experts of the Centre for the Ecologic Adversity Counteraction created the decision support system for industrial pollution monitoring in the Voronezh River Basin. The elaboration of decision support system was made in light of the above-named features and representation of monitiring process as a specific procedure of control; its purpose is the determination of the state of river basin health. This idea is in a good agreement with the contemporary understanding of a control as the process of performing the purposeful directive actions on the controlled object, which in this case is a river basin. The main task of controlling the monitoring process is to increase its efficiency by the choice of rational algorithms for the determination of industrial pollution by certain chemical compounds.

The functioning of the decision support system is realized in the local calculation network thus allowing to provide multiuser mode of data base operation, as well as the input and processing of the results of water quality researches.

The operation of the system assumes execution of several stages such as:

- input and analysis of a priori information;
- formation and choice of research algorithms;
- organization of research execution;
- control of execution and record of research results.

My experience shows that with the help of decision support system it is possible to develop quite efficient strategy of industrial pollution monitoring in the Voronezh River Basin, allowing an increase the accuracy of control process and a reduction in the time and economic expenses while making water quality tests.

Based on results of decision support system employment the Centre for the Ecologic Advirsity Counteraction initiated the following actions : carry out certification of wastewaters and production wastes and make comparative analyses to find out whether actual amounts of emissions and wastewaters conform to maximum permissible emission and maximum permissible concentration levels; revise the current norms in all areas of production, including treatment facilities, and make the necessary amendments and changes to meet maximum permissible emission and maximum permissible concentration levels and provide for the reduction and utilization of wastes; introduce the latest achievements and physicochemical water treatment methods at the stage of basic tertiary wastewater treatment using ozone before water disposal into the water bodies, to meet current sanitary norms and regulations.We consider these efforts as the key point for maintaining the ecological balance in the Voronezh River Basin for a long period.

Local Millennium Development Goals - Initiative (LMDG-I)

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Keywords: Millennium Development Goals, Sustainable Water Supply Sanitation, Hygiene Promotion

Introduction

WaterAid is the world's leading international NGO providing community-managed water and sanitation/hygiene (WASH). The work is crucial. Over one billion people have no access to safe water; one third of the world has nowhere safe to defect. A child dies every 15 seconds from a water-related disease.

Since 1981 WaterAid's simple, low-cost, and sustainable work has helped nearly eight million people in 15 countries. We began operating in Nigeria in 1995 and now work, in association with local partners, with 30 Local Government Authorities (LGAs) in six states.

Not only does our work result in improved health and reduced mortality, but WASH provision underpins all other areas of development. Time gained by people, mostly women and children, who no longer spend hours collecting water or lose so many days to sickness can go to education, growing extra crops to sell or establishing small businesses. Our work is the vital first step out of poverty.

Local Millennium Development Goals - Initiative (LMDG-I)

In response to the 2000 Millennium Development Goals (MDGs), WaterAid West Africa has devised (in partnership with Enda Tiers Monde) the "Local Millennium Development Goals Initiative" (LMDG-I), the object of which is to bring the MDGs down to the local level.

The two year initiative will be implemented in Burkina Faso, Ghana, Mali, Mauritania, Nigeria and Senegal. Country offices will involve local partner NGOs delivering plans in collaboration with local government institutions in the six target countries.
The objective of the LMDG-I is to provide LGAs with the capacity to lead on the changes needed to meet goals on WASH access. More specifically, it will:

- Raise LGA awareness of MDG targets and responsibilities, and establish mechanisms for acquiring appropriate WASH delivery skills.
- Improve the leadership abilities of elected officials to conceive, implement and evaluate projects to increase community access to WASH, and;
- Capitalize on lessons learnt from national experiments to improve the institutional framework of decentralization and transfer of WASH competencies.

Nigerian Context

Nigeria is Africa's most populous country. Nearly ¾ of its estimated 130 million people live in poverty. It has a three-tier system of government. All tiers have responsibilities in the provision and management of water resources with different areas of emphasis and levels of financial burden.

- The Federal Ministry of Water Resources (FMWR) provides overall policy and regulation for development of the sector, and collects data, coordinates, monitors, evaluates, and maintains external donor relations.
- State Water Agencies (SWAs) in all 36 states and the Federal Capital Territory provide water in urban and semi-urban areas.
- LGAs supply water to small towns and rural areas and also establish WASH committees in these areas.

The three tiers collaborating to implement the National Policy on Water Supply and Sanitation.

There are 774 LGAs responsible for provision of rural water supplies and almost none have the resources and skills to address the problem. In the past two decades the quality and coverage of basic services has not improved and in some areas has dramatically declined. According to the 2000 National Policy on Water Supply and Sanitation 39% of the population in rural Nigeria has access to safe water and 29% to safe sanitation. Figures for urban and semi-urban areas are 42% access for both water and sanitation.

WaterAid Nigeria Local Millennium Development Goals - Initiative
WaterAid Nigeria has made the LMDG-I its priority programme, believing that instilling a sense of ownership in LGAs and locally elected officials will lead to greater efficiency in WASH delivery. Nationally the MDGs on water and sanitation seem daunting, but taken down to a local level seem realistic and achievable. The key activity is engaging decentralized government in the 30 LGAs where WaterAid works to develop and implement, in consultation with all concerned stakeholders, local plans which will meet the MDG on water supply and sanitation. LGAs are more accountable as they have the direct responsibility for provision to communities.

WaterAid Nigeria’s piloting of the LMDG-I in four LGAs has refined the process into 8 steps:
1. Awareness raising to familiarise government and elected officials with MDG targets, obligations and benefits.
2. Stakeholder analysis/LGA capability assessment to determine existing capacity to provide sustainable WASH access.
3. WATSAN Mapping Process/Field Data Collection to provide a true assessment of existing facilities and establish implementation priorities.
4. Restitution workshop with WaterAid support team meeting local council and traditional leaders to set targets and identify gaps.
5. Planning Meeting to formulate long-term work plan and resource mobilization/monitoring plans.
6. Development plan sharing at the local level with authorities and community leaders.
7. Disseminating outputs with all interested stakeholders to encourage learning and project replication.
8. Translating the plan into action with LGAs taking lead and active involvement of communities.

Merits of the LMDG-I
Potential for replication and scaling-up, Financial viability, Sustainability, Sanitation, Capacity building

Challenges to Water Allocation Reform

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Keywords: Water allocation reform, Co-operative government, Equity and redress, Compulsory licensing, Conflict management

Water is an essential asset, and the sustainable reduction of poverty requires equitable access to water. However, productive use of water (i.e. over and above that required for basic human needs), and the contribution this makes to employment and economic growth, occurs within a wider social, political and economic context. South Africa is facing increasingly vociferous demands and growing activism for social equity in all areas including improved service delivery, land reform and water reform. Consequently, government is likely to face increasing pressure to speed up the pace of reform in all sectors.

The Water Allocation Reform (WAR) programme is a specific intervention to address issues of race and gender equity as one part of the reform package for the water sector in South Africa. The programme is highly integrated and multidisciplinary and its thrust is primarily socio-political. It is, however, informed and supported by legal, institutional, economic, technical and scientific considerations. Within this programme, the Department of Water Affairs and Forestry has identified factors that could: (1) affect its pace of delivery; and, (2) influence the sustainable use of our water resources within the framework of providing basic services required by the Millennium Development Goals and the Water Allocation Reform (WAR) process.

The WAR process will involve the reallocation of water from existing users. This raises particular challenges. South Africa's Constitution, while allowing government to take proactive steps to redress the impacts of the country's past, also protects the rights of all South Africans. Accordingly, reallocations of water must be fair and reasonable, and must be beneficial in the broader public interest. Any reallocation of water from lawful existing users, many who provide and contribute towards stable local and regional social economies, especially in rural environments, runs the risk of upsetting this stability. Equally, socio-political instability could result where existing users are slow to relinquish some of their water entitlements. The integrity and sustainability of aquatic ecosystems is also a major consideration within the process.

The programme is comprised of three distinct phases, which are not necessarily sequential in their execution. The phases are:

Phase 1: The Vision and Approach phase, of which the draft Position Paper for Water Allocation Reform in South Africa" is the focal point. Its primary purpose is to provide an aligned and collective vision for the programme that all South Africans can identify with and relate to as a point of reference. This is also in support of the government initiative of nation building.

Phase 2: The Implementation Phase, in which the Toolkit for Water Allocation Reform
A Manual to help Achieve Race and Gender Equity in Water Allocations and the Regional WAR Champions form the backbone. This phase addresses the coordination of all National Water Act activities in the regions into a coherent approach towards achieving the goals and objectives of the programme at a local and regional level, as well as ensuring the effective implementation of the National Water Act, as articulated constitutionally and in the National Water Policy of 1997.

Phase 3: deals with Auditing and Monitoring & Evaluation of the progress and implementation of the programme.

Furthermore, because the programme is a highly integrated one, its implementation approach is one where linkages and partnerships are established – either in an agreed support or a lead capacity, or both, depending upon the prevailing circumstances.

This paper focuses on the processes required during Compulsory Licensing, one of the WAR processes and a specific provision in the National Water Act (Chapter 4, Part 8) that deals with the authorisation of water use, on a collective basis, in a defined geographical area. Compulsory Licensing is resource intensive and administratively demanding and has phases fraught with the potential for conflict. Innovative approaches to minimising the administrative demands, resourcing needs and potential for conflict during Compulsory Licensing are discussed, in addressing these challenges to the WAR programme in South Africa.

The Cathedral and the Bazaar: An Examination of Centralised and Distributed Models of River Basin Management.

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Keywords: river basin management, centralised, decentralised, problem solving, conflict resolution

In this paper we explore two different models of river basin management. One is a mainstream, normative integrated river basin management (IRBM) model that is predominantly hierarchical and sophisticated in institutional design culminating in an apex 'regulatory authority', which seeks comprehensive hydrometric networks for data collection and analysis for use in computer decision-support models for water allocation. Normative IRBM can be identified in the curricula of water resource training programmes and in the many derivatives of RBM programmes throughout the world. A very different model of RBM, termed here 'distributed river basin management' (DRBM) is institutionally more horizontal or distributed in form emphasising user-to-user negotiation and trades in water. This model provides a means to craft operational water resources management founded on conflict resolution, problem-solving and step-wise adjustments of flows supplied to different sectors. Purposively pragmatic, the distributed model attempts to answer the question of how to make tangible operational progress in basins where data monitoring is limited and basin office resources are constrained. Envisaging a slimmer version of the basin office that aims to facilitate distributed decision-making, we apply the term 'regulatory personality' to contrast this against a larger 'regulatory authority'. We liken the two approaches to The Cathedral and The Bazaar analysis of Eric Raymond who depicted two markedly different ways of constructing computer source code, one 'in house' drawn up by a few employees, the other 'open-source', added to by many contributors. We are wary of inaccurate parallels here, but feel compelled to package our argument in this way to contentiously and effectively counter the predominant hierarchical model. With respect to river basins, we theorise that each approach has elements of each other, and that a particular mix of the two can be chosen to apply to river basins with a given set of circumstances. Our theory is informed by case studies from Tanzania, Nigeria South Africa and Europe.

We argue here that the normative model of integrated water resources management is 'regulatory' and hierarchical in fashion. Normative IWRM quantifies the resource via water resources assessment so that the supply may be parcelled out to users via regulatory instruments (water rights) by or overseen by a central regulator or service provider. The hierarchy is seen as sensible because water supply and demand in a river basin manifests itself as an additive common resource. The total supply needs to be quantified and added up to be balanced against the total, added up demand, so that excessive demand can be regulated to meet a changing supply. A central viewpoint is required in order to explore trade-offs between users and supplies that may be very distant from each other.

However, the question must be asked whether the regulatory model is the only version available and whether it has functioned well in river basins such as found in Sub-Saharan Africa. These basins are generally large, between 15 to 150 thousand square kilometres, comprising disparate communities, institutions and environments. Moreover, the basins' regulatory organisations, logistics and infrastructure for monitoring both demand and supply is limited. Such basins are very different from those found in Western Europe where basin authorities have access to considerable financial, human, transport and technological resources which allows them to fulfil their duties according to accepted standards and protocols associated with RWRM. Yet it is from these well-resourced situations that policy templates and curricula for IWRM in poorly resourced river basins are exported. The appropriateness of the regulatory model to the latter is a question that should be posed more frequently and deeply. However, such is internal logic of the regulatory model, that the main issue is not whether alternative IWRM models might exist, but how to assemble the provisions necessary to implement the regulatory model. At a river basin workshop in Northern Nigeria (Lankford 2005), participants were asked to consider what they could do in the short term to improve allocation of water. After some 30 minutes to consider the question, respondents drew up long lists of actions that constituted 'regulatory river basin management' rather than immediate 'make-do' steps that might resolve pressing conflicts. When asked at a recent seminar in London how the Environment Agency would manage a river basin in East Africa that had no monitoring network, the answer given was to set up a monitoring network (Hepworth 2005). This is sensible provided the cost, sustainability and usefulness of such a network are assured. However, networks for hydro-metric data collection in Africa are in a poor state, rehabilitation efforts are short-lived, and data often goes uncollected or un-analysed. So the question remains, how can a river basin be managed if very little or no data remains the de facto situation?

We attempt to bring together a number of issues to look at the debate about centralised and decentralised river basin management, asking how to design for one or the other in any given situation.

Citizens Action for Water and Sanitation - generating citizen-led accountability

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Keywords: Accountability, Participation, Citizens, Water, Sanitation

For all the good intentions of governments and service providers too many poor people are seeing their entitlements to water and sanitation unmet. There is international agreement that access to safe, affordable water and sanitation are human rights, and yet poor people see few agencies acting with any urgency. There are the much-trumpeted poverty reduction strategies (PRSPs) but poor people rarely see water and sanitation anywhere among the priorities. At the current rate of progress the Millennium Development Goals (MDGs) of halving the proportions of people without access to water and sanitation will be missed by some distance.

In these dire circumstances poor people are asking not only where is the water and where are the toilets, but also, who can be held accountable?

A new source of momentum is needed to ensure agencies stick by their commitments, that governments put into place the legislation or policies necessary to support service provision and that service providers meet demand. There is an urgent need for action to ensure improved accountability. WaterAid is convinced that poor people themselves should be able to hold service providers and governments to account.

This is the essence of the Citizens' Action project: citizens supported to engage in ongoing dialogue and negotiation with service providers and government. Citizens' Action is a major, inter-agency process which WaterAid believes represents a new way of conducting work with communities that lack adequate access to water and sanitation. It started earlier this year and is set to run throughout the Water for Life decade (2005-15).

The basis of the Citizens' Action projects is the universal right to water, while its method will be to foster a dialogue between citizens and their communities on the one hand and their governments and service providers on the other. Citizens' Action complements other WaterAid supported activities which aim to strengthen the ability of local government, not-for-profit and private small scale providers and communities to deliver water and sanitation services themselves.

There will be projects in many locations and each will be implemented by citizens and facilitated by project partners alongside WaterAid Country Programme staff. Each project will ensure that local people develop a fuller understanding of:

- their entitlements to water and sanitation
- their current water and sanitation service situation
- the range of responsibilities for policy and service delivery

Citizens will then be supported to negotiate with government/service providers on these issues. Empowerment is a key feature of the process, and ultimately will lead to citizens gaining access to sustainable and affordable water and sanitation services.

Overall, the project process is innovative and challenging: citizens will take action themselves through direct engagement with governments and service providers. Non-governmental organisations (NGOs) will facilitate the work, rather than mediate on behalf of citizens as is often the case.

Citizens' Action will create widespread opportunities to advocate the principles behind the project, what has been carried out, what has been achieved, the obstacles and the hurdles. The first of the annual, detailed Citizens' Reports will be launched on World Water Day, 22 March 2006.

The first Citizens' Action projects are already underway in Bangladesh, Ethiopia, Ghana, India, Nepal and Uganda; more will follow in Mozambique, Nigeria, Burkina Faso and Mali and other countries. Millions of people will be reached.

In all locations WaterAid and other international agencies will work with local partners to assist citizens to conduct the projects. Citizens will decide upon suitable data collection methods from a choice of community scorecards, slum enumeration and censuses, water and sanitation mapping, and report cards:

- Community scorecard: local people are assisted to rank or score the range of services with which they are provided and to engage with service providers and government agencies to discuss the findings. The exercise is done at a communal level
- Slum enumeration and censuses: slum dwellers and street sleepers join together to map accommodation and amenities in their area and use this as a democratic basis for planning with responsible authorities. These can be huge in scale, spreading across vast tracts of land where tens of thousands of people live and work
- Equity of distribution of water and sanitation: this maps amenities and then analyses their distribution. Clear facts about equity (or otherwise) of resource distribution are established and are shared between communities and providers/government. Often the mapping process is carried out by professionals; the idea is to embed this process in the community and to ensure that they have ownership of the outcomes and the follow up processes
- Report cards: This is essentially a professionally conducted market research exercise, much like an opinion poll, the report card name arising from using the research findings as a barometer of public satisfaction with services

While citizens will define much of the information that will be collected in each location, there will be some common elements, to allow comparison across locations and over time. This will enable us to work jointly with citizens to produce the annual Citizens' Reports that form an important part of the process.

Critically, we are looking to create a wide alliance at all levels – to give guidance, to manage similar current and future projects, to learn, to share experience and to spread the word about this new and exciting approach to gaining access to water and sanitation for more of the world's poorest people. Please join us!

Harnessing the potential of water for improved livelihoods in a rural household in Pretoria, South Africa

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Keywords: rainwater, gray water, household, food security, liveluhood

Mrs. Tshepo Khumbane is rural development activist living in Dinokaneng Municipality Cullinan, Gauteng Province in South Africa. Mma Tshepo as she is commonly called lives on a farm located in a rolling expanse of open grassland known as the high veld. The general elevation of the high veld is 1370 m to 1800 m, receiving on average about 500 mm to 760 mm of precipitation. Mma Tshepo's first everyday priority is to capture every drop of water for domestic and intensive crop (mainly vegetable and fruit trees) including among others beetroot, broccoli, carrot, cabbage, lettuce, green peas, spinach, onions, e.t.c and animal (poultry and pig) production. Existing sources of water for the various water demands in the household, include, mainly ground water and rainwater harvested from roof and ground catchments. In addition for crop (peach trees) a non-conventional source of water of internal recycling of gray water from kitchen and ablution, is used to augment the water sources. Mma Tshepo practices intensive productive water use, in the household yard and in areas near and around it.

In 2003, the International Water Management Institute (IWMI) of Silverton, Pretoria undertook a research study to quantify the water supply and demand of the water resources at Mma Tshepo's homestead. IWMI's interest in studying Mma Tshepo's water resources use was to mainly understand how much water goes into her system including rainwater and how much she uses for the different household activities. The study was also to determine the water storage of the vegetable gardens. During the study, data were collected by having discussions with Mma Tshepo and her household members. The water sources identified for the household were ground water, surface ground surface runoff and rainwater. The rainwater source was quantified using the area rainfall data and also measuring the roof area, to estimate the volume of water harvested from the roof. The surface runoff from the ground catchments used for vegetable production was estimated using the planimeter method. The ground water source from in the household was estimated from household pumping records. The water demand for domestic use and animal production was determined using recommended water consumptions from literature, and the water requirements for vegetable production were determined using SAPWAT computer program.

During the study period (2002-2003), Dinokaneng Municipality Cullinan received an approximate annual precipitation of about 650 mm. Of this, 113 m3 was collected from Mma Tshepo's total roof catchment area with three roof sections of about 173 m2. An amount of approximately 40 m3 of water that was harvested off one of the roof sections (section 3), was stored in an above ground 3.12 m3 galvanised iron tank, which was later used for domestic and animal production. The over flow from the tank was then directed to an underground brick masonry tank of 19 m3capacity, covered with galvanized iron sheets, which was later used to water peach trees. More rainwater with volume of approximately 36m3 that was harvested off another section 2 of the roof area was directed to another underground brick masonry tank of 6 m3capacity, also covered with galvanized iron sheets, where also gray water from the kitchen and household ablution water was collected to be later treated with ash and used to water peach trees. Still from another section 1 of the roof area a volume of water of approximately 36m3 was not stored, but was joined with the surface runoff from uphill and directed through an earth trench about 10 m long, to vegetable gardens. The harvested surface runoff from the up hill ground catchment to the vegetable garden trench network was estimated to be about 5000 m3. Indirectly most of the water directed through the earth trenches, infiltrated into the soil, which in turn recharged the ground water. Ground water which was pumped and stored in the overhead tank was mainly used for irrigating vegetable gardens, as well as domestic use. The water demand during the study period for domestic, animal (chicken and 6 pigs) and vegetable production was estimated from the methods discussed to be 25 m3, 16 m3, and 107 m3 respectively, with a cropped area of 222m2. The water storage for the vegetable gardens was determined using the laboratory method where the water storage was found to be higher than in the undisturbed soil (sandy loam) due to organic materials added to the gardens.

Mma Tshepo optimized all the available resources and maximumly practiced productive water use at household level. She involved every one in the home as much as possible as a way of ensuring sustainability of the practice of productive water use in the household. The household kept a daily roster where every member of the family at any one time got to do every activity in the home. As a result of Mma Tshepo's innovative approaches of effective and efficient utilization and management of rainwater, ground water and the unconventional water source of gray water, the household witnessed tremendous improvement in their livelihood. Her household became more food secure since she was able to produce enough food for the family and even sell off the surplus. She even diversified into rearing of local chicken branded "Khumbane Chicken" and was able to derive income by selling it in Cullinan and other supermarkets in Pretoria.

The case presents the potential of intensive household productive water use, which is believed to be one of the contributors to food security and better livelihoods at household level by utilizing available and accessible resources as demonstrated by Mma Tshepo's experience. Therefore considerations during planning and management of water sources at community level, should seek to understand, the uses to which water is put at household level, in order to have an integrated and innovative approach under various community settings.

Decentralised and Participatory Approach to Management of Water Resources- A Case Study

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Keywords: Utilization, Water Users Association, Participatory dialogue, Institutions, Sustainable

Presentation of topic and analysis of issues: Katepurna water resource scheme has completed its 30 years of operations. The scheme was designed and constructed to provide irrigation facility to 8325 ha, domestic & industrial water supply to Akola town and nearby villages. During first 25 years, the scheme could irrigate on and average 2025 ha as against 8325ha. As a result water was remain unutilized. Therefore, Government of Maharashtra (GoM) has taken decision to allocate water for non-irrigation (domestic & industrial) purpose leading to curtailment of irrigation service area to 5967 ha, which too could not be brought under actual irrigation. Hence, scheme was termed as failure scheme.

One of the major reasons for failure was non-participation of users (farmers) in the irrigation management of the scheme. There was feeling among farmers that it is a government scheme and they used to blame Water Resources Department (WRD) for poor utilization of precious water resources. On the other side WRD used to blame users for the cause. Though there were some initiatives from WRD, but it could not succeed in participating users in irrigation management.

A systematic and all round approach adopted to find solution to the poor utilization of water resources of the scheme. The measures include engineering, agriculture, management, public awareness and capacity building. Initially, there was resistance from farmers towards departmental initiative and distrust on officers; but with participatory approach resulted resistance into support and distrust into trust. Earlier there was no response to formation of water users associations (WUAs), but with initial successful example and realizing it's benefits, farmers accepted the concept. The movement resulted into formation of 24 WUAs on entire command area (service area). Farmers were so convinced about their participation that they have voluntarily taken over management of tertiary level irrigation systems. The transfer of management took place without rehabilitation of the existing system. To co-ordinate WUAs and take over irrigation management of the scheme, scheme level association has been established. The scheme level association is involved in planning and decision making. There is also set mechanism for conflict resolution/grievances redress at various stages. The total and sustained approach has resulted into actual irrigation touching to revised irrigation potential.

Various innovative ways were adopted to achieve dialogues and participation of users and stakeholders. The silver jubilee celebration of scheme involving all sector users, stakeholders, public, policy makers and media was one of such novel attempt.

With the reality of water reaching to tail end farmers who were deprived of irrigation due to allocation of water to non-irrigation started demanding their right of water. The scheme level association followed the demand at various forums. Ultimately it resulted in amicable understanding among all sector water users and re-allocating water to irrigation use. ' Sinchan Sahayog' (Irrigation Collaborative) – a voluntary organization, which is working in irrigation sector and having representation of experts from fields related to agriculture, at district level as well as at state level, has facilitated and strengthened the participatory dialogue.

The Katepurna experience was repeated by users in other schemes in the district and adjoining districts, which resulted in efficient water resource management. To continue the dialogue further, 'Sinchan Sahayog', federation of WUAs and Water Resources Department are working hand-in-hand. This arrangement has shown its relevance when there were low water yields in the reservoir. The farmers agreed amicably and sacrificed irrigation for meeting drinking and industrial water requirement. This arrangement will ensure true participatory dialogue among all section of society.

Discussion of Results: Katepurna scheme could actually irrigate 5940 ha of land, which is almost equal to revised potential of 5967 ha. Secondly, 75 WUAs were formed on 20,000 ha area, which is 80% of irrigation service area. The actual irrigation in the district is raised from 5000 ha to 14500 ha along with fulfilling increased domestic and industrial water requirement. The Katepurna example has shown that with true participatory initiative it could turn failure into success. It has given boost to Participatory Irrigation Management (PIM) program in the region and the State. GoM has taken policy decision to make participation of farmers in irrigation management mandatory based on Katepurna and experience from other projects in the State. The contribution of the Katepurna scheme is recognized at national as well as international level.

Conclusions: Katepurna scheme demonstrated that the true participatory dialogue among all sector users and stakeholders could result in greater integration in planning and service delivery. The appropriate institutional arrangement in form of federation of WUAs, Sinchan Sahayog and irrigation division has facilitated in better co-ordination and continued dialogue. The social acceptability to the initiative can be clearly seen from its replication to other schemes in district. The water resources infrastructure developed for the society were previously unable to deliver the goods that they were supposed to, but with decentralized and participatory approach and consequent actions resulted in better water governance benefiting society at large. The Katepurna example underlines the need for decentralized and participatory approach for sustainable water resources management.

Planning and implementation of ecological sanitation projects

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Keywords: Ecological sanitation, planning, household centered environmental sanitation, inception phase

In order to achieve the Millennium Development Goals and the Johannesburg Plan of Implementation, a new paradigm is required in sanitation, based on ecosystem approaches and the closure of material flow cycles rather than on linear, expensive and energy intensive end-of-pipe technologies. This paradigm must recognise human excreta and water from households not as a waste but as a resource that should be made available for reuse.

Ecological sanitation, 'ecosan' for short, is this urgently needed new holistic paradigm in sanitation. It is based on the systematic closure of local material flow-cycles, and introduces the concept of sustainability and integrated, eco-system oriented water and natural resources management to sanitation.

The basic principle of ecosan is to close the nutrient loop between sanitation and agriculture. Closing the loop enables the recovery of organics, macro and micro-nutrients, water, and energy contained in household wastewater and organic waste and their subsequent productive reuse mainly in agriculture, although there are many reuse options outside of agriculture. An essential step in this cycle is the appropriate handling of the materials throughout the entire treatment and reuse process in order to ensure a satisfactory sanitisation of the excrement and protection of public health. Therefore, unlike conventional sanitation systems, ecosan systems not only control the direct hygienic risks to the population but also protect the natural environment. Making the organics, and micro and macro nutrients available to agriculture preserves soil fertility and safeguards long-term food security. The commonly applied ecosan strategy of separately collecting and treating faeces, urine and grey water minimises the consumption of valuable drinking water and allows a low-cost treatment of the separate wastewater flows for subsequent reuse in soil amelioration, as fertiliser, for groundwater recharge or as service or irrigation water. Rainwater harvesting and the treatment of animal manure may also be integrated into ecosan concepts.

Ecosan does not favour a particular technology but is rather a philosophy in recycling oriented resource management and offers modern, convenient, gender friendly and desirable solutions, in accordance with the Bellagio Principles as formulated by the WSSCC (Water Supply and Sanitation Collaborative Council).

Planning of ecological sanitation projects is a challenge for planners and engineers: to obtain sustainable and integrated solutions, stakeholder involvement is of central importance, a wide range of sectors other than water and sanitation needs to be integrated, and in comparison to traditional sanitation projects, a much greater variety of technical and organisational solution to be considered.

The wide range of activities required for planning of ecological sanitation projects can generally not be included in traditional planning instruments such as the feasibility study. Therefore GTZ has proposed a planning methodology for ecological sanitation, based on the 10-Step process proposed by the household centred environmental sanitation approach (HCES).

The ecosan planning method may be applied within traditional planning instruments by emphasizing an enlarged inception phase that includes activities to inform and raise awareness for the creation of an enabling environment, to identify and involve all relevant stakeholders, and to conduct a thorough and integrative analysis of the situation.
The presentation will describe the proposed planning methodology in detail.

About Horizontal and Vertical Integration for Water Governance in Central Asia

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Keywords: Cross-sector integration, Hierarchical levels, Public participation, Hydro-solidarity, Water Governance

From the viewpoint of horizontal (cross-sector) integration it should be taken into consideration interests of all water users (sectors) equally and provided a priority for water saving and eco-system safety within the hydrological basin. The issue is that different authorities in Central Asian countries manage separately the use of different waters. At the same time, not all the above-mentioned public departments and ministries, as a rule, do co-ordinate their activity with each other.

Gathering different sectors under "a single organizational roof" is not efficient at all. According to the GWP publication "Catalyzing Change…" (2004) this approach can be even harmful since a sectoral specialization is a good environment for efficiency only within the specific sector. However, the main basis for inter-sector integration is the co-ordination of sector interests in the process of joint planning and use of available water resources according to agreed schedules, and re-use of wastewater derived by one sector to another. At the same time, the mechanisms for conflict settling should be developed to integrate contradictive interests. It may be achieved by participation of representatives from different sectors in public bodies at any level of the water governance hierarchy. There are the following instruments for such co-ordination:

- Integrated planning of water use;
- Co-ordination of the driving forces for economic growth in sectors;
- Data exchange; and
- Participation in material and financial inputs that are of mutual interests.

The recent water management system in Central Asia is a multilevel tree of water distribution system starting from water source to the final user via main distribution network to secondary and tertiary canals. The basic water losses and water supply irregularities appeared due to the lack of co-ordination between different vertical (hierarchical) levels of water governance. The one of the main tasks of IWRM is the proper co-ordination of activities among these hierarchical levels. The situation when each water agency develops its own criteria and approaches that do not meet the general purpose of IWRM (to reach the maximum aggregated water productivity) needs to be obviated. The water agencies hold an interest in supplying water to consumers as much as possible in volume, and vise verse, water users hold an interest in reducing their water consumption down to the optimal minimum (if they pay for water).

A basic tool to co-ordinate activities in different hierarchy levels (both according to horizontal and vertical links) is public opinion involvement into water governance and operation via properly established institutional framework. In the actual conditions of water deficit growing the all levels are coordinated based on considering the applications (demands) for water that are formed along the line "bottom-up" and on establishing restrictions in the form of water quotas (licenses) and relevant delivery schedules that are formed along the line “up-down” by water authorities and are supported by contractual relationship between water system administrations and water users.

Apart from institutional tools for co-ordination, there are also managerial, legal, and economic (financial) tools. The principal managerial tools recently implemented in the Central Asian countries are the following:

- Keeping records of water on the way from the basin to the end user, strict water demand rationing;
- Drafting the coordinated plans of water allocation and use at all hierarchical levels of water management that include control of organizational water losses;
- Reporting that shall provide not only annual and quarterly reports but also an operational reports containing specified criteria and indicators for timely adjustment of water supply;
- Improving the dispatcher control to ensure equitable and sustainable water supply upholding the priorities of eco-systems and municipal and industrial water users as well as the observance of limits related to water infrastructure safety; and
- Adjustment of water use plans based on tailor-made computer models in case of changes in hydrologic, climatic, economic, and other conditions.

Legal and economic tools are closely interrelated and mutually complementary. The principle tools are listed below:

- Water rights and their protection by the Government;
- Contractual relationship between water users and water agencies, and also between water agencies operating at different hierarchical levels;
  The law on a liability for infringing water rights and contractual relationships;
- Payment for water supply and other servicing of water users (it has to be differentiated depending on water services’ quality);
- Penalties for water pollution;
- Fee for water as resource (still discussible);
  Governmental control for rights and duties of water management organizations and water users, as well as the state liability regarding support to both sides;
- Providing incentive and preferential terms both for water users and water management organizations under rational water use; and
- Fines for surplus water withdrawal from the water supply system.

Again and finally, it needs to keep in mind that public participation was, is, and will be the main tool for coordinating water users both according to horizontal and vertical links. This is the most important factor to achieve “hydro-solidarity” in contradiction to “administrative hydroegoism” of decision makers and “professional hydroegoism” of water managers. The public participation is a guarantee for equity and equality of water allocation, and consideration different interests in the other issues of water management. The role of public could be increased by establishing, in parallel way to water governance organizations, public structures in form of “Unions of Water Users”, Water Councils or Committees.

Workshop 5:

Decision Support Systems and IWRM

Promote IWRM to Resolve a Complex Agriculture & Fishery Issue through Dialogue - A case from Sri Lanka

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Keywords: Conflict resolution, Stakeholder interaction, Fishery & agriculture, Win - Win Strategy, Capacity Building

Presentation of the project and analysis of the issue

Sri Lanka is one of the very first countries in Asia where IWRM plans were prepared well in advance. Presently most of the IWRM documentation are available even in our local languages. As the IWMI head office is based in Sri Lanka IWRM is well aware among the management level of agricultural & irrigation sectors. However the crucial point is, the general public does not accept IWRM in Sri Lanka. The reason behind is that the message of "cost & benefit sharing" has misinterpreted & the message gone to the general public is that "IWMI is promoting water privatization" and in the near future farmers have to pay for the water they use for agriculture, irrigation etc. Being an Asian country, culturally people think that poor need to be subsidized, and cost sharing is very much negative term in Sri Lanka. Further, the next controversial issue is Government agencies and NGO are running two parallel structures to cope up complex issues, which require IWRM approach. Therefore even though the plans are available, IWRM cannot be implemented within existing management and decision-making structure unless new management strategies are introduced.

Being a participant selected to follow a training program on IWRM conducted by SIDA in 2005, I got an opportunity to do an individual project to promote IWRM. I was able to successfully implement this project, by taking a real complex example in Sri Lanka through dialogue and fair stakeholder interaction. The experiences gained through out the process, are presented here as a case study, a success story.

Sri Lanka, being an island has 103 rivers flowing to the sea interaction between fresh water and seawater is a major issue comes under the preview of Coast Conservation Department. Most of the rivers come to a formation of a lagoon is very common in Sri Lanka, and these lagoons are predominantly closed from the sea by sand bar formation due to wave action of the sea.

One of the most critical livelihood related problem in coastal lagoons & inland water bodies is conflict between irrigated agriculture and fishery. The nature of the problem varies according to seasonality. In the dry season the opening of the sand bar of the river mouths by fishermen to facilitate the larvae breeding grounds in the lagoons leads to salt water intrusion upstream and resistance by farmers. In the wet season, unless the widening of lagoon mouths are allowed, the situation leads to floods and inundation of a paddy lands, the same situation in this instance leads to loss of fishing stock in the lagoons and resistance by lagoon fishermen.

Koggala lagoon is located in the Southern coast of Sri Lanka, This lagoon measures around 5 km by 2 km and covers 727 ha It is bordered by a narrow fringe of mangrove and mash or paddy lands beyond which a catchment area of 64 square km. This lagoon is a focus of a very rich ecosystem for lagoon fishery. The southern boarder of lagoon is formed by a 500m wide coastal belt basically closed and about 200 families are depending on lagoon fishery. Due to the adhoc decisions taken by lagoon fishing community to open the sand bar, irrigation &

agriculture are in a major threat due to the salt water intrusion.

This project focuses the importance of a development of win – win strategy among stakeholders based on Integrated Water Resources Management (IWRM) principles through community participation in decision making & by building of ownership sense among them, with the support of relevant officials representing Government institutions, non governmental organizations, political authorities, local authorities & donors as it is a multidisciplinary stakeholder issues.

The main objective of the project is to get a consensus through stakeholders participation to prepare guidelines for opening of the sand bar to sustain agriculture & fishery in the long run.

There are three main activities identified under this project. Firstly, to conduct an awareness program and take all stakeholders into one platform to give them an overall view of the situation. Secondly to conduct a dialogue among them in order to make some decisions to arrive a technical solution to the salt water intrusion problem which is severe and much more favorable for lagoon fishery, but very much affected for agriculture. Finally, incorporate stakeholder's requests and propose a technical solution to regulate salinity intrusion problem and form a lagoon committee, build their capacity and hand over the authority to regulate their own scheme for the benefit of all stakeholders.

Results/Findings

The stakeholder identification was done and 13 stakeholders were identified. Then their interest in the project and influence on the river basin has been analyzed. Then the relative importance of each stakeholder have been analyzed and their awareness level have been graded. With the above findings stakeholder mapping has been done. Initially a brief overview during the awareness meeting has been given and then conducted a stakeholders meeting to incorporate ideas and consensus for a compromised solution. The proposed and agreed solution has been incorporated in the annual program of the Coast Conservation Department for implementation. The GWP–SA, Sri Lanka country water partnership has provided funds and expertise in conducting the stakeholders dialogue. Finally lagoon stakeholders committee has been formed and their capacity has been build up to accept the challenge of opening the river outlet.

Conclusions

Complex water issues can not only be managed by water professionals in favour of the most dominant stakeholder, which we are practicing usually. Compromised solutions can be achieved if a fair stakeholder interaction and dialogue is allowed and sense of ownership is build up among stakeholders.

Practical Experience towards Implementing IWRM for Sustainable Management of Water Resources in Ethiopia: the Case of Two Pilot Watersheds

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Keywords: IWRM, Ethiopia, piloting, stakeholders' forum, sustainable management

The Project:
Ethiopia is endowed with huge water resource potential (about 122 Bm3 annual surface runoff and 2.9 Bm3 ground water) even though its contribution to socio-economic development is little. The country's average access to water supply is 34; area of land under irrigation is only 5% of the potential; and that of hydropower is only 2% of the big potential (2nd in Africa). This is due mainly to lack of coordination/cooperation among various stakeholders, lack of integrated and participatory approaches in planning and implementation.

Ethiopia formulated Water Policy, Strategy and 15-years Development Program based on the principles of IWRM. It is therefore possible to say that the county has already adopted the principles and approaches of IWRM and has already developed its National IWRM Plan.

Ethiopia Country Water Partnership (ECWP) is currently testing the National Plan on the ground. ECWP's project, to promote and implement IWRM in Ethiopia, will test IWRM principles and approaches at two pilot learning watersheds for country-level scaling-up.

One of the IWRM pilot learning sites is Berki. Berki catchment is shared by two districts or weredas. The upper Berki catchment is characterized by mountainous terrain, where the river has formed some gorges. Farmers in this area use pumps to take water from the river, with a possible impact on downstream users. In the lower wereda, there are two diversions constructed on the Berki river for irrigation purposes. Local businesses extract sand from the river and use the water to make bricks and concrete pipes. Moreover, communities in the lower catchment area have been practicing traditional irrigation for more than 100 years. Near the Berki diversion, there is a holy water spring capped by a Church for spiritual purposes, but the Government plans to use it to supply water to a small town nearby. Communities farther downstream suffer from lack of water in the dry season due to pumps and diversions at upstream locations.

The other pilot IWRM site is Messena micro-watershed which includes mountains, villages and farmlands. It falls within two sub-district or kebeles. Most inhabitants depend on growing crops for their livelihoods but their farmlands seasonally flooded by overflow of a river. World Vision diverted the river from its natural course in one place by constructing a dike to reclaim farmlands. People also plant eucalyptus trees to solve drainage problem. There are large numbers of animals in the Messena watershed that freely graze on the mountainside during the rainy season and on the floodplain during the dry season. Overgrazing has led to destruction of natural resources, especially on the mountainside. On top of this, some stone mining activities are taking place in the mountain area, also destructing natural resources, leading to heavy runoff during the rainy season. Pastoralists migrate to the Messena area during dry seasons in search of pasture and water for their cattle. Migrants bring huge numbers of cattle, causing a lot of destruction to natural resources in Mesena watershed.

There are different sectors (water, agriculture, environment) and stakeholders (NGOs, private enterprises, local communities, pastoralists) with various interests in using water in Berki and Messena watersheds. Different sectors/stakeholders are working independently without integrating or worrying about the sustainability of the two systems. Conflicts between upstream and downstream communities; between the administrative authorities; between local business and other development schemes, etc are prevailing in the two watersheds. Water in Berki is scarce and therefore needs to be used efficiently and effectively. However, water in the Mesena watershed is not scarce, the main problems being runoff from the mountain due to deforestation and uncontrolled grazing, and drainage of farmlands due to overflows from the Borkena River.

Results/Findings:

1. policy and implementation gaps for IWRM have been identified and strategies for IWRM promotion developed. The strategic approach being followed is to learn from practical experiences of two IWRM pilot projects and scale-up at country-level by building on the existing framework.

2. the study on existing water resources framework of Ethiopia identified gaps such as lack of integrating water with land resource management, decentralization with out building local level capacity, lack of holistic approach and integration among different sectors and programs. Moreover, low level of awareness, lack of regulations and limited private sector involvement are identified.

3. Applying IWRM in a watershed requires establishing stakeholders' forums for participation and coordination at different levels.

4. use of hydrological boundary instead of administrative boundary as planning and implementation units in water resources management

Conclusions and Recommendations

Integrated Water Resources Management involves integration across sectors, integration of use, integration of demand, integration with the environment as well as integration with the people. The presentation will cover the challenges of sustainable water resources management in the two pilot IWRM watersheds in Ethiopia and some of the approaches being followed by the ECWP towards implementing IWRM approaches/principles/. This will help to bring changes in the country's water resources management approaches from sectoral to cross-sectoral/integrated, using watersheds/hydrological boundaries as units of water resources management. Moreover, ECWP's project would provide lessons for other countries and regions by way of implementing National IWRM Plans agreed during the World Summit on Sustainable Development (WSSD) in 2002 since the project is the first of its kind in the country, if not in the African region, in terms of actual implementation of IWRM principles on the ground.

Participative management decision making guidelines for Quebec watershed agencies

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Keywords: participative management, decision making process, facilitators, information flux, efficiency

Water in Canada is clean, free and so abundant that the resource has always been taken for granted. The international reality on water has made Canadians realize their privileged situation and is slowly increasing their awareness of the necessity of a more integrated and responsible type of water management. Being a constitutional federation, the political scene in Canada is often complex. Water is no exception. General jurisdiction over water was not allocated to any specific level of government in the constitution. Jurisdictions thus rely on a certain number of enumerated powers. For example, fish, navigation, and dams fall under the federal jurisdiction while the quality of the water and most potential sources of pollution such as mines, agriculture, forestry, industries, etc. are under the provincial jurisdiction, or both (federal and provincial) if fish habitat is affected. Water utilities are provided and regulated by each municipality. As a result of this political reality water management must not only be integrated horizontally (by sectors) but also vertically (by jurisdictions). In 2002, the Quebec Government released a Water Policy, which introduces measures and commitments to implement a watershed-based management through the establishment of 33 watershed agencies. According to the new policy: "watershed-based management is based on the concerted efforts of all the water-management players involved (municipalities, citizens, developers and interest groups, ministries and government organizations), and it aims to facilitate better integration of the multiple interests, uses, concerns, and action mechanisms of the community." Watershed agencies are responsible for implementing integrated management by preparing a Master Plan for Water (MPW) for their respective watershed, which includes watercourses, lakes, marshes and other wetlands, as well as any aquifers in the area. They act as planning and consultation tables. The MPW must include: 1) a description of the watershed, including a diagnosis of its environmental problems (hydrological and plant- and wildlife-related); 2) a list of wetlands and aquatic environments of ecological significance; 3) a statement and prioritization of the relevant issues, orientations, and courses of action, and of the results to be achieved, based on the orientations of the Policy and due to concerted efforts by the water-management players in the watershed and on public consultations; and 4) an action plan specifying the goals to be reached as well as the terms and schedule of implementation. Although the watershed-based management formula is welcome in Quebec, it encounters nevertheless several formal and informal barriers such as: constitutional jurisdictions, agencies' lack of legitimacy and legal powers, non enforceability of the MPW, plurality and diversity of interests, lack of financial resources; deficient informational flow, lack of expertise, etc. In its actual form, watershed agencies are used as consultative entities without even powers of recommendation to the government. Three years after the organization of water agencies, many community stakeholders are now asking for a more influential role for the agencies. Acknowledging that further development toward official recognition needed a better structured relationship between actors, a cooperative watershed-based management model based on local governance was developed at the University of Sherbrooke, in collaboration with the watershed agencies. Main features include: a dynamic decision making process which combines pluralism, transparency and accountability; efficient dialogues through developed information networks and use of multidisciplinary facilitators specially trained at the University of Sherbrooke in the prevention and resolution water related conflicts; the establishment of performance indicators, educational programs for stakeholders, a coordinating leadership entity, etc. This new operational framework has the advantage of: 1) increasing the credibility of the decision making process and raising the public participation, consequently; 2) legitimising the watershed agencies and enhancing their central role in water management even without formal legal recognition; and 3) assuring a functional and efficient water management system.

Issues Related to the Regulatory and Legal Base Development for Water Quality in Central Asia

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Keywords: water quality issues, sustainable development, Maximum Permissible Concentrat, Maximum Permissible Water Disc, transboundary rivers pollution

It is known that excessive water intake and development of irrigated farming in Central Asia have exceeded the capacities of water ecosystems and entailed its destruction and relevant disastrous consequences. However, despite the Aral disaster, the needs of ecosystems and their limited natural capacities are still not being taken into consideration.

Water quality issues

A crucial issue, wrongly put aside, is water pollution, though, as it is known, the quality and quantity of water resources are interrelated and indivisible. As a result, the quality of drinking water and health of the population is being aggravated, the soil fertility and yield are being reduced, poverty and migration are flourishing.

As irrigation is developing in the CA region and drainage systems are being constructed, we could witness sustainable growing development of return water, which was particularly intensive within 1960-1990. On average, for the period of 1990-1999 the total of return water ranged from 28.0 to 33.5 km3 a year. 13.5 to 5.5 km3 was annually developed in the Syrdaria basin and up to 19 km3 in the Amudaria basin. Over 60% of the total of return water is being taken through headers to the rivers, about 27% remains in saddles. Only 13% of return water is re-used in irrigation, which is due to its uselessness because of pollution. The downstream countries receive water after it has been used and badly polluted with chemicals, which brings to the pollution of crops and repeated soil salinization and pollution. Thus, the issues of tansboundary rivers pollution should be addressed on the agenda of international organizations, such as TACIS, USAID, IFAS, IWCC, ICSD, etc., where the issues of interstate and intersectoral apportioning of water should take into consideration both quantitative and qualitative water features.

The issue of return water and numerous reservoirs, established on their basis, should also be addressed both at the regional and national levels.

The issue of regulatory base development

The CAREC activities, supported by GWP, UNECE and UNDP, addressing water quality issues for CA and Caucasus and exchange of experience in the field of regulatory and legal base and perspectives of its development, have revealed the following:

- insufficient systematization of the legislative base and by-laws in the field of water quality regulation;

- the Maximum Permissible Concentration lists contain substances, which, in principle, cannot be identified through analytical methods;

- lack of differentiated approach to the regulation of natural substances in water objects of various physical-geographic regions (regional or basin norms);

- almost no link between regulation of dumping of pollutants and real relevant economic and technological capacities;

- insufficiently justified norms of pollutants, being dumped into the water objects entailed by imperfect system of standards and acting methodologies of Maximum Permissible Water Discharge;

- lack of system of overall toxicological supervision of the wastewater quality;

- departmental isolation in terms of development, application and supervision of the water quality indicators;

- tendency to expand lists of chemical indicators which entails a more expensive supervision of pollution estimate in line with the adopted payment system;

- lack of developments in the single interstate list of regulated pollutants in water environment and regional lists of priority pollutants;

- lack of information exchange between transboundary states;

- decision-making support systems, as a rule, are not being used within the regulation and supervision processes;

- lack of priority system of on-line forecasting and liquidation of consequences of disasters, related to pollution of water objects.

According to experts, the acting nature management regulation of the surface water quality in Central Asia also has some drawbacks as follows:

- lack of the single concept of nature management regulation of water quality, identifying the objectives and criteria of estimates of the condition of river ecosystems under these or those anthropogenic impacts;

- lack of unified principles and methods of environmental regulation of the subsurface water quality both at the interstate and national levels, specific requirements to justification, reliability and regular correction of norms and regulations of the environmental safety;

- lack of space-time differentiation and restrictions for use of environmental norms, applicable to various natural zones, and to preserve the whole river ecosystems and not some of their components;

- lack of sufficient empiric data and proper procedures of environmental diagnostics of both the quality of surface water and the conditions of river ecosystems on the whole, physical and mathematical models of river ecosystems;
- lack of organizational and material and technical conditions to carry out scientific research and development activities to ensure environmental safety, including environmental regulation of the water quality.

The following recommendations were made at the workshops on water quality issues:
CAREC should continue enhancing cooperation between the countries, water and environmental sectors, to improve the systems of water quality regulation. To this end it shall:

1. Establish a task group, comprising representatives of CA countries, to enhance cooperation in the field of improved regulatory base for water quality regulation.
2. CAREC, REC Caucasus in collaboration with the task group shall summarize the workshop reports, materials and recommendations to develop further practical steps in the field of improvement of the regulatory base for water quality regulation.
3. Request international organizations to provide support to CA and Caucasus in their efforts to improve the regulatory base and harmonize legislations of the countries, based on the best international practices.

The Rationale for Development of a Participatory Decision Support System for Water Resources Management in Uganda

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Keywords: decision support systems, multi-criteria analysis, stakeholder participation, social learning, Uganda

Presentation of Topic and Analysis of Issues:

This paper presents results of a needs assessment that was carried out as a preliminary phase of a study being undertaken by Makerere University, Kampala in collaboration with KTH, Stockholm. The study will involve the application of Multi-Criteria Analysis (MCA) to structure and analyze the conflicts inherent in water resources management for the Kafu River catchment, Uganda. The goal of the study is to establish a framework to guide subsequent development of a participatory Decision Support System (DSS) that will aid planners and decision-makers to make better decisions concerning water resource utilization for the area.

At the onset, it was considered necessary to explore the need for enhanced decision support in the sector, and to identify a suitable approach towards meeting this need. Specifically, a needs assessment was carried out in order to: (1) assess the current system of WRM in Uganda with respect to the need for provision or enhancement of decision support in the planning and management processes; (2) identify DSSs in current usage in WRM in Uganda, and assess their contribution in meeting the need for decision support in the sector; (3) make recommendations concerning a suitable approach for the planned development of a DSS for the selected catchment.

In the Constitution of Uganda under Objective XXI, the state undertakes “to take all practical measures to promote a good water management system at all levels”. Based on this, a National Water Policy (NWP) was formulated to promote an integrated, multi-sectoral approach to water resources management in the country. According to the NWP, the role of Government is “… to manage and develop the water resources of Uganda in an integrated and sustainable manner, so as to secure and provide water of adequate quantity and quality for all social and economic needs of the present and future generations with the full participation of all stakeholders.”

Prior to the formulation of the NWP, water resources management in the country relied ineffectively on single-sector and top-down strategies, without proper holistic concerns and sense of partnership and shared responsibilities. There is now growing consensus that an effective way of ensuring sustainable development and use of water resources is through locally-based planning and management of development activities, characterised by the involvement of the beneficiaries in managing water at the lowest appropriate level.

This calls for the development of decision support tools that enhance the participation of both technocrats and the lay public in the decision process. Such tools need to be structured to fit in with existing policy frameworks and responsibility allocation in Uganda's water sector. They should be tailored to the local conditions prevailing in the country, and accommodate specific needs as identified by stakeholders within a participatory, bottom-up development framework.

Discussion of Results/Findings:
Within the prevailing decentralized framework of local governance, the capacity at district and lower levels to plan and implement sector activities is low, and additional central support is still needed. Likewise, the capacity at the centre (in terms of skills, technology, etc) is also limited. Efforts geared towards providing the requisite capabilities, in form of an appropriately constructed DSS, are therefore both timely and desirable.

Few DSSs for WRM were found to be in use in Uganda. Examples of those encountered include the Lake Victoria Decision Support System (LVDSS) and the Nile DST. However, these DSSs were considered to be rather technocratic in nature, deploying mainly scientific/quantitative information, and requiring skilled users to undertake the analysis. This was considered to be a hindrance to the effective devolution of such tools to users at the grass root (the district and local authorities).

Furthermore, to persuade stakeholders to collectively arrive at a decision, especially when involving compromise, requires the decision making process to be transparent and fair. This calls for the application of rigorous logical procedures which can incorporate all relevant factors. A number of possible approaches, including the traditional monetary based methods such as Cost Benefit Analysis and Cost Effectiveness Analysis, were considered and it was found that decision analysis techniques such as Multi-Criteria Decision Analysis (MCDA) were better suited to the above purpose. It was therefore considered that it would be beneficial to use MCDA as a basis for the participatory DSS to be developed.

Conclusions and Recommendations:
In spite of rapidly advancing computer technology and the proliferation of software for decision support, relatively few DSSs have been developed, implemented, and evaluated in the field of water resources, particularly in Uganda. Furthermore, there are still open methodological questions concerning the development and structure of operational DSSs in the field of WRM, and so there is room for applied research in developing tools that match local needs.

Because emphasis should be placed on the involvement of stakeholders in decision making as part of a social learning process, the need for development of an appropriate stakeholder-participatory Decision Support System for use in the local Ugandan context has been identified. It has also been recognized that MCDA methods are well suited to group decision making in a multi-factorial context, and so MCDA will be applied in the ongoing study in a participatory process of problem structuring, identification/evaluation of alternatives, and group consensus seeking. This work is being carried out within the framework of the Sida/SAREC-funded project "Sustainable Technological Development in the Lake Victoria Region".

A Decision Support System for an Integrated Water Resources Management in Vietnam

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Keywords: Decision Support System, IWRM, GIS, Vietnam, South-East Asia

Vietnam is facing a rapid economical growth. Connected to this development severe problems and challenges concerning the environment and the water resources occur. Also, water conflicts began to arise between different water uses such as irrigation and water supply for domestic and industrial demand, fisheries and eco-system protection. Additionally, Vietnam is obliged to the Agenda 21. Here, the Vietnamese Government developed the "National Plan for Environment and Sustainable Development: A Framework for Action" in which the implementation of an Integrated Water Resources Management is embedded.

In this context a Decision Support System (DSS) for an Integrated Water Resources Management in Vietnam is being developed and is going to be applied exemplary to three provinces in Vietnam. The project is funded in a framework of eight Integrated Water Resources Management (IWRM) Projects in different countries all over the World by the German Federal Ministry of Education and Research (BMBF).

The three selected provinces in Vietnam are characterized by different hydrological, economical, socio-economically and ecological challenges: a coastal area located in the north of Vietnam, facing industrial water pollution issues; an area situated in the central highlands dealing with rural water pollution issues and an area in the Mekong Delta, facing severe water pollution issues due to agricultural land use (e.g. agrochemicals, animal husbandries, etc.), water quality problems because of salt water intrusion from the sea and acidification due to acid sulphate soils. Also the latter is facing problems such well severe flooding by the end of the rainy season and water shortage in the dry season.

The Decision Support System integrates economic, environmental and social aspects with the objective to serve River Basin Agencies and Governmental Agencies in Vietnam. With this Decision Support System prognoses of the water demand is being calculated. This calculations include among other things the water demand of the population and the different economical sectors (e.g. agriculture, industry, aquaculture). Also, the use of the different water resources is being simulated and the impact on the quality and availability of water resources due to its use are matter of the investigations.

The Decision Support System is distinguished by a modular concept, so that in the future the DSS can be implemented and adjusted to other areas with different boundary conditions. The different modules of the Decision Support System do exist out of databases, simulation tools as well as assessment and appraisal tools. The Decision Support System is connected with a Geo-Information System (GIS) so that a spatial evaluation and visualization is possible.

Modules are created for the water resource, for the possible water technologies and for the socio-economical background:

- the modules on water resources do enclose ground water, surface water, rain water regarding their quality, quantity and availability. This also includes mathematical models to calculate the impacts on surface water and ground water resources.

- the modules dealing with the water technologies consider drinking water and waste water treatment systems including the water supply for drinking water, domestic water and water for the industrial use. Also the demand of different user groups, the influence of the different water technologies on water tariffs and operational costs are matter of these modules.

- the modules regarding the socio-economical background is considering among other factors the development of the population, the industry, the trade agricultural as well as the possible impact of on the state of health through the installation of different water treatment systems.

Following this modular concept a survey and an appraisal of the status-quo as well as a prognosis and an appraisal concerning the expected development is done. Based upon these results measures for possible answers to the problems concerning the sustainable development of the water management are deducted.

Partnership approaches to decision making: 20 years of progress in the Mersey Basin

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Keywords: partnership, decision making, clear objectives, public participation, sustainable development

Introduction

The Mersey Basin Campaign is a government-led cross-sectoral partnership with over 20 years of experience in the delivery of Integrated Water Resources Management. The Campaign provides a setting for the UK government and other key organisations to discuss and resolve issues relating to the management of water resources in England's Northwest. The decision support system provided by the Campaign has enabled partners to transform the River Mersey and to enable the region's watercourses to contribute to, rather than detract from, sustainable regeneration.

The Mersey Basin Campaign

The Mersey Basin Campaign was established in 1985 and is now active in the catchments of the Rivers Mersey & Ribble. The Campaign territory covers 1,756 square km from the Irish Sea to the Peninnes taking in Merseyside, Greater Manchester & Cheshire along with parts of Lancashire & Derbyshire. The population of this area is over 6 million.

The Campaign has successfully pioneered a partnership approach to Integrated Water Resources Management. The Campaign works pro-actively with actors from the public, private and voluntary sectors. Many of these partners are not traditionally associated with water resource management.

The Mersey Basin Campaign has three core objectives that are integrated through an annual corporate plan:

- improving river basin quality
- encouraging sustainable waterside regeneration
- engaging individuals, communities and businesses in the process

What has the Mersey Basin Campaign achieved?

In 1981 water quality in the River Mersey was described as "disgraceful". By 1999 the Mersey Basin Campaign had secured the inaugural World Riverprize for its clean-up of the catchment. By 2004 there was an active fish population within the River Mersey. This turn-around in water quality is the result of many integrated actions, including the investment programmes of the water company, greater regulation by the Environment Agency and changing practices within industry.

The second objective of the Mersey Basin Campaign focuses on waterside regeneration. Since the 1980s watersides have played a major part in the rejuvenation of the cities of Manchester & Liverpool. Major investments have taken place at waterside sites such as Albert Dock and Salford Quays. The Campaign has also implemented a number of innovative environmental improvement projects. For example, Speke Garston coastal reserve, Liverpool. Local young people, many of them excluded from the formal education system, have contributed to the design of this project.

Public participation is a key principle of the Campaign approach. Groups & individuals across the region are engaged on a regular basis with an annual Mersey Basin Week the focus of this work. In 2005 over 4500 volunteers took part in over 300 events throughout the region. Meanwhile, an annual programme of business awards recognise excellence within the private sector and help to drive up environmental performance.

How does the Mersey Basin Campaign work?
The Mersey Basin Campaign's philosophy is based on practical project implementation through a number of approaches:

The Campaign seeks to influence policy makers and decision takers across the region. Its quarterly publication, Source NW, highlights significant issues and promotes debate under a number of headings: waters, regeneration, environment & sustainability.

The Campaign enables partners from all sectors to manage water resources. For example, the European Interreg IIIc funded ENMaR programme is helping planners in England's Northwest to understand the Water Framework Directive and bring together the disciplines of land-use planning and water resource management. At the European level ENMaR brings together partners from Germany, Latvia, Spain & Sweden. Meanwhile, the Campaign has developed an innovative stakeholder mapping technique to enable the Environment Agency to test public participation in the Water Framework Directive (WFD) Ribble Pilot Project.

The Campaign enhances the water management practices of partner organisations. A network of local Action Partnerships works to engage the community and deliver small-scale environmental improvement projects.

The Campaign communicates with partners at all levels through an annual conference and a programme of sub-regional forums. These events enable the Campaign to communicate with its audience and to gather and understand the views of partner organisations. The Campaign website provides a regional portal for groups and individuals interested in the management of water resources.

Critical success factors
The Mersey Basin Campaign highlights a number of factors which would be central ingredients to any decision support system in the field of IWRM:

Partnership: the rejuvenation of the Mersey & Ribble catchments requires the concerted efforts of many players.

Clear Vision: the 3 simple objectives have enabled the Campaign to maintain clarity of purpose.

Realistic time scale: it takes at least 25 years to repair the damage of over 200 years of neglect.

Delivery at all levels: the contributions from large companies and small-scale voluntary organisations are equally valid.

Resources: the scale of investment by the water company has underpinned much of the progress of the Campaign.

Leadership: the appointment, by government, of a strong chairman helps to ensure partnership focus.

Conclusion
The Mersey Basin Campaign has worked with the UK government and partners from the public, private and voluntary sectors to transform and regenerate the Mersey & Ribble catchments. This practical, output-oriented, approach has attracted international interest in the work of the Campaign.

The Campaign faces new challenges in the years ahead. It is confident that it has the structure and experience to continue to make an active contribution to the sustainable development of England's Northwest.

Improving Software for Decision Support Systems of the Dnieper River

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Keywords: Dnieper River, Decision Support System, software, management, reservoir system

Presentation of the topic and analysis of the issue: The Dnieper River is the third largest river in Europe, with a catchment area of 505000 km2. The lower part, from the border between Belarus and Ukraine to the Black Sea, is regulated into a cascading series of six reservoirs. The total head is approximately 100 m. The average flow varies from 1050 m3/s (33.1 km3/year) at the upper reservoir (Kiev) to 1650 m3/s (52.0 km3/year) at the lower reservoir (Kakhovka). This is a multipurpose river regulation, mainly for irrigation, hydropower, and navigation. The hydropower system has an annual production of approximately 10 TWh. The Dnieper Cascade has also played an important role as a reserve energy production facility during the last decade. This situation has led to extensive reservoir utilisation, which has resulted in increased conflicts with other user interests. The Joint Commission has proved to be a useful instrument for compromising between conflicting interests among its members. It is mandatory for the member organisations - the main water users - to participate in the meetings and to reach decisions. The main conflicting interests are the need for the hydropower companies to draw on reservoirs to produce energy, the irrigation interests to extract water from the reservoirs. Decision support system is important decision support tools both for short and long term planning of reservoir and HPS operation. In work the analysis of the software decision support system is represented and the methods of its improving are shown.

Presentation of the results: There is always room for improving the hydrological forecasts in a system like the Dnieper River, and it would normally be cost efficient to do so. A hydrologic forecasting model for the Dnieper would seem to be an obvious upgrade of the present forecasting system. In the present situation, however, it is even more important to focus on the necessity and importance to maintain and upgrade the real time hydrometeorological monitoring and data collection system of the Dnieper Basin, including Belarus and Russia. The obstacles in such a process are mainly financial and administrative, not technical.

The short term planning is essentially an internal matter for the reservoir and hydropower operators, and is commonly strongly integrated with other decision support software for the operators. Development of such software is best seen in connection with the new SCADA system planned for the Hydropower Stations in the Cascade. Standard program systems developed by specialised software development firms companies like VNIIE or other providers are probably the best choice for this task.

The weakness of the present simulation/optimisation model (VNIIE "BWD") is, apart from its limitations in number of time steps and its somewhat outdated user interface, that it requires deterministic input, i.e. that the inflow is known throughout the simulation period. This is not very well suited to the hydrology of the Dnieper, which in spite of its size show rapid variations that are difficult to predict. It is easy to develop in a modularised approach that does not interfere with the other programs and the day-by-day operation of the HPS. As a result of this, an integrated inflow forecasting/hydrograph generation module, FHGM, has been developed and implemented at the Client. This software generates hydrological input to the "BWD" model, which is the standard optimisation/simulation model used at UKRENERGO.

A stochastic simulation model can further be combined with economic loss functions (when they are better developed than presently) to describe risk and expected losses and gains for the different users. When this is done, with the consensus of all users about the loss function parameterisations, an optimising water allocation model is in principle realisable, treating the environmental aspects through constraints.

Conclusions and Recommendations: The information on the economics of other water users than the hydropower sector is still too scarce and unsystematic to parameterise optimisation models for water allocation (see above). Further, the organisational set-up of the water management of the cascade, with negotiations between the users through the Joint Commission, calls more for simulation models to clarify consequences of alternative actions than for optimisation models. It is recommended that the BWD model in due time is replaced by a stochastic simulation model that describes probabilistically the outcome of different operation alternatives.

Development of a portfolio of computational and participatory tools for Lower Mekong Basin

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Keywords: integrated approach, multidisciplinary, modelling, socio-economic analysis, stakeholder participation

Introduction: Integrated Water Resources Management (IWRM) asks for a comprehensive approach that analyses and integrates information of various types. This, in turn, supports balanced decision making and management processes that include a variety of stakeholders and see water as a broad entity having close connections to other sectors. This poster discusses the implementation of the IWRM to support decision making and management by presenting a practical example from a water modelling project in the Lower Mekong Basin in Southeast Asia.

The context: The mighty Mekong River is one of the largest rivers in the world having a total length of approximately 4880 km, catchment size of 795,000 km2 and average flow of 14,500 m3/s. The river is shared by six countries: China, Myanmar, Lao PDR, Thailand, Cambodia, and Vietnam. The four latter downstream countries form the Mekong River Commission (MRC) which, following the Mekong Agreement in 1995, was established to agree an equitable and sustainable use of water resources in the Lower Mekong Basin.

The Mekong River is a lifeline for its riparian countries, as a majority of the basin's inhabitants are dependent on water and natural resources–particularly rice and fish–for their livelihood. In addition to direct economic values, basin's water resources possess remarkable social, cultural and spiritual values. The Mekong Region is currently facing rapid changes, and there are different kinds of plans and needs for the development of region's water resources. The hot topics for the development range from hydropower development to sanitation, and from traditional farming and fishing practices to aquaculture and irrigation. Many of these plans and needs are conflicting, and a balanced management of basin's water resources asks therefore for comprehensive understanding of area's water resources and well-functioning dialogue between different levels and stakeholders.

WUP-FIN: The poster shares experiences in supporting the water-related decision making process within the Lower Mekong Basin and the MRC by presenting on-going work carried out within the Lower Mekong Modelling Project (WUP-FIN). WUP-FIN is a complementary project to the Mekong River Commission's Water Utilization Programme and it is realized by a multidisciplinary consortium consisting of governmental research institute, university and small private company. In addition to actual hydrological, hydrodynamic and water quality modelling, the project has strong focus on socio-economic and policy analyses and on capacity building for both the MRC and national ministries and universities. The main aim of the project is to complement the MRC's Decision Support Framework (DSF) to improve its hydrological, environmental and socio-economic impact assessment capabilities, and thus to enable more balanced decision making within the Lower Mekong Basin.

The Mekong Basin is a complex system of rivers, channels, dykes, embankments and large areas of floodplains. In order to simulate this system comprehensively and to understand different hydrodynamic and water quality conditions and their possible changes under different kind of development scenarios, a set of a set of hydrological, hydrodynamic and water quality models (1D/2D/3D) were developed within the WUP-FIN Project. The models were used to analyse information particularly on following indicators: flood characteristics (duration, area, arrival time and depth), dissolved oxygen, total suspended solids and net sedimentation, and dry season water quality.

Just developing these models were, however, not seen sufficient in order to carry out social and environmental impact assessment of different development scenarios, and to link modelling better into social, economic and environmental issues. Consequently, the developed models were complemented with comprehensive environmental, socio-economic and policy analyses with strong stakeholder involvement in different levels. In order to ensure wide stakeholder participation and a comprehensive understanding of most relevant social, economic and political issues within the Lower Mekong Basin, several different methods were applied for the socio-economic and policy analysis. Main methods used included participatory village surveys based on PRA-methods, key-informant interviews in different management and user levels, socio-economic database analysis in GIS, and water-related policy model based in Bayesian probabilistic networks.

Conclusions: Integrated and multidisciplinary approach is needed to manage water resources in an environmentally sustainable and socially just way. Standard practices for this kind of integrated approach do not exist and several challenges are confronted in the practical level. Among the most important questions are: how to integrate the different types of information available on water resources; how to carry out the integration in a participatory way including all the stakeholders; and how to link the actual analysis and integration work on decision making processes in a meaningful and efficient way.

The experiences from WUP-FIN Project show that for IWRM to truly be successful and meaningful, also sectoral projects with main focus on for example hydrological modelling should develop more compatible and multidisciplinary approaches. This leads to increased understanding of other sectors, enables creation of better linkages with these, and ultimately, leads to decision making that is transparent and better connected with other sectors and management processes.

Water Supply: a Gift from God or Does it Come with a cost?

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Keywords: cost recovery, water management, water supply, awareness raising, perceptions

Water is a limited resource in Namibia, the most arid country south of the Sahel, and much needs to be done to address its management and sustainable use. Namibia's policy on Integrated Water Resource Management (IWRM) regards water as an economic product, and individual water users are expected to pay for their water supply. NamWater, the country's bulk water supplier, operates on a cost-recovery basis. But payment for water is not being easily accepted, and it is a hot discussion topic within government, the media and amongst water users in Namibia.

Two independent studies on socio-economic and biophysical aspects of payment for water were conducted in north-central Namibia through the Desert Research Foundation of Namibia (DRFN). The aim of both projects was to elaborate on the use, supply, payment and management of water in order to provide information to the relevant decision makers, including Water Point Committees (WPCs), the Basin Management Committee (BMC) and the Directorate of Rural Water Supply (DRWS), the government authority that oversees water distribution in rural areas. The study area in north-central Namibia included four constituencies for the one study, with two additional, nearby constituencies being addressed by the second project.

The water provision set-up is this: NamWater has its own pipelines to supply bulk water to its clients, such as DRWS and Municipalities. DRWS, in turn, has its own pipelines that supply individuals and water points in rural areas. Each communal water point has a WPC responsible for overall management of the water point, including collecting monthly water payments. In both DRFN projects, households with private connections pay more than households using communal water points, because their consumption is individually metered and it is generally higher than the consumption of people using communal water points.

The two studies involved interviews with rural farmers on communal land and water supply authorities. Results indicated that most people in the study areas pay for water, but only a few know why they must do so. The majority of interviewees have the perception that water supply is the responsibility of the government and should therefore be free. Some believe that it is a temporary arrangement. Some even consider water as a gift from God - and how can one charge for that? Moreover, because of the resistance to pay for water, some people still rely on potentially unsafe water sources such as hand-dug wells, earth dams, excavations and natural pans.

There is considerable confusion on where and to whom communal rural farmers pay. The majority of people interviewed in the one project claimed that they pay a fixed price of N$10 per month, while in the other project interviewees said the rate is N$13. According to DRWS, there is no such thing as a fixed price, and all water users should pay at a rate based on their consumption.

Fifty-eight percent of the people interviewed in the one project stated that they are connected to the DRWS pipeline, while 79% of the people in the other project said they are connected to NamWater. In fact DRWS is responsible for supplying water to all the people in both project areas. With confusion regarding the payment system, some communities believe that the WPC members are to blame, and this makes the WPC members feel unsafe in their own communities. One of the reasons why people think water should be for free is because they do not know the whole process involved in supplying water to them and where the water comes from. The findings also suggest that the problem is more related to unwillingness to pay, based on this lack of understanding, rather than actual inability to pay for water.

For better implementation of IWRM, it is important to distinguish between perceptions held at the grass-roots level, what the suppliers plan to implement and what national policy says. Awareness raising on functions of water supply systems and payment procedures could contribute to better understanding amongst individual farmers and decision support groups such as WPCs and the BMC. This could lead to a change in their perceptions regarding payment for water and enhance implementation of IWRM principles.

Industrial Enterprises and Public Participation in the IWRM in Bulgaria

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Keywords: IWRM, WFD, public participation, industrial sector, Bulgaria

The poster outlines some major aspects concerning the implementation of IWRM in the context of EU Water Framework Directive /WFD/ in Bulgaria. The importance the business sector as a partner in IWRM and the participatory decision-making is justified. The analysis is focused on the private sector role and the need of partnerships in IWRM.

The implementation of the IWRM in Bulgaria requires for the first time full integration of stakeholders and civil society in the decision-making processes. It is necessary to raise the awareness of relevant sectors and to strengthen stakeholders' partnerships and networks so that they could efficiently participate in new public-private consulting bodies for development of river basin management plans. The review of initiatives, that have been implemented so far, shows that industrial enterprises do not participate actively in capacity building projects or their involvement is limited to informing them only about technical requirements concerning water resources quality and quantity. At the same time, these enterprises are an important sector in the partnership for integrated water resources management. That is why, it is necessary to improve their capacity for participation in decision-making processes.

The poster presents empirical results of a survey of medium- and large-sized industrial companies (major water users and polluters) from the Black Sea, East Aegean and West Aegean Sea Basin Districts, carried within the framework of a Phare project. The main topics of the survey are: awareness of the water protection Acquis, experience in implementing Bulgarian legislation for water protection, notions about participating in water resources management, attitude towards networking and partnerships, assessment of institutional capacity.

The poster outlines lessons learned. The experience of Bulgaria shows that the success of the new approach IWRM strongly depends on the efficient participation of all interested parties (stakeholders) and the synergy among different sectors, legislative acts and policy instruments. Tools for enhancing involvement of the business sector in the IWRM and improving the functioning of basin councils as decision-support systems are proposed.

Bibliography

Common Implementation Strategy for the Water Framework Directive (2000/60/EC), Public Participation, 2003
GWP ToolBox, www.gwptoolbox.org
Lanz, K., S. Scheuer, EEB Handbook on EU Water Policy under the Water Framework Directive, European Environmental Bureau, 2001,
Phare CSD Programme, 2002-Lot 1-012, Awareness raising and improving the implementation of the EU legislation in the water protection area /unpublished results in Bulgarian/, 2005

Mapping of Local Water Supply Coverage – A Case Study from the Lake Kiyanja Watershed, Masindi District, Uganda

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Keywords: Rural water supply, Uganda, Water supply coverage, Geographic Information Systems, Decision Support Systems

The goal of this work is to produce a map suitable for integration within a Water Resources Engineering and Management Decision Support System. Such a system would enable water-supply planners to make appropriate planning decisions in order to improve a given population's access to safe water, to effectively co-ordinate future development plans, and to prepare for potential threats that may affect those water supplies.

In the early 1990's, Uganda began an Integrated Water Resources Management process, of which a primary goal was to improve access to potable water for the country's population. This process has led to a groundwater-resources mapping program. Such efforts are timely: a detailed understanding of the water resources available within a particular region is essential in order to help maximise a given population's access to water, efficiently plan for future developments and potential threats, and consider the sustainability of water exploitation programs.

In rural Uganda the population rely on deep borehole wells, shallow wells, protected springs, streams and rivers, lake water and even wetlands for water supply. Only the first three are considered to be potable water sources, although even these sources may be contaminated. In some of the larger towns people may have access to a water-distribution system. However, many still rely on the aforementioned sources. The water supply coverage (the percentage of the population that has access to potable water) was estimated to be 58% in 2004 by the Directorate of Water Development. This value is somewhat short of the United Nations Millenium Development Goal of 95% water supply coverage by 2015.

Water supply coverage can be estimated by conducting house-to-house surveys, as was done by the joint monitoring program undertaken by UNICEF and WHO in 2002. The method used by the Directorate of Water Development in Uganda is to assume a given type of water source supplies a fixed number of people; then by multiplying this fixed number of people by the number of water sources and dividing by the total population the water supply coverage can be estimated. Both these methods suffer from various disadvantages: the former method is work-intensive, requiring much time and effort in data collection, while the latter method may grossly underestimate or overestimate the percentage of the population with access to potable water.

In this paper a method of determining the water supply coverage in Uganda is developed using the Geographic Information System software, ArcGIS. The Lake Kiyanja watershed in Masindi District is used as a study area. Known water resources are mapped, and then combined with a map of the local population distribution. This combination results in a map of the water supply coverage within the study area. Spatial data for the water sources was available from the Directorate of Water Development. However, population density data was not available. Thus various methods of mapping population density are studied in this paper, and then an appropriate method applied, using the available data (village population data and maps of village boundaries). The method for determining the water supply coverage developed in this paper is then compared with the other methods described in the previous paragraph.

The advantage of determining water supply coverage in a Geographic Information System is that further rules may be applied in order to make the estimation of water supply coverage more accurate. For example, a specific water source may be set to supply a limited amount of water, based on its flow rate; water-source quality characteristics can be mapped so that unsuitable water sources can be tagged for replacement; and a maximum walking distance to a water source may be set.

Although the method developed in this paper has only been applied to a relatively small watershed (approximately 345 km2), it could be applied to Uganda as a whole. This is facilitated by the fact that Uganda has already a database of water sources. The bulk of the work in preparing water supply coverage maps is within population density mapping. However this work would be offset by the many possible uses it would have.

It is anticipated that this paper will provide a springboard for further work within the study area, and assist in the development of an Integrated Water Resources Management (IWRM) framework, appropriate for local-scale water resources planning. This would allow for a better understanding of the various processes within a watershed: such as how a certain water supply might be affected by schemes to exploit water or sources of pollution in the area; or how water exploitation might affect the local environment. Such a framework should ultimately lead to the sustainable use of water resources within a given watershed.

RIVERTWIN – development of a regional model for integrated management of water resources

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Keywords: regional modeling, model integration, IWRM, strategic planning, EU Water Initiative

Presentation of the project:
Water resources in the European Community, as well as in developing countries, are under increasing pressure from the continuous growing demand for sufficient quantities of good quality water for all purposes. Consequently, in 2003 the European Union (EU) Commission launched the "EU Global Water Initiative", which proposes to apply the principles of the European Water Framework Directive (WFD) to other continents. The central feature of the WFD is the use of river basins as the basic unit for all planning and management actions. The RIVERTWIN project (www.rivertwin.org) supports the goals of the EU Global Water Initiative (www.euwi.org) by adjusting, testing and implementing the integrated regional model MOSDEW for the strategic planning of water resources management in three river basins in Europe, Central Asia and West Africa.

Results/findings
The regional model MOSDEW will assist planning authorities and decision makers to assess the impacts of economic and technological development, and the effects of global climate and land use changes on the long-term availability and quality of water bodies. The model is based on a geographic information system, which integrates ecological (water availability and quality) and economic aspects (water demand and water use) of water management. The integration framework has been developed and tested in a European river basin with high data availability and data density. The transferability of the model to other regions with different economic level, ecological standards and with low data availability is jointly tested by the project team and river basin organisations in two river basins in Westafrica and Uzbekistan. Here, the problem of adequate human resources and the uncertainties of input data for the implementation of computer based decision suppport tools is addressed.

Three river basins with catchment areas between 13.000 and 40.000 km2, and with contrasting ecological, social and economic conditions, were selected. The river basins are located in different climatic regions:

- Neckar basin – temperate-humid Central Europe
- Oueme basin – tropical–subhumid West Africa

- Chirchik basin – continental-semiarid Central Asia

Adoption and use of decision making tools requires the involvement of stakeholders and planning authorities in model development and definition of key indicators as target variables for the model calculations. In an intensive participatory process, the model structure has been adjusted to the stakeholder requirements in the individual basins. In particular the heavily modified water bodies in Central Asia need the adoption of specific submodels that respond to the tasks of complex water distribution networks and to the optimal allocation of scarce water resources.

In parallel to the model development, integrated alternative basin scenarios were compiled with the responsible institutions. The model was used for impact assessment of the scenario options. Scenario runs for the Neckar basin with downscaled climate scenarios from different GCMs suggest that climate change impacts differ between climate scenarios, but there is a general trend of reduced diffuse emissions into the surface and groundwaters in the future 30 years. Projected changing agricultural land use due to the common agricultural policy since 2003 will further support this positive trend.

Conclusions and recommendations

Although some modelling processes are applicable in all basins, the results have shown that stakeholder involvement in model development is crucial for capturing specific additional modelling necessities in each basin. The participation process and model adjustments are time consuming. However, the stakeholder involvement as project partners in the model development promotes an understanding of interactions between the different sectors that are affected by water management and creates the notion of own property in the respective basin authorities. Human capacity building in the application of GIS based modelling approaches must be intensified in developing countries in order to make adequate use of decision making tools at the basin scale.

Decision Support Systems, IWRM and INMAS, Towards a Full Integration of All Stakeholders in to the IWRM in Sri Lanka

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Keywords: resource, implement, policies, harmonised, coordination

Introduction

Water resources and adequate water supplies are essential preconditions to the achievement of MDG target to halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation. For that all countries should have their own national Integrated Water Resource Management and Water Efficiency plans by the end 2005, where models are widely accepted as key management tool. Progress in understanding water resources has developed through advances in modeling, e.g. rainfall-runoff. Models also have an important role in linking policies and plans with implementation and in providing a sound basis for decision making. Although we are ready to implement it in 2006, still the pressure in water is increasing in the world. Currently 1.1 billion people lack access to safe drinking water, and 2.4 billion people lack access to sanitation, "the biggest scandal of the last 50 years" according to the WSSCC. The results are devastating. More than 2.2 million people die each year from diseases associated with poor water-sanitary conditions.

Problem.

Today we are wasting much water or used inefficiently. Providing access to water for food and agricultural production is a proven ingredient for poverty alleviation and economic growth. While in most regions there is enough water to meet every ones needs. We must also be organized and harmonized with other diceplines in society such as land policies, programs to achieve essential development objectives through IWRM.

Despite poor economic growth, Sri Lanka has achieved considerable progress in IWRM, according to the UNDP Human Development Report says, “they performed well within the South Asian Region with regard to eradication of extreme poverty". As a policy response, The President emphasized the importance of IWRM, "We have to search for practical tools, instead of more engineering base foreign funded projects by building dams or canals, we should shift our policy approach to Integrated Management of Agricultural Settlements (INMAS) by strengthening institutional and management capacities and to devolve responsibilities to the stakeholders to manage their own watersheds and systems under the umbrella of IWRM”.

This report describes the processes and procedures INMAS Model adopted, in association with stakeholders to overcome various requirements of the rapid increasing population. And also, reveals the fundamental structural Reforms, Ordinance and alternative systems and critical hard and soft components for sustainable management of vital ecosystems and resources. Their decision making body is the Project Management Committee (PMC). The INMAS model is now considered a key component of the Sri Lankas National Water Resource Policy.

The coping mechanism adopted by the agency officials and stakeholders, in management of the water resources, and water related sectors, was the both parties agreed and higher management efforts done by the PMC. It is an inter disciplinary team of experts, incorporating Engineers, Agronomists, Economists, Sociologists and Stakeholders.. These projects improved their performances up to 85% equity of allocation, water use efficiency was 80%-(IWMI), canals turned over to Farmer Organizations, to carry on operation, maintenance and water distribution by their own management and they have reduced the 50% of state allocation. Farmer Companies own by the beneficiaries, managed the system and provide marketing and other services to the people to improve their living conditions.

Food production, paddy is the major grown variety under INMAS, on the demand side, the agriculture sector used 96% of the total withdrawals in 1991(ESCAP) Harvesting Rain Water is an integral part of IWRM and it is implemented specially drought affected projects, while Sprinkler Irrigation and Dug wells introduced for security.

Protecting the ecosystem, reforestation promoted in upper watersheds with peoples participation, while 65% reduced exploitation by enforcing Low with the Forest Department. To mitigate the drought and floods, 98% stakeholders renovated their own tanks, cascading the water flows for down tanks, and it improved the water storage capacity, helps to ease societies out of their vulnerability to changes in rainfall, under the 10000 Tank Rehabilitation Project. For drinking water and sanitation the World Bank initiated Community Water Supply Project through a holistic and community based approach, referring to the IWRM. Soft solutions like training and awareness programs, seminars, workshops, field visits also conducted with the funding of INGOs and NGOs and Commercial Enterprises.

Altogether, Sri Lanka has been quite impressive in achieving most national targets at aggregate level, for example 82% and 92% country population has access to safe drinking water and sanitation respectively. But the critical issues arise from the regional levels. The incidence of poverty is estimated to be severe in North East Districts, due to the two decade old conflict.

There is a strong need for enhanced stakeholder participation in the formulation and implementation of national and local water management plans to reach the MDG targets through the IWRM where the INMAS Model in Sri Lanka have been done an important role in linking policies and plans with implementation, and in providing a sound basis for decision making for the development of the country and the region.

Widening the scope of IWRM from natural to socio-economic watersheds – the conceptual framework of a research network in the Jordan Valley

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Keywords: socio-economic watershed, Jordan Valley, research network, IWRM, decision support systems

Repercussions of the management of water resources on the livelihood of people go beyond the boundaries of natural watersheds and river basins. Water infrastructure, such as pumping, storage, conveyance systems and wastewater recycling facilities, already change the sphere of influence of decisions to social and economic entities that exceed geographical watersheds. But social impacts may go even further due to interdependencies with regard to (1) the exchange of commodities, rights, services and migration or (2) comparative regional advantages in resource use.

Such situations are frequent in developed countries as well as in densely populated regions of developing countries that suffer from water scarcity. The simple consideration of linkages beyond natural water catchment areas as external – and thus independent – frame conditions does not reflect reality in such cases. Conclusive decision support systems towards Integrated Water Resources Management (IWRM) have to consider all stakeholders and actors whose living standard, economic success and quality of life depend to a predominant part on a common water resource. The comparatively simple expansion of target regions of decision support systems on IWRM by combining natural catchment areas and zones linked through water infrastructure is a feasible approach for the consideration of the set of primarily affected social and economic parameters - such as domestic water supply, added value from agriculture and other economic sectors and the performance of ecosystems. The incorporation of consequences from changes in those parameters for the social and economic conditions of zones outside of the natural watershed and its technical extensions via water infrastructure requires the additional consideration of linkages that cannot be covered by standards of natural sciences alone. Social, economic and political interrelations determine the boundaries of such "socio-economic watersheds" rather than geographical and hydrological criteria.

The Jordan Valley presents an exemplary case for a situation, where redirections of substantial amounts of water by riparian states entail significant social and economic consequences in the concerned river basin as well as in areas that do not even have a share in the physical water follows. Israel pumps about 400 x 106 cube meter out of the annual influx of 500 million cube meter to Lake Kinneret in the upper Jordan Valley into the national water carrier and most of this water is used in her coastal areas and the Negev dessert. Jordan diverts already about one fifth of its 250 x 106 cube meter share of waters from the natural influxes to the Jordan River to urban areas in the Jordanian highlands and redirects substantial amounts of recycled water into the Jordan Valley. Model-based results of research implemented by a network of German and local socio-economists on different aspects of water resource use and management in the Jordan Valley since 2000 indicated significant impacts of probable changes in the price and quality of water on agricultural production. Preliminary projections of consequences for the Jordanian part of the Jordan Valley indicate significant repercussions not only on markets for products and production means but also on migration due to changes in production structures, sustainable farm sizes and thus the socio-economic carrying capacity of regions. Additional reflections focus on the changing comparative advantage of areas for the preservation of biodiversity within and outside of regions that partake in the use of water from the Jordan River watershed. The understanding of these advanced impacts from decision making in IWRM due to the obtained knowledge on partial socio-economic consequences led to the development of a broader conceptual framework of the socio-economists' research network. Methodological goals focus on the combination of socio-economic models for rural, peri-urban and urban zones within and outside the area of access to water from the Jordan River catchment area as well as on the development of suitable interfaces between models that consider the different social and economic situation in Jordan, Israel and the Palestinian Authority. Simultaneously, the network teamed up with a group of natural scientists from these countries and Germany under the umbrella of the GLOWA-Jordan River Project (funded by the German Ministry for Education and Research, BMBF) in order to identify probable scenarios on the development of water availability and distribution in view of potential future impacts from global change.

A Bayesian Approach to IWRM Policy Analysis: The Mekong Case

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Introduction: The starting point of the Integrated Water Resources Management (IWRM) policy analysis of the Tonle Sap Area in Cambodia was the Mekong Agreement of 1995. It specifies three development goals for the Mekong basin: economic growth, poverty reduction and environmental sustainability. These goals are virtually identical to the concept of IWRM. The possibilities to find combinations of sector policies for achieving these, often conflicting goals were analyzed using the probabilistic, Bayesian network approach. This DSS approach and related software has been developed over a decade within various case studies in a wide spectrum of geographic areas.

Four policy scenarios were constructed, one promoting each of the three development goals separately and one integrated scenario. The results indicate that a compromise policy is possible, being radically more balanced and acceptable than any of the policies that target on one of the three goals at a time.

Analytical approach: The Bayesian Network methodology used (Varis, 1998) is based on the systematic analysis of causal interconnections in complex environmental-social-economic systems. The approach is suitable for interdisciplinary analysis of a high number of imprecisely known variables. The objective is to assess risks to various components of the environmental and social system under consideration as consequences of the different policies and strategies under evaluation.

The social system components consist typically of stakeholders, i.e., different communities and groupings of people that are influenced by the implementation of policies in the studied geographical area. It is not rare that their aspirations and interests are in conflict with one another.

Information from various sources, and of varying quality, is condensed in a risk-analysis framework, and a multidisciplinary analysis that reveals the major risks, uncertainties, mismatches of information, and opportunities to find win-win solutions among stakeholders and the environment is performed.

The structure of the model is defined as a matrix, in which each pair of variables can be linked together with a link strength parameter that stands for the likelihood of a conditional probability between those variables. Many of the variables are also assigned an a priori tendency of evolution, which is then updated with probabilistic information from the rest of the model, in a Bayesian sense.

The analytical procedure starts from a set of scenarios, followed by a selection of development priorities that allow the society to react to these scenarios. Different policies have different impacts on the environment and the socioeconomic system. Finally, the local and national stakeholders feel these changes, either benefiting or suffering from them.

The model allows trade-off analyses between different development objectives, and helps in seeking policy combinations that create a maximum number of win-win situations between competing stakeholders.

The Tonle Sap Policy Model: The model for the policy analysis of the Tonle Sap Lake (Varis and Keskinen, 2006) has 47 variables in total. They consist of 11 sector policies, 28 impact variables, and 8 development goals. An expert consultation process was in a central role in the construction of the model, and in the associated decision support and mutual learning process. This was supported by a spatial GIS data base and a set of hydrological and hydrodynamic simulation models.

Results and conclusions: Some sector policies would be crucial for both the economy and poverty reduction, but not all. The huge shortcomings in education and institutions are obviously the ones that most strongly support these two goals. Rural development, in turn has a very important social function although it has not much immediate economical implication. Large-scale fisheries would be economically beneficial but counterproductive for poverty reduction. At the same time, with every scenario and sector policy, uncertainties related to their impacts remain very high and must therefore be appreciated. The reason for high uncertainties result partly from the lack of data, but even more importantly from highly complicated network of direct and indirect impacts that tend to be inconsistent in many cases, thus increasing uncertainty of possible impacts.

The biggest surprise was that the domestic policies appear relatively toothless to environmental problems. As the majority of the population of the Tonle Sap area live in villages and make their living from the lake or the floodplain in a fairly direct way, the environmental issues are tightly bound to social issues. It must also be noted that the Tonle Sap system is governed by the mighty floods of the Mekong. The sediments and other mass flows are also dominated by these monsoon floods. There are no strong handles in the domestic sector policies that would allow the control of these issues.

The Policy Model proved to be a useful tool in analyzing impacts and uncertainties of different management options and finding compromise solutions between them. Thus, the policy model is efficient and useful in decision support and mutual learning.

The extension of the effort is now in progress in two fronts; on the Mekong Delta as well as in the basinwide dimension of the Mekong River. Experiences from these two cases will also be summarized in the presentation. This work is being done as a consultation to the Mekong River Commission which is the implementing agency of the 1995 Mekong Agreement.

References
Varis, O. 1998. A belief network approach to optimization and parameter estimation: application to resource and environmental management. Artificial Intelligence, 101: 135-163.

Varis, O. and Keskinen, M. (2006). Policy analysis for the Tonle Sap Lake, Cambodia – A Bayesian network model approach. International Journal of Water Resources Development, 22(2). In press.

Integrated Water Resource Management in Khulna Jessore Drainage Rehabilitation Project in Bangladesh: A Case Study

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Keywords: Environment friendly TRM, People' participation, IWRM Plan, Sustainable Development, Livelyhood and poverty

In the 1960's, a large tract of coastal land areas in the south west region of Bangladesh were brought under protection from regular saline water inundation and tidal flooding with a view to boost up agricultural production through construction of a number of polders by Bangladesh Water Development Board (BWDB). In the 1980's however, many polder areas started to suffer from drainage congestion and water logging problem as the surrounding rivers became silted up in the mean time and also due to lack of adequate operation and maintenance and people's participation.

A drainage plan includes both infrastructures and institutional arrangements for making the project operational and sustainable for Khulna-Jessore Drainage Rehabilitation Project (KJDRP) was implemented during 1997 – 2001 to relieve about 100,000 ha of land from drainage congestion and water logging. One of the principal components of KJDRP drainage plan was selection and implementation of environment friendly and innovative tidal basin management (TRM). A total of nine potential tidal basins were selected on rotational basis. The first planned tidal basin was made operational in Beel Kedaria in 2001 on a pilot basis and operated for last three years (2001-2004). This basin has been selected on a pilot case with a view to gather knowledge and experiences during operation as a tidal basin, at the same time the laps and gaps will also be delineated. At the letter part of the implementation of the project a participatory IWRM plan was prepared by WMOs under facilitation of CEGIS to take care of the problems both at local and regional scale which could not been taken care in the drainage plan. The IWRM planning process was a mixture of both top down and bottom up process following three III (Integration, Iterative and Interactive) planning process.

The project yields good and acceptable results for last three years. The execution of the drainage plan has brought relief to the project area as well project people from long sustained water logging. Water area now stands only at 7% compared to 26% in 1997. Monitoring during implementation period indicates that livelihood opportunities related to agriculture and fisheries have increased and had positive influence on poverty situation.

The Beel Kedaria tidal basin was closed end of 2004. No other tidal basin was yet ready for next round of tidal basin operation and at the same time no attempt has been taken to implement the IWRM plan prepared three years back. As a result, severe drainage congestion and water logging due to sedimentation in the water resources system and some more new water management problems were resurfaced again in 2005. The concepts of IWRM were duly considered in the preparation of water resources management plan for KJDRP, it has been found that integration of various issues i.e. process of closing and opening of TRM basin; participatory operation and maintenance activities and process of keeping WMO's active; compensation modalities and process of updating the IWRM plan and sustainable generation of fund were largely absent in the follow-up activities. These issues will be discussed in this paper.

In addition, this paper will discuss the results of monitoring using different tool and techniques and also how the local stakeholders were involved in the monitoring works. Clearly spell out the problems at the present situation are prevailing at different zones and their reasons. How these problems could be addressed to be solved. Moreover, their may be some recommendations how this TRM techniques could be applied in natural resources management under IWRM prospect in other parts of the country.

Workshop 6:

Changing Diets and their Implications for Water, Land and Livelihoods

Improving Livestock Water Productivity to Help Satisfy Future Human Dietary Requirements

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Keywords: livestock water productivity, food security, animal production, animal based food products, demand

Emerging concerns about the availability of fresh water to produce food and provide services for the world's growing population has led to suggestions that people must shift away from consumption of animal products, particularly red meat, and by implication from animal production more generally. A prime reason given is that milk and "meat production require large amounts of water" that is far more than what can be sustained in future. While such concern can be justified in some cases, livestock production globally consists of a diverse set of livelihood options that require more thorough analyses to understand how animal keeping interacts with water resources and crop production. Collaborative research involving the International Livestock Research Institute, International Water Management Research Institute, CGIAR Challenge Program on Water and Food, and CGIAR Comprehensive Assessment of Water Management and Agriculture assessed water-related opportunities and constraints associated with animal agriculture. This paper summarizes their findings.

The assessment examined global trends and distributions in livestock production and demand for animal based human foods. The research developed a livestock-water productivity (LWP) assessment framework that aids in understanding how animal production uses and degrades water resources in diverse agroecosystems and farming systems. Because water required for feed production is particularly important, feed sourcing options that can reduce water use received considerable emphasis and options for improving LWP are proposed.

Livestock are an important part of global agriculture and are associated with a large number of poor farmers who depend on them. Domestic animals provide meat, milk, blood, eggs, hides, cash income, farm power, and manure for fuel and soil nutrient replenishment. They have important cultural values and serve as an important means by which poor people accumulate wealth. Animals contribute to human diets through four important pathways. First, direct consumption of animal products potentially enhances quality of human diets particularly in areas where crop-based foods are only available seasonally, lack in nutritional diversity, and are grown on depleted soils. Second, sales of high-value animals and animal products provide essential cash income that can be used to purchase alternate foods. Third, manure applied to soil enhances crop production, and when used as fuel it enables households to cook their food – an often neglected but water demanding aspect of satisfying food security. Fourth, animal power is an essential input that enables farmers to cultivate their soil, thresh grain and transport food products to market. Without animal power, many farmers would experience significant declines in crop production and marketing options. All contributions of animals to human food security require water.

Globally, production and demand for meat and milk products is growing at less than 1% per year in developed countries where consumers increasingly demand leaner meat produced under grazing rather than in feed lot conditions, a shift that can ultimately require less water for meat production. In developing countries, production and consumption are growing at rates of about 3%. In the massive potential markets of China, India, and Sub-Saharan Africa that have about half of the world's human population, milk production and consumption are growing at about 4% per year. In Africa, rapidly growing demand for meat and milk will concentrate in urban areas. Globally and particularly in urban areas, meat production is shifting away from reliance on ruminant animals such as cattle and sheep to greater use of monogastrics such as poultry and swine. By 2010, livestock production would require at least 2.7 trillion m3 of water for feed production if this feed were to be produced with water specifically allocated for this purpose. However, feeding options requiring less water exist.

Assessments of livestock water productivity suggest that improved feed sourcing strategies can help ensure that animal production becomes more water efficient. Most critics of the water inefficiency of animal production focus on direct use of water for production of feed crops. This strategy appears to require at least 15,000 litres of water to produce one kg of beef. In contrast farmers in developing countries tend to rely heavily on crop residues as animal feed. This feed, being a byproduct of crop production, requires no extra water. The water used by the crop would have been used anyway with or without animals consuming the residues. Using such residues for animal production in theory could enable production of one kg of beef with less than 500 liters of water. Furthermore about half of the biomass of the feed animals ingest is subsequently defecated. The manure produced "contains" about half of the virtual water that many critics assign to meat production, and this manure when properly managed has other valuable uses.

In dry-lands that are not suitable for crop production, livestock keeping may be the only practical food production strategy available. Use of the limited water available in such areas does not compete with other food production livelihoods, particularly if evapotranspiration rates are equal to or greater than actual rainfall and ecosystem services are not compromised.

This research also suggests that improved grazing, watering, and strategies to improve animal productivity can also contribute to increased LWP. Taking a balance demand-side and supply-side approach to animal production may be needed. Evidence strongly suggests that integrating livestock production into both rainfed and irrigated crop production can enhance overall efficiency and productivity of use of agricultural water for human food production.

From Rain-fed Millet- and Cassava-Based Diets to Irrigated Sorghum- and Wheat-based Diets: "Diet Displacement" and Increased Scarcity in Nile Water

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Keywords: Market integration, collapse of subsistence econom, crop zones, land degradation, Nile water scarcity

The early 1970s witnessed the presence of larger numbers of "rain-fed grain producers" inside the irrigated areas, who under normal circumstances should have remained in the rain-fed millet/cassava crop zone, tilled, harvested, and consumed crops in this zone and until recently exported them to towns in the irrigated wheat/sorghum crop zone. This presence in the irrigated crop zone was reinforced in the 1980s and 1990s by waves of mass population displacement. Almost a third of the population of the Sudan was on the move during this period. All population on the move was targeting central and northern Sudan, where they live concentrated today along the Nile banks.

Emphasising these recent population distribution trends, namely population concentration in the irrigated areas, this paper argues that some economic structural changes, as well as pressing natural hazards and civil strife have collectively caused a dramatic change in diets of large groups of population. To evaluate the changing diets' implications for water, land, and livelihoods in the rain-fed and irrigated crop zones, this paper will divide the larger landscape of the Sudan into riverain-zone (RZ)—the downstream River Nile, the abode of irrigated wheat and sorghum, and non-riverain zones (NRZ)—beyond the river's irrigated zone, which comprise all regions where rain-fed grain production prevails.

The economic structural changes are manifest in the market integration processes, which led to the abandoning of subsistence crops. Farmers abandoned the cultivation of millet, for instance, because it was too labour-demanding and vulnerable to birds and thus not profitable under market integration. The sharp rise in prices of cash crops led to diversification away from millet has made of sorghum the main alternative if not the sole food crop, which farmers started to cultivate in their own farms. Diversification away from millet and leaning on production of cash crops led either to new lands being brought under cultivation or old fields being cultivated more frequently. By the time passing, especially in association with the state and state-backed groups' appropriation and abuse of communities' lands, the expansion in cash crop cultivation (reducing the production of staple food grains, resulting at least in a slight change of diet) had led to severe land degradation, dramatic decline in farm productivity, and almost total collapse of subsistence economies. Rural population started to become almost totally dependent on sorghum produced outside their localities through large-scale mechanized farming and partly on wheat produced in the irrigated RZ. Vulnerability of rural communities increased and by mid-1980s, ultimately leading to the worst famine in recent history of Sudan. This famine, reinforced by civil war and tribal conflicts, was the primary cause of mass population displacement and ultimate population concentration in the RZ.

Our main argument here is that the IDPs' diets changed when they entered a different "grain zone" and, especially when became under the urbanite culture influence. Large segments of the inhabitants of the "rain-fed millet/cassava zone" (i.e. NRZ) are now settling in the urban "irrigated wheat/sorghum zone" (i.e. RZ). The rapid urbanization since the mid-1980s, largely due to mass displacement, caused a dramatic leap in the size of the area cultivated with wheat—Sudan's wheat area was expanded by over 600 per cent between 1984 and 1994, i.e. from 48,000 to 357,000 hectares. The area cultivated with sorghum also witnessed dramatic expansion, whereas it increased from two million hectares in the 1970s to 16 million hectares by the end of the 1980s. Despite this expansion, sorghum produced through mechanized farming proved insufficient for meeting the heightening demand, primarily due to unsustainable land use and climatic reasons. This has necessitated the increased leaning on irrigated sorghum whose area increased from 280,000 in 1984 to 551,000 in 1992.

Availability of wheat and sorghum in the RZ mixed with the "urbanite" culture of townsmen and its mass food processing, had greatly displaced the food of the country. Wheat, in particular, belongs to a hegemonic culture, it being the staple food of the riverain hegemonic group that reshaped towns and influenced their taste. Therefore, in towns, Millet, for instance, is considered unhandy for making kisra (pancake-like flat bread) and certainly not good for making town bread, while it is considered best for rural people to make aseeda (porridge) and their kinds of rural bread.

Given the poor level of water management, the changing diets of population concentrated in the RZ implies additional demand for Nile water for irrigation, to meet—in the wheat and irrigated sorghum zones—the food needs of the previous inhabitants of the millet and cassava zones, added to the needs of the downstream RZ's original population. In fact, the expansion of wheat production stands as the clearest indicator of the dominance of the riverain Sudanese, and this is precisely what makes increased demand for irrigation water more forceful.

While changing diets may put more pressure on Nile water, they also mean the "loss" of the rains and more nutrient grains in the NRZ, which for centuries allowed a stable population distribution and "diet zones". What may be advanced here as recommendation is a policy guided by the ethic and vision of "hydrosolidarity", which goes beyond the downstream/upstream relationship in order to bring on board the RZ/NRZ relationship with the ultimate goal of rehabilitating the NRZ ecosystems. At one level, this would allow communities to regain their "lost" diets. Millet should be reintroduced, not only as nutrient diet but also because it is good for the local ecosystems—it has bushy stems, making a thick cluster in the way of water flow, unlike sorghum stems which are thin and cannot hold water for long.

Urbanization in West Africa: Impact on diets, informal irrigation and health risks

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Keywords: Urbanization, exotic vegetables, urban agriculture, wastewater irrigation, fast food

In West Africa, more people live today in towns and cities than in rural areas. The dynamic expansion of the sprawling conurbation of Lagos in Nigeria from a port-city with a population of only 75,000 in 1939, to the world's sixth largest mega city with a current population of 16.9 million is the most obvious example. Rapid urbanization has changed the traditional diets of the West African population. Throughout the sub-region, the urban demand for poultry, fast food and exotic vegetables is booming. A whole irrigation sub-sector specialized on perishable vegetables is emerging in and around the cities taking advantage of low transport costs, as well as the common lack of refrigerated transportation and storage.

Results/Findings: Only around Kumasi, Ghana, there are about 60,000 people benefiting from year-round and dry-season irrigation. The sector supplies up to 90% of all perishable vegetables consumed in the cities, many of them hardly consumed in a rural setting. As usually less than 10 percent of the urban households are connected to a piped sewerage and wastewater treatment system, urban floodwater drains take over the sewerage function for gray water. As these drains end in natural water bodies, it is difficult to find any unpolluted water source for vegetable irrigation in and around many West African cities. The consequences are obvious:
In Accra, Ghana, for example, 400,000 people, that is a quarter of the urban population, eats over a week exotic vegetables produced by urban and peri-urban agriculture. Besides all known benefits of salad consumption, this figure represents also the risk group from wastewater irrigation as the analysis of pathogens in water and crop samples clearly shows.

Conclusions and recommendations: The changes towards multi-cultural diets is followed by a thriving irrigation industry specialized on perishable cash crops, but also a significantly increased health risk potential for the urban population as long as wastewater treatment remains rudimentary or cold transport the exception. A sensitive policy response is needed which safeguards the consumers without threatening the livelihoods of the irrigators. The new WHO guidelines for wastewater use in agriculture offer corresponding options.

Malnutrition, Obesity and Projected Water Demands

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Keywords: Malnutrition, Obesity, Dietry Energy Supply, Public Health, Water demand projections

Presentation of the project/topic and analysis of the issue(s)
Over the next twenty-five years, demands for freshwater for agriculture will increase throughout the developing world to provide food security for rapidly increasing populations, even though population growth rates are declining everywhere. These demands have been projected by organisations such as FAO and IWMI, based on the need to significantly reduce, if not eliminate, under-nutrition. Taking into account the inequality of distribution of food within a population, these organisations have estimated average per capita dietary calorie needs by estimating minimum requirements for a productive lifestyle and increasing them by 23% to allow for the inequality of distribution among households. However, there is ample evidence than in many countries of both the developed and developing world, over-nutrition is becoming a serious public-heath issue which needs to be taken into consideration in projections of water demand.

If average supply is significantly in excess of these minimum requirements, then obesity will increase and benefits to public health of reducing under-nutrition will largely be lost due to the adverse public health impacts of over-nutrition. This paper considers the impact on projected incremental water demands of changing the policy objective for food security from reducing under-nutrition to improving public health with respect to both under and over-nutrition.

Presentation of the results/findings
The analysis uses the standard models used by FAO for the computation of dietary energy supply at the population level, taking into account the changing work patterns associated with increased urbanisation, and also the unequal distribution of food among households, to investigate the impact on total calorie needs of different public health policies. It concludes that, in many countries where average consumption is low but not excessively so, policies to increase average per capita food supplies as at present pursued would be counterproductive. It also demonstrates that a combination of programmes to target food supplies directly to the undernourished, raise awareness of the problems of obesity and discourage excess calorie consumption could achieve the twin objectives of eliminating under-nutrition and minimising over-nutrition. The paper includes a discussion on how some of these programmes can be implemented, and some of the experiences with them.

The impact of this would be to reduce projections of increases in calorie production, and hence water consumption, by a significant percentage in both the developing and developed world. Since the two sets of countries are interconnected by the global trade in food, the combined impact is important.

Conclusions and Recommendations
The paper concludes that the present approach to the estimation of future food demands should be revised to take into account the increasing impact of over-consumption on public health. Instead, it recommends that the food policy objective should be to aim for a nutritional

intake that will maximise public health. Although this policy will require interventions and programmes that lie outside the water sector, it would impact significantly on water resources planning by changing projected demands for food, and hence the water needed to grow this food.

The author suggests that this approach is an example of how water resources planning should be integrated into national planning rather than circumscribed by the confines of the hitherto accepted framework, the natural river basin. By examining the role of water in the wider economy (WINE), he suggests it should be possible to manage the world water crisis without massive investment in dams and irrigation schemes, and the potential for international conflict to which they give rise. This approach can be implemented by demonstrating to national planners the impact of non-water sector polices in areas such as such as economic growth, trade, public health and population planning on the sustainable development of water resources.

The State of Fishery and Aquaculture and Hydroecological-Economical Conditions for their Development in Amudarya River Basin, Central Asia

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Keywords: Fishery, aquaculture, ecotoxicology, Amudarya River, Fish-farming

The expected 27% increase in population (more than 13 million) in Central Asian countries over the next 20 years require more food, much of which is to come from the expansion of irrigated agriculture. The demand on fish products will be also higher than at present, especially in rural areas where more than 60% of population of the region live.

After the Aral Sea crisis shrank the Uzbekistan fish production substantially, especially in Amudarya River Basin. Before the 1990s about 100.000 t of fish were sold throughout Uzbekistan, from which about 40.000 t were produced locally. Nowadays this has dropped to an all time low of not more than 9-10.000 t. Obviously there is a need for fish, from an economic as well as from a nutritional point of view. The present level of consumption of fish products per capita of the population amounts to less than 0.5 kg/year.

Aftert the division of the former USSR into independent countries, the fish farmers in Uzbekistan lost the links with equipment and fish-fodder suppliers from other NIS countries. The utilisation of uneconomical fish farming technologies based on extensive use of imported fodders did not consider the potential of the region for aquaculture. All of these have caused dramatic consequences for fishery and aquaculture during the transition of the economy of independent Uzbekistan from a state controlled to a market economy and the consequences of a complete privatisation of the aquaculture. For the first years the fish farmers had to adopt to the new conditions and in 1990-2000 they managed their fish production to become profitable, though the volume of fish catches and production sharply declined.

Aquaculture appears to become highly profitable in Uzbekistan, where the natural environment is preferable, but its development demands the solution of a number of problems. First of all it requires the change of the mentality of the fish farmers. Aquaculture is a beneficial agricultural business; when the present technology will be developed further, using an ecosystem approach. This can be achieved in small ponds by using local raw materials (organic fertilizers and locally grown fodders). With that can the aquaculture sector increase the production opportunities of local agriculture by using their surplus products.

Fisheries and aquaculture demand more from the hydrological regime and the quality of water as other branches of agriculture. Recent observations in natural water bodies and human made reservoirs have shown that water deficit caused by natural disasters (e.g. drought), technical problems such as dam breaks and irrigation have often extreme negative influences on the biodiversity and growth of fish. At the same time the results of hydro-ecotoxicological investigations conducted during 2002-2004 and their comparison to previously obtained data (Karimov, 1988, 1990, 1991, 1995, et al.) allow us to conclude that the present concentrations of most environmentally dangerous pollutants such as chlorinated hydrocarbons (α, β-HCH and Lindane, DDT, DDE and DDD) sharply declined in the main ecosystem compartments like water, bottom sediments, plants and fish. In all cases were they down to or below the detection limits, this was even true for the accumulation rate of main chlor-organic pesticides in commercial fish species which declined below detection limits from the dangerously high levels 15 year ago.

There are good economic and natural conditions to develop fish farming oriented not only to cultivate low value fish for general purposes, but also high value species for special uses and export to increase the economc potential of the country for fish production. For the people living in or near the deserts are the new plans possibly difficult to understand. Traditional practices of landscape management and fishery are well-known and very popular. As objects of aquaculture in Uzbekistan are grass carp Ctenopharyngodon idella, common carp Cyprinus carpio, silver carp Hypophthalmichthys molitrix preferred. Methods of silver carp cultivation are well developed and do not require researches within the project. At the same time is the solution of some problems rather urgent. For common carp and grass carp is it particularly profitable. Some species do not have conditions for natural spawning. If we create special hatcheries for pike, catfish, chinese carps, sturgeon and aral barbel – fish catches may increase strongly. Among others it is an urgent necessity to study the possibility of acclimatization of stock-making planktofags, e.g. caspian herrings: kilka – Clupeonella delicatula, pusanok - Alosa caspia

The modern state of fishery and aquaculture and the analyses of hydroecological-economical conditions for their development in the Republic of Uzbekistan have shown that new technologies are required for production as well as for processing, storage and transportation. The development of fish farms in closed systems as part of the development of new communities in wasteland environments is also a very important option for the resolution of socioeconomic and ecological problems of fish industry in the country.

From all points of view is the cooperation with investors and scientific institutions necessary in order to adopt such technologies. There is a group of scientists and fish farming technologists which have developed new production systems in which the water as well as the nutrients are recycled in order to maximize profits and optimize ecological aspects. Such systems allow fish production in freshwater as well as saline water above ocean level. This is especially interesting for desert countries like large parts of Usbekistan, where water is in short supply and very often saline. However, before this can be proposed for general adoption we need to analyse the validity of the concept with regards to the ecological sustainability, the economical feasibility and the socioeconomic impact.

Multi-purpose Use of Run off Water as a Community Initiative to Improve Livelihoods

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Keywords: Multi- purposes, run-off water, community, improve, livelihoods.

Harvesting of run off water from rain water and well drained ordinary spring channels has proven to be a potential for improving crop, livestock and fisheries production for rural communities in Wakiso district. The district is estimated to receive 1,200mm rain and located in the equatorial zone.

Wakiso district comprises of Kakiri and Wakiso sub-county and is the operation area for Voluntary Action for development. VAD is an NGO that has empowered rural communities in Wakiso into sustainable management of natural resources for the last 10years. As one of its objectives, VAD seeks to contribute to poverty alleviation for poor rural peasant communities through sustainable management of water resources, to increase community access to safe water for improved quality of lives.

VAD has also engaged communities in grass rooted advocacy both at sub- County and district levels, to create a forum where the rural peasant communities can lobby for adequate and clean water from the government. This has been strengthened through capacity building programs for the local communities, to enable them to sustainably be innovative, think of their own and to fully utilize local resources that are valuable to economic development in our country.

Rain water and ordinary springs run –off water have been utilized by the communities in which VAD works to engage in various economic activities which improve incomes, diets and general livelihoods more still ensuring functional eco- systems.

Fish farming/ aquaculture has been adopted in low lands of various villages. Run-off water from well drained ordinary spring channels and rain water have channeled to swampy areas and have supported aquaculture. Poor farmers have been able to harvest fish for sale, improve incomes as well as improve diets through increased households consumption and access to fish.

Run-off water from rain water and ordinary springs has through communal collaboration been channeled to man made ponds thus livestock has able to access enough drinking water, besides increasing milk and meat productivity for improved household nutrition and incomes. Thus animals and communities stop sharing water.

Local and traditional irrigation schemes have successfully sprung up and this has enabled farmers channel harvested rain water to their gardens with lowland growing fruits, vegetables and other crops for example sugar canes rich in potassium, zinc and glucose have been grown, both for home consumption and sale; besides tomatoes, cabbages and other green vegetables have been grown for sale and household consumption. This has improved incomes, nutrition and enhanced availability of pastures for livestock in critical dry seasons and further utilization of land which wouldn't other wise is utilized towards improvement of community livelihoods.

However, there is a need to increase the capacity of the poor rural communities to manage the available run-off water sustainable for increased incomes to improve quality of life. This can be done through effective means to deal with the climatic variability and community conflict resolution after communal collaboration. In some seasons there are prolonged draughts, this owes to the fact that climatic variability and communal conflicts have hampered effective functionality towards such initiatives and in some areas complete failure.

This poster will highlight the successes that have been achieved through farmer initiated and managed fresh water run-off systems; the various ways through which run-off can be utilized for different activities to produce nutritious diets inclusive of livestock, fish, agriculture, enhanced land use at the same time improving incomes for poor rural farmers thus reducing poverty.

Coping with Floods for Livelihoods

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Italy

Keywords: Livelihoods, Institutions, Land, Water, Rangeland, Governance, Natural Resource Base

The Gash Sustainable Livelihood Regeneration Project (GSLRP) of IFAD and the Government of Sudan aims to regenerate the livelihoods of 67,000 poor households in and around the Gash delta (21,000 km2) by providing support over eight years for efficient, equitable and sustainable operation of the Gash Agricultural Development Corporation (GADC) and further pro poor integration of the Natural Resource Base into the local economy. The cost of the project amounts to US$39.0 million.

GSLRP relies on the physical rehabilitation and institutional reforms on land and water (land and water governance) that are required to address the combined restoration of the livelihoods, farming systems and environment. The project introduces radical and massive changes to secure sustainable livelihoods in balance with the natural resource base of the watershed and is based on scaling up traditional knowledge and institutions for land tenure, water and rangeland governance.

Local difficulties arise from the overburdening of the coping capacity of the spate irrigation system which forms the core of GSLRP. Where 8,000 tenants crop-rotated 240,000 ha in Turkish and British colonial times, at present more than 40,000 farmer households cultivate about 100,000 ha. The problems identified by the various agro-pastoralist and nomadic local tribes include:

- A decrease of the average area cultivated by households in the flood irrigation scheme from 3 to <1 fedan, combined with a decrease in the average herd size per household, which combined do not sustain livelihood security;
- Insecure and insufficient access to water for livelihoods (wetted land, livestock watering points -hafirs-, household water supply, flood control, rangeland –'balags' within the irrigated scheme and 'Dye' in the Gash delta) despite traditional coping systems;
- Fragmented and weak management of the flood irrigated scheme, which is in a state of constant non-compliance with formal and informal land and water access rules.

Along the Gash River, freshwater is put to a number of uses which support the livelihoods of the various local tribes:

- Domestic use for drinking water produced in Kassala City and distributed there and throughout villages in the irrigation scheme;
- Agricultural use for crop production in the scheme and on the Right Bank, whether for human food, for livestock feed and fodder, or else for cash crops;

- Agricultural again for watering livestock in and around the scheme and Right Bank;
- Environmental use securing flood water to the Gash Dye Rangeland allowing for grazing later in the dry season.

The radical and massive changes supported by IFAD in full cooperation with the Sudanese Government are:

- Adoption of a holistic watershed approach which allows for coordinated massive public investments instead of fragmented, partial interventions.
- Mobilization of the traditional knowledge to secure (a) land and water tenure within the flood irrigation scheme and (b) pasture rights in and around the irrigation scheme and Right Bank.
- Addressing the political dimension of the issues fostering policy dialogue capacities that lead to legislative reforms: establishment of the Legal Committee for Land Reform (LCLR) and of an updated charter for the GADC at Federal level, and implementation of the Community Organizations Act at Kassala State level.

In order to implement these changes, a combination of livelihoods, farming systems and environmental approaches is being used. The key for making implementation successful and introducing effective technical and legal changes is putting people's interests first. In this regard, a whole series of activities is under way in order to empower irrigating farmers, herders and their respective organizations so that they can better position themselves in the change process. As a consequence, the changes brought about reflect local traditions, or in developers' vocabulary the changes 'build on traditions'.

Improving the Diet of the People through Poverty Reduction from Freshwater Stimulated Livestock, Fish and Crop Production.

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Keywords: Local technology, Crop production, Livestock, Fisheries, Ecosystem

Poster topic and analysis of the issue: The posters in pictures capture the mode and means of livehood of the people living along the banks of the River Niger and River Anambra, and in Urban and rural areas of Anambra State of Nigeria. The region lies within the humid tropical rain forest belt of West Africa and has an average annual rainfall of 2000mm. The heavy precipitation period is from April to September and is characterized by heavy downpour, high infiltration and percolation rates, fashst flow rates and increase in water levels.

In the dry season the cycle reverses necessitating water storage for domestic, aquaculture, livestock and crop production. The state is densely - populated with an average of 500 persons/km2. Herd of cattle and pigs graze along the banks of the rivers. The ecosystem is a habitat for the multiplication of diverse fish species. These are caught and sold in fresh and dry states, generate income and improve the diet of the people. Wood products from the rich rain forest belt are hewed, transported and sold along the banks of the rivers. They serve as source of fuel energy for cooking, drying and marketing. Vegetable crop production are actively carried out in the dry season to ensure availability in local markets and a source of income. Groundwater resources are exploited by local technology for livestock (poultry)and fish production. The local technology involves construction of hand dug wells, auger bored wells, tripod powered drilling and hydraulic rotary method. Grain production as raw materials for animal and fish feeds is boosted by river flow all year round. The rich fauna and flora thrive on the water resources of the area. The organization, pricing and sanitation by local market authorities ensure price stability and product availability. The farmers associations through dialogue benefit from favourable pricing as to be motivated and stay in business. The consumers are the ultimate beneficiaries from variety of food products and balanced diet.

Discussion of results/ findings:

Pictures, tables and charts are used to futher illustrate the hydrogeologic processes depicting the interrelationship between atmospheric water, surface and groundwater, the tropic relationships in the ecosystem involving decomposers, autotrophs and heterotrophs. The complex food web generated is terminated by omnivores who are consumers of plants and animals. Plants through their cells absorb essential nutrients and water as well as harnessing solar energy. Plentiful supply of nutrients from the chemical weathering of rocks are made available by river drainages. Analyses of surface water from the River Niger and groundwater from shallow aquifers for nutrients: Phosphate, nitrate, silicate, trace element for iron and other water quality parameters for temperature, salinity, oxygen, acidity or alkalinity were evaluated for their suitability for livestock, aquaculture and crop farming. Phosphate nitrate and silica values gave 1.4,3.4,3.0, and 18.0 coliforms/100ml for total coliform for surface water while shallow aquifers intercepted by hand-dug wells recorded 0.00, 0.02, 0.1mg/l and 0.00 coliform/100ml for total coliform respectively. An integrated approached for efficient use of surface water and groundwater exploitation through surface water impoundment in wetland and high mesh, springwater harnessing, water well construction, and treatment are hereby discussed for sustainable water supply for livestock, fisheries and crop production. The objective is to overcome any adverse weather condition that may result in depletion of groundwater supplies and damage to the ecosystems by flooding thereby improverishing the living condition of the people.

Recommendation:
It is hereby suggested that a strategic implementation of an action plan / model based on Water Resources Exploitation and Management for Poverty Reduction and Food Production (WREMPRAFO) should be vigorously executed for the people by all concerned stakeholders in the country.

Extent and Impact of Communication Behaviour of the Farmers in the Adoption of Micro Irrigation Systems (MIS).

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Keywords: Farmer, Communication behaviour, Micro irrigation technology, Attitudes, Economic motivation and scientific orientation

Presentation of topic and analysis of issue: For successful adoption of any technology it is necessary to have the participation of farmers and social will power. With the development of science and technology, the forms and the ways of communication have become more specialized. Irrigation technology is changing fast from conventional methods to modern methods like MIS. Therefore it is necessary to communicate the scientific knowledge to the farmers. It will helpful to narrow down the gap between knowledge generation and its utilization and ultimately enhance the adoption of MIS. Present study is an attempt to precisely assess the sources of information, constraints, suggestions and communication behaviour attributed to the adoption of MIS. Low level of formal education is a barrier in disseminating useful information and the rate of adoption vary from farmer to farmer depending upon the situation and availability of information sources. But this can be overcome by the use of proper communication strategy, media mix and with the use of audio-visual aids. Therefore a comprehensive study has been undertaken with specific objective to precisely assess the communication behaviour in terms of information input, processing and out put besides over all communication behaviour attributed to adoption of MIS.

From the purposively selected regions of Maharashtra state (India) about 650 farmers were contacted and finally 505 were selected randomly those who were using the MIS consequently from last three years and surveyed with the help of pretested questionnaire. In the present study communication behaviour of the farmers refers to all such activities which are related to the input, processing and output of information. The correlation coefficients (r) and multiple regression analysis were carried out to know the statistical significance and contribution of predictor variables.

Discussion of Results / Findings: In the Maharashtra State (leading state in country) 22.3 percent dropout in MIS was observed. Information storage and evaluation was done by the majority of respondents through memorizing, printed material and were compared with the past experiences, discussed with the family members and progressive farmers, friends, relatives. Similarly majority of the farmers disseminate the information to the neighbors, friends, relatives. Some of the worth mentioning constraints and suggestions reported by majority of farmers during communication were information about MIS is theoretical and not practical oriented, verbose, repetition of information and not related to their problems. Similarly other constraints were insufficient time to note, discussion groups are not in existence in villages, rapid disposal of information on TV and inadequate information in literature. Study revealed that the level of utilization of information input, processing and output behaviour besides overall communication behaviour of the farmers adopting micro-irrigation systems (MIS) is neither low nor high in Maharashtra. There exit a significant

positive relationship between personal (except age and family Size), psychological variables and communication behaviour attributed to the adoption of the MIS.
The coefficient of multiple determination (R2) with 13 independent variables computed for overall communication with 'F' ratio of 6726.69, indicating its significance at 0.01 level of probability revealing that all these 13 independent variables could jointly explain a significant amount of variation to the extend of 99.40 per cent in overall communication behaviour attributed to adoption of the MIS by the farmers. However, negligible 0.60 per cent of unexplained variation is attributed to other factors not included in the study.

Most of the farmers have moderate level of communication behaviour. They know the MIS but lack the details need for its adoption. Hence it can be send that unless detailed information is acquired by the farmers they will not move towards its acceptance and adoption.

Conclusion and Recommendation: 1. In the adoption of MIS the variables age and the family size of the farmers affect adversely 2.The independent variables studied are more appropriate and important towards effective adoption of micro-irrigation systems through appropriate communication behaviour. 3. Most of the farmers have medium level of communication behaviour. It is recommended to enhance the level of adoption. 4. Innovation is necessary condition but not a sufficient condition for a farmer to be appropriate in his communication behaviour. 5. It is recommended to change the values like economic motivation, scientific orientation and risk preference of the farmers to enhance the level of MIS adoption.

Changing Diets and their Implications for Water, Land and Livelihoods: Case Study from Lake Victoria basin

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Keywords: Nutritional, Marine pollution, Conservation, Sustainable, Environmental Restoration

There is no dought that wetland, river basins and other water catchments areas are being depleted and over exploited, which happens to be a global challenge meeting the supply of fresh water for consumption and production of the required nutritional diet in form of fish and livestock products.

Despite the above-mentioned scenario, fresh water has continued to support communities for the services that contribute greatly to the environmental conservation, creation of labour, nutritional supplement and for poverty alleviation.

It has offered Farmers with an alternative income by engaging in fisheries or livestock other than depending on crop production alone.

Fisheries and other fish products represent a major contribution to the economy and to the diet of communities both directly as food and indirectly in terms of production of meal and oil for livestock and this contributes a lot tot to domestic diet and income improvement.

Statistics show that the worlds aggregate catch of fish from freshwater has grown overtime, but this growth if not well observed is likely to overstretch the capacity of production and this will result into some species being extinct and this kind of exploitation of these resources is not sustainable. As human population increases, the demand for freshwater supply, and freshwater products increases too, which has doubled the threats to marine pollution and overexploitation.

While sewage is seen to be the main source of pollution, to our fresh waters and land surrounding them near cities and towns, the use of pesticides, fertilizers and other agrochemical use is rising world wide .The atmospheric pollution from vehicles and industrial emissions are increasing too. These factors and many others have affected the quantity and quality of production, as some of the above pollutants are persistent organic pollutants, which will finally affect the ecosystem.

My case study is Lake Victoria basin, which is shared by the three East African countries, that is Uganda, Kenya and Tanzania. The role played by this lake to these countries is great in terms of providing fish for food and other marine products. It benefits more than thirty million people that live in this lake basin.

The land in here has been supporting agriculture as the soils are fertile and the environment conducive for both growing of crops and rearing of animals.

These activity have improved the lives of these communities in terms of poverty eradication and nutritional provision.

However, the lake is facing a great danger as the practices and methods used in exploiting these resources are unsustainable and affecting fisheries and aquaculture in this basin. Over fishing and pollution of wetlands has paused a great threat to the ecosystems in this location. Fish poisoning as a method of catching more without regard to other marine life and the young fish that will be killed too is likely to wipe out some species and even the fish population will reduce which will affect the quantity and quality as well.

Poor methods of agriculture and overstocking have strained this basin and environmental conditions have deteriorated causing the lowering of the lake level and reduction of some species of fish such as the tilapia. This in a long run has affected the income of the communities in this basin and the reduction in their diet.

Solution:

Regional institutional arrangements should be put in place to safe guard and promote a meaning full participation of the three East African countries in sensitizing the communities on environmental conservation and restoration practices, and study these communities needs and interests or requirements that had not been provided for by states and addressed earlier for effective management and conservation of these resources.

To achieve a meaningful change and a positive action, the regional civil society organizations and Local leadership must participate fully.

Workshop 7:

Sharing the Benefits of Ecosystem Services and the Costs of Ecosystem Degradation

Sharing the costs of ecosystem degradation in the Murray Darling Basin, Australia – the results of the first century of negotiations!

Author: **Mr. John Scanlon,**
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Director, International Centre of Excellence in Water Resources Management, Australia
Vice Chair, IUCN Commission on Environmental Law, Germany

A pragmatic ecosystem approach – the Murray Darling Basin Initiative

In the late 1890's, a fierce debate raged over how the proposed Australian Constitution should address the sharing of the waters of the River Murray between the (then) colonies of New South Wales, Victoria and South Australia – a debate that threatened to derail the process of federation itself.

The colonies of New South Wales and Victoria had claimed the sovereign right to divert the whole of the water in their tributaries and the River Murray, with some slight concession to South Australia as compensation water. Not surprisingly, during the pre-federation convention debates the colony of South Australia, the downstream colony, argued for the Commonwealth to be given the power to manage the waters of the River Murray, which was fiercely resisted by the upstream colonies. A last minute compromise was negotiated between the colonies clearing the path for the finalization of the Constitution and the creation of Australia as a nation State.

The history of the creation of the Commonwealth of Australia and the constitutional sharing of powers between the states and the Commonwealth has had a significant influence on the measures that have been taken over the past 100 years to manage the shared resources of the Murray Darling Basin. The past century has involved an ongoing negotiation between all parties, which has resulted in a co-operative, pragmatic, ecosystem based approach being adopted by governments and the community to managing the shared resources of the Basin.

The collective efforts of the Commonwealth, the states of South Australia, Victoria, New South Wales, Queensland, and the Australian Capital Territory, together with the community, are known as the Murray Darling Basin Initiative (the Initiative). This pragmatic and cooperative approach continues today as do the negotiations!

Confronting the challenges of a stressed system – the major issues in the Basin

The Murray Darling Basin spans across five state and territory jurisdictions, is over 1,000,000 million square kilometres in area, or 14% of Australia, home to two million people and is Australia's most productive region for irrigated agriculture – with over 70% of all of Australia's irrigated agriculture occurring within the Basin. The City of Adelaide, which lies outside of the basin and has a population of over one million, relies on the River Murray for up to 90% of its water supply in drought years.

Today the Basin enriches Australia by an estimated $23 billion per year. Agriculture produce now exceeds $10 billion (recent figures say $13.6 billion), mining $3 billion, tourism and leisure around $6.5 billion, hydro electricity generation $0.3 billion and commercial fishing and other industries $2.5 billion. It is a highly productive Basin.

But economic gain has taken its toll on the environment resulting in significant ecosystem degradation throughout much of the Basin, which is threatening both ongoing productivity and environmental health. The key issue is that too much water is being extracted from the Basin. The impact is most severe in the lower third of the 2530 km long River Murray. The challenges confronting governments and the community of the Basin include irrigation induced and dryland salinity, the overallocation of water, a decline in water quality and ecological health, and the under-pricing and inefficient use of water.

Dealing with these challenges comes at a price and who pays, and when and how has involved a series of separate but related negotiations based upon Constitutional roles and responsibilities, political and social imperatives, a shared knowledge base and intensive interaction with the Basin community. Within this context governments have negotiated extensive and detailed market based measures to share the costs of ecosystem degradation in order to protect the productivity of the Basin and restore its ecological health, which are seen as being inter-twined. Three separate but related initiatives will be explored in the presentation:

- **The Basin Salinity Management Strategy**, a co-operative and jointly funded strategy to maintain river salinity at an agreed level, control salt loads in all tributaries, and control land degradation while allowing productive activity to expand where appropriate.

  This strategy builds upon earlier agreements to collectively address irrigation induced salinity to now cover both irrigation induced and dryland salinity. The strategy revolves around a Schedule to the Murray Darling Basin Agreement that sets agreed time based 'salinity baseline conditions' and quantitative basin wide and river valley salinity targets. Each jurisdiction acquires salinity credits and debits based upon the actions they take after the 'baseline date' that may affect salinity levels, and are required to remain in credit overall. Credits are achieved by investing in measures to reduce salinity, with debits being assigned to actions that increase salinity. The overall result has allowed productive areas to expand while achieving significant reductions in river salinity.

- **The Living Murray First Step**, a co-operative and jointly funded initiative to return 500 gigalitres of 'new water' to the River Murray as an environmental flow to improve the health of six agreed icon sites and to invest in a range of capital works and measures to make the best use of recovered water.

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  This initiative followed an extensive process of scientific investigation and analysis and community consultation. It was concluded through a separate inter-governmental agreement between the Australian, New South Wales, Victorian, South Australian and Australian Capital Territory governments, and is overseen by the Murray Darling Basin Ministerial Council. Each jurisdiction is set investment and water recovery targets based upon its share of consumptive water use, and is responsible for developing water recovery plans for icon sites within their jurisdictions. The Murray Darling Basin Commission is responsible for the Basin wide environmental watering plan. It is recognised that the additional flow is a first step towards recovering the health of the River Murray and more water will be needed over time to restore the River to good health.

- **Interstate trade in water entitlements**, a pilot trading scheme limited in area and volume that is now being expanded to cover a wider area and larger potential volume of water to be traded.

  This scheme seeks to build upon longstanding permanent and temporary trade in water within jurisdictions. It allows, and sets the rules for, cross jurisdictional trade in water in order to maximise its commercial use by allowing the market to determine where water will achieve the best return, subject to environmental and social issues and physical constraints being assessed. It does not affect agreed water sharing rules between jurisdictions, but adjustments to volumes are made to take account of trading, which may also affect future contributions to the recurrent costs of the overall Initiative, which are based upon the service received by each jurisdiction.

A well informed negotiation – sharing the costs of ecosystem degradation in the Basin

The platform for all negotiations has been a sound legislative and knowledge base, and stable governance arrangements. Parties have entered negotiations with a shared knowledge of the challenge to be confronted and in the context of previous negotiated outcomes. While extreme positions have sometimes been taken, common sense and recognition of the importance of shared responsibility and ongoing collaboration has ultimately prevailed.

A never ending story – creating the framework for ongoing negotiations
Negotiations on the sharing of the resources of the River Murray, and later the Murray Darling Basin, can be traced back to the 1880's, being the time when irrigation schemes first started to emerge in one of the up stream colonies causing alarm to the down steam colony that had invested heavily in navigation to promote trade and communications.

Many Royal Commissions and government and community based conferences have been held both prior to and since the creation of the Commonwealth of Australia in 1901 and strongly held negotiating positions have been argued with great vigor. However, a sense of shared ownership and responsibility has prevailed as the parties have strived to work with the Basin community to find pragmatic and co-operative solutions to the economic, social, and now increasingly environmental challenges that confront the Basin, its governments and its community.

The legislative framework created in 1915 has changed ever since, including in 1986 to cover the entire Murray Darling Basin and to incorporate all jurisdictions and the community into the process. The Initiative's solid legislative framework and the willingness to review and adapt this framework over time has provided a sound and robust negotiating environment within which to operate and confront new challenges as they emerge.

We are now just over one century into the negotiating process, which will continue on in perpetuity as governments and the community adapt to changing economic, social and environmental conditions by utilizing new and innovative tools to enhance productivity and improve the ecological health of the Basin, and so it should be.

An Economic or Pro-poor Pathway? The Dilemma of Water Allocating Institutions in the Great Ruaha Catchment in Tanzania

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Keywords: Water transfer, water benefits, water values, pro-poor returns, income inequality

Presentation of the project/topic and analysis of the issues: Water is globally regarded and treated as a social and basic good where the social aspects are given the most attention. Water being a basic good and a human right has called for government regulations to safeguard this right in the interest of especially the economic weak, the poor and disadvantaged group. This has been so from time immemorial until recently when the increase in population and the effects of human activity on the quantity and quality of water have resulted into an evolution thinking whereby water is now being considered as not only a social good but also an economic good.

The concept of "water as an economic good" has emanated from the understanding that water is finite, its allocation should therefore, consider its nature of being scarce and water should not be considered as 'free.' According to the economic efficiency principle, water should be allowed to flow to the sector generating the highest marginal value. Several authors have however, argued that the concept of "water as an economic good" is still vague and questionable, particularly when the poor are concerned: it ignores the crucial question of "benefits for whom" and the distribution of wealth within society. The hypersensitivity of the counter theory on water resource (the social good opinion) stems from the fact that the resource being essential for all types of life if its allocation is left purely to market mechanisms, which are dictated by economic factors, other characteristics of water, such as social and environmental values might be negatively affected. These counterarguments translate to the dilemma of whether allow water to flow to the sector generating the highest economic or pro-poor returns, which is globally debated with most countries taking a neutral perspective and striving to achieve the objectives of economic efficiency, environmental integrity and social equity. The true meaning of this is however, reflected in a harsh reality of ensuring balanced water benefits. This is even more challenging in drought prone areas or areas which suffer from occasional or chronic water scarcities and it needs a thorough understanding of the value of water in its different uses. Water managers and decision makers need to be informed of the value and benefits of water in its competing uses and the implications of water transfer from one sector to another before embarking on devising strategies to balance water demands. Using the "value-focused approach", this paper presents a discussion of the dilemma facing water allocation institutions in the Great Ruaha Catchment (GRC)." The paper draws on the data collected during a study conducted by the RIPARWIN (Raising Irrigation Productivity And Releasing Water for Intersectoral Needs) project - a DFID funded project implemented by the Overseas Development Group (ODG), University of East Anglia (UEA), United Kingdom; the Soil Water Management Research Group (SWMRG) of Sokoine University of Agriculture (SUA), Tanzania; and the International Water Management Institute (IWMI) through its Africa Regional Office in South Africa.

Presentation of the results/findings: The findings from this work showed different values of water for different uses. The values of water for livestock, brick making and domestic uses were the highest, averaging at around a dollar per m3 of water consumed. In terms of total net benefits however, the hydroelectric power (HEP) sector (Mtera-Kidatu system) generates the highest annual net benefits (about US $ 230 Million versus US $ 22 Million per annum for irrigated agriculture in the Usangu Plains). The values of water in irrigated agriculture, and in particular irrigated paddy was relatively lower (averaging at Tsh 20.73 ($ 0.02) and 34.87 ($ 0.03) per m3 of abstracted and consumed water respectively), than those in HEP [cf. US $ 0.06 per m3 of gross water used (turbine discharge and net evaporation) and $ 0.21 per m3 of net water consumed (evaporation)]. Looking at these values one would generally argue that HEP generates higher economic returns than irrigated agriculture, but a number of other aspects need to be considered as well. These include, for example, the question of whether HEP is also superior to irrigated agriculture, in terms of generating higher pro-poor returns. Never the less, the question of benefit sharing is also important and it needs a closer analysis. Recognizing that only 10% percent of the total population in Tanzania (1% in the rural areas) have access to electricity versus, for example, the share of the Upper GRC irrigated paddy in the total national production (which ranges from 14 – 24%), and the fact that more than half (60%) of all the paddy produced in the Upper GRC is sold outside the area through inter-regional trades to other regions in Tanzania, one would also see the role that irrigated paddy plays, particularly in enhancing both the local and national economies as well as the national food security at large. Irrigated paddy supports about 30,000 agrarian families in the Upper GRC with average gross income per family of about Tsh 969,960 or US $ 911.90 per annum. The income decomposition analysis showed that irrigated agriculture represents an inequality-decreasing source of income.

Conclusions and recommendations: The findings in this paper have illustrated that the "economic or pro-poor dilemma" with its associated belief in the GRC that hydropower generates higher economic returns than irrigated agriculture need to be observed critically. Ideally being neutral is safe and sound – i.e. aiming at achieving the objectives economic efficiency; environmental integrity, and social equity would mean a lot. Just as important, the issue of benefit sharing is key to winning the support of all the stakeholders and ensuring sustainable management and allocation of water resources. Embedded in this is the whole issue of poverty alleviation. Most of the poor people in Tanzania live in rural areas and they depend on agriculture as their major source of income. Based on this understanding, this paper argues that any intervention to transfer water from irrigated agriculture to other sectors should be undertaken with caution.

Access: A Precondition for Payment for Environmental Service Understanding - The Case of Tiquipaya Watershed, Bolivia

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Keywords: PES, Integrated Watershed Management, Water rights, Access, Bolivia

This paper explores the importance of understanding access relations for the implementation of systems of payment for environmental service (PES). It argues that it is not enough to understand who bears the costs of environmental degradation or who benefits from environmental services and the implementation of PES. Water and watershed management often take place in contexts of competition and conflict over water rights and access. With case in the Tiquipaya watershed in Bolivia it is claimed that we need to understand how people gain, maintain and control access to water resources to assess the potentials for PES as well as to be able to initiate processes of negotiation and institutionalisation of PES.

The assumption behind PES is that a payment or compensation by downstream beneficiaries will provide an incentive for upstream land users to adopt conservation and sustainable land management practices (Pagiola et al., 2005). Particularly, if certain conditions are fulfilled e.g. the presence of strong externalities between upstream land management practices and benefits of environmental services received by a downstream population. Moreover, it is an advantage if the downstream population has the recourses to pay and is more numerous than the upstream population.

Tiquipaya watershed is situated 10 km north of the city of Cochabamba with almost one million inhabitants. The watershed is part of the Tunari mountain range and is one of several almost parallel watersheds whose rivers run down to the Cochabamba valley. The services and benefits produced by the watersheds are very much related to water quality and quantity, as the mountain range is the principal source of water for both consumption and agricultural production in Cochabamba and the surrounding municipalities. The watersheds retain rainwater in soils and riverbeds allowing for the recharge of aquifers in the valley. Moreover, the watersheds regulate the flow of water in streams and torrents determining the risk of flooding in the valley. However, human intervention and management practices have lead to large-scale degradation of the watersheds with serious consequences for particularly water supply and the occurrence of natural disasters (PROMIC, 1996). Downstream urban settlers as well as upstream farmers who loose fertile land both endure the cost of this process.

In order to respond to upstream degradation and its downstream consequences a local NGO in collaboration with upstream communities, the departmental government and international funding agencies has carried out projects of integrated watershed management since 1994. The benefit of this process of integrated watershed management is not only received in terms of environmental services downstream such as recharge of aquifers and mitigation against flooding and landslide. The upstream population receives employment, training and inputs for a more sustainable and productive agriculture.

Although the integrated watershed management project has brought benefit to a number of both upstream and downstream settlers the process is fragile and needs continuous input in terms of maintenance of hydrological works as well as training and input for upstream agriculture. Hence, the fundamental challenge now is the find a way to sustain the funding of these activities over time. Some of this is envisaged to come from some kind of PES. However, although externalities are strong, the benefits are clear and the downstream population much larger than the upstream population, we argue that PES is unlikely to succeed unless we understand and are capable of managing access relations.

An improved understanding of access relations is essential because any change in land management practises such as those associated with PES will always imply some degree of renegotiation of water rights (Burns & Meinzen-Dick, 1998) – in the case of PES a right to compensation for sustaining water resources/preventing water related risks. Thus PES legitimises a claim and establishes a water related rights. At the same time, in the process of negotiating a system for PES, already established rights to water will be validated. If compensation is recognised then the right to the water resources paid for is also recognised/legitimised. Hence PES becomes a kind of formalisation of water rights and PES negotiation becomes a platform for negotiation of contested water rights.

The paper is divided into three sections. Section one describes the biophysical characteristic of Tiquipaya and looks closer at who bears the cost of degradation and who receives the benefits of environmental services and PES. Section two analyses how people gain, maintain and control access to water resources in Tiquipaya within a context of competition and conflict over water resources. Access is here understood 'as the ability to derive benefit from things' and includes right based and illegal mechanisms as well as structural and relational mechanisms (Ribot & Peluso, 2003). Finally, section three discusses the probability of implementing PES in Tiquipaya considering biophysical externalities and social access relations. The paper concludes that despite strong externalities and the potential that PES may improve the livelihood conditions for poor upstream farmers and downstream settlers the implementation of PES is not a possibility in the near future. The main reason being that PES will have to operate in a context of competition and conflict over water resource between urban/commercial interests and traditional norms and costumes.

Financing of the Decision of Water Problems of Russia: Between Command Approach, Market-Based Approach and Ethical Traditions

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Keywords: management of water resources, Economic mechanisms, payment for ecological service, mechanism of tax of payments, Water Board

Financing of water sector in Russia: a today situation.The basic economic mechanism stipulated Russian legislation, now are the ecological payments, which serve in the basic tools of mobilization of means for financing nature protection measures. Other elements of the economic mechanism of ecological management connected as with positive motivation of the users practically are not used, except for transfer on account of repayment of payments for pollution of an environment of means actually used by the enterprise on performance of nature protection measures, stipulated by the order of updating of the sizes of payments. Main reason is absence of definiteness in the property right, right of the order of resource potential in hierarchical mutual relation at all levels of federation: the managing subject in territory of municipal formation - city - regions a federal level. The necessity of the prompt decision of this problem is caused by that the right of this aspect of the property, is especial on resources, i.e. the conditions of reproduction of the material boons, cost in subsequent are defined with the property right and right of the order by results of work, and at the end and output on a level of the taxes, payments.

Payment for usage by natural resources. It is possible payment for usage natural resources by the "rudimentary" form of a payment for ecological services (PES). The previous years in Russian Federation the system "Payments for usage by water resources", shown the imperfection and requiring changes worked. The second minus: the similar system does not take into account real damage and necessity of ecosystems restoration as a whole, and reduces the circuit to withdrawal "of the certain quantity of cubic meter of water for definite purposes". Still, the at all influence anthropogenous of influence on all ecosystems elements is not taken into account: wetlands, interests of preservation of a biodiversity. At measurement of ecological services the relationships of cause and effect of system were not taken into account. The economic ecosystems estimation, connected with water was not made also, - the analysis was limited only to water supply. By distinctive feature of definition of value of service " payments for waters the usage " is that at its account the estimation of an opportunity of the consumer was taken into discounted to pay for services, instead of desire to pay for this service, and also attitude which has stayed from socialist times, to water as to an almost free-of-charge resource.Such approach is perfectly justified, as, on the one hand, for the population water and ground long time did not associate with paid resources, and the sudden introduction of a high payment for it could become a shock, on the other hand, overwhelming part of the population concerns to needy layers and be not capable to pay the large sums. Same is characteristic and for the majority of the industrial enterprises - majority of them are in a difficult financial position.Now basic contractual mechanism of the tax of payments are the circuits of state payment.Payment for ecological services in Russia. Regional aspect.It is obvious, that the circuit, existing in Russia, of financing of use and protection of natural resources requires perfection: the transition from command methods to market-based mechanisms promoting really rational and sparing influence of the people on water ecosystems is necessary.Probably, one of acceptable variants can become begun to be developed the contractual mechanism on base of Basin Water Boarder. In the Ural region in basin of the Iset-river works the pilot-project of the Russian Network of the Rivers on creation of the effective mechanism of ecological improvement of the river. Within the framework of the project the Water plan is created, is created Basin water Board. In an operating time within the framework of the project the motives and interests of the majority of water users, conducting activity in basin, their opportunity and desire were found out to pay for the certain kind of activity directed on improvement and maintenance ecosystems to the given territory.The payment for ecological services can exist within the framework of the legislation, working in Russia, (opportunity of activity Basin water Board of a framework is described in the Water code of Russian Federation). The intentions, plans and contributions of all water of the users who are taking place in basin of the river, are registered in voluntary contractual basins agreements. These agreements are entered in the existing real circuit of the social, ecological and market attitudes in territory. The financing is made as creation of resource funds (material means, practical measures).

General motive of participation of all water of the users - steady development and improvement of quality of life of the local population in the given territory. It is necessary to note, that as against Water Board existing in Europe, at the given stage the local water agreements are not provided directly from the state budget, but the local bodies of authority accept the financial participation, including concrete measures on protection of environment in the budget programs.

The stability gives the given circuit also account of so-called "informal" rules - ethnic and local traditions regulating water resources. Works on result and that all local community is involved practically in activity.For Russia, as well as for many countries with transitive economy the economic forces remain basic for the persons accepting decision. That the development of economy should go not to the detriment of ecology, in practice frequently declarations: the real persons accepting decisions, are convinced, that the introduction of ecological values destroys economy. Necessity and urgency of introduction of the real circuits and accounts proving value ecosystems and benefit from their preservation therefore is obvious.

Compensation for Environmental Services in the Andes, Reflections for a Wider Application

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This paper are the reflections of the author after being involved in the promotion of Integrated Natural Resource Management and poverty reduction activities in the Andes, including the possibilities offered by the application of compensation for ecosystem services provided. In the Andes, valuable environmental services that support surrounding ecosystems and cities are threatened mainly by erosion and natural disasters. The situation becomes very serious since smallholders living in the upper catchments and steep slopes of the Andean mountains engage in unsustainable land use practices that degrade soil and contaminate water. With declining prices of agricultural products and decreasing investment in the rural sector, these communities are facing poverty with few alternatives to improve their livelihoods. Their actions are contributing to degradation of the natural resources base in the watersheds of the Andean region, directly affecting their own long-term livelihoods as well as that of the users of environmental services in the lower catchments. In this part of Latin America, it is only natural that the provision of ecosystem environmental services, particularly those related to hydrological resources, be tied to the possibilities of reducing poverty and aiming at improving income for the small farmers.

Several reviews and workshops have taken place recently in the region on CES experiences. One can conclude that the objectives have to be very clearly defined to avoid confusion when using and analyzing the effectiveness of schemes of Compensation for Environmental Services (CES) since these are only part of an array of means by which resource transfer can be made between sectors of the Andean society. These mechanisms are still at their initial stage and their evaluation can only be partial at this time. Moreover, the type of service provided (carbon sequestering, forest protection, biodiversity, water resources) differ widely in their complexity and possibilities of application.

From the point of view of contributing to rural development in the region, and although CES generally does not yet involve direct transfer of resources from the users to the providers of the service, the CES concept and intention of application, does contribute to raise awareness on the potential links between ES and poverty reduction. Several initiatives are taking place at this time that, in the short term, will probably contribute more to the conservation of natural resources than to the reduction of poverty. Linking CES to poverty reduction is a very complex task. Apart from the local conditions, the larger context (education, economy, environmental awareness, policies, culture) of the specific developing country plays an essential role in the feasibility of applying a CES mechanism. Even then, so far CES at the local level are either not based on a rigorous valuation of ES (and thus with the risk of not being sustainable) or are in fact incentives for land use changes rather a true CES.

Research activities can play a very important role in the valuation of ES, policy changes and the promotion land use alternatives and strategic alliances between stakeholders. Researchers, however, should link more effectively with development and aim at achieving a real sustainable change. The challenges and opportunities to achieve this will be analyzed in the presentation.

Carbon Sequestration Services of Reforestation Initiatives in the Catchments Area of Lake Singkarak in Indonesia: Local Action for Global Benefit

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Keywords: ecosystem services, carbon sequestration, catchments area, Lake Singkarak, Sumatra Indonesia

Problem Statement

Carbon sequestration to alleviate global warming is an example of ecosystem services increasingly obtained attention in academic, government, private sectors and organizations concerned with the empowerment of civil society. Providers of ecosystem are generally people living upstream such as in the catchments of Lake Singkarak in West Sumatra, Indonesia. Land use systems, techniques and knowledge adopted for farming practices in the upstream significantly affect the nature of resources and the quality of ecosystems services. The beneficiaries of the services include people living downstream, private entities, national and international organizations interested in conserving the resources. However, upland communities, generally the poor and most marginalized, are not sharing in the benefits that these services provide. The benefits of national and local investments in economic development often bypass these people and in many cases these upland communities are bearing a large share of the negative aspects of development.

There is an urgent need to support a process of self-empowerment so that poor upland communities can take the necessary decisions to build a sustainable future based on their resources, on improved technology and centuries of accumulated wisdom. These people have to be rewarded for their massive initiatives in applying reforestation or at least avoiding deforestation, which could qualify for carbon sequestration funds of clean development mechanism (CDM) at global level according to The Kyoto Protocol. However, as the institutions governing the interactions among these stakeholders have not developed properly, establishing rewards and payment transfers for ecosystem system providers would face serious complexities. Under such institutional arrangements, the transaction costs of implementing rewards and payment transfers are extremely high. In addition, political constraints to implement the concepts are substantial, especially when the communities receive rewards for services only in exchange for votes.

Objective and Approach

his paper examines reforestation initiatives performed by poor people living in the catchments area of Lake Singkarak in Sumatra, Indonesia that could contribute to the reduction of global warming phenomena. In this case, carbon sequestration services are analyzed using an entry point of watershed and hydrologic functions of the forest in the lake environment. A purposive participatory rural appraisal was used to collect new information and to verify some information on the institutional mechanisms already available. The data collection was focused on the typology of institutions, including the notions to which available institutions governing the arrangements to accommodate collective actions in control, liberation and expansion of individual action. An in-depth analysis is also employed based on head-to-head interview with prominent figures of informants and competent resource persons in the field and in the office.

Result and Discussion

Catchments area of Lake Singkarak in Sumatra, Indonesia cover an area of 129,000 ha, previously known as the heartland of the Minangkabau Kingdom, and served as the food basket of the region. About 39,000 ha (31%) of the catchments is considered "critical land" as a result of non-suitable land use practices, resulting in either land degradation or wild imperata grassland. Water in the lake comes from at least five main rivers, from the south (Solok district). The original outlet of the lake is Ombilin River to the east, which provides irrigation for rice paddy in four downstream districts: Solok; Padang Pariaman; Tanah Datar; and Sawahlunto Sijunjung. In addition, artificial outlets of the lake to the west have been used for generating power of HEPP (hydroelectric power plant) or PLTA Singkarak, serving the electricity demands of the provinces of West Sumatra and Riau.

As the watershed management in catchments area involves several agencies and stakeholders responsible for maintaining or regaining watershed environmental services, negotiation process for reward mechanisms for the poor are also complex. Stakeholders of Lake Singkarak have established a public-private partnership, BPDS, to coordinate and implement water management of the lake, land rehabilitation of the catchments. More importantly, the BPDS is to perform reforestation of degraded areas of the catchments as a basis for initiating carbon projects under Clean Development Mechanism. Strong local collective actions, sophisticated Nagari institutional arrangements, indigenous systems of land use within the catchments area and some formal laws and regulations could be seen as important driving forces for developing ecosystems services "markets" in Singkarak.

The immediate challenge is how the interests and commitments shown by local stakeholders to rehabilitate the catchments area of Singkarak could be rewarded properly, especially to empower local people who are most dependent on water resources and forest resources, and to improve their livelihoods for a better future. Such mechanisms of reward transfer involving public-private partnership have been adopted in some cases of ecosystem services in some countries in Latin America. Indonesia just passed the new Act No.17/2004 to ratify the Kyoto Protocol and established a key authoritative body of Designated National Authority (DNA), an independent institution, representing government agencies and other stakeholders for broader carbon sequestration. The main agenda of these public-private partnership and other related institutions would be to establish criteria on how to implement the reward mechanism system, to maintain the interests and commitments shown by local stakeholders to rehabilitate the catchments area, and to empower local people who are most dependent on water and forest resources, and to improve their livelihoods.

Paying for Environmental Services in Upland Watersheds in China: Lessons Learned from a Promising Approach

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Keywords: Southwest China, Upland watersheds, flooding, erosion, forest plantaions

Perhaps in no country in the world is the tension between watershed conservation and poverty alleviation as acute. China's mountains house the headwaters of many of its greater and lesser rivers; they are also home to a majority of its chronically poor.

This divide between upland conservation and development priorities was accentuated following China's shift from a centrally planned to a more market-oriented, decentralized economy in 1978. While the costs and benefits of maintaining environmental services provided by upland forests — flood prevention, erosion control, and water quality in particular — had traditionally been borne by and accrued to a centralized state, state withdrawal similarly produced a new gap between producers and beneficiaries. With declining government support and without incentives for households, businesses, and local government to conserve, deforestation in the uplands was widespread.

The notion of paying and charging for specific environmental services emerged in this context. To cope with declining revenues and worsening deforestation, local officials in Qingcheng Mountain — a tourist attraction in Sichuan Province — designed a system where a percentage of ticket proceeds were used to pay for forest protection. Forests quickly recovered, and the scheme inspired an official dialogue on payments for environmental services that began in 1989 and continued throughout the early and mid-1990s.

Severe flooding on the Yangzi (Yangtze) and Song Rivers in 1998 accelerated the Chinese government's growing recognition of the benefits provided by upland forests, as well as the difficulties inherent in using regulatory approaches to control the behavior of resource-dependent, smallholder farmers. As a result, public payment schemes came to the fore in China as a means to compensate farmers' investments in forest restoration and protection. Their emergence was combined with formal recognition of the importance of compensating environmental service provision in both China's revised Forest Law (1998) and Water Law (2002).

Most payment schemes for environmental services in China, both larger and smaller scale, have been publicly financed. Large-scale, central government initiatives are best represented by two forest conservation programs: the Sloping Land Conversion Program (SLCP), which pays farmers to convert their marginal farmland to forest; and the Forest Ecological Compensation Program (FECP), which compensates farmers for reforesting and protecting forests. Provincial and local schemes cover a wide range of institutional innovations, such as electricity and water consumption fees dedicated to forest conservation, and direct payments to upstream farmers from downstream hydropower facilities. As limitations in public funding become increasingly apparent, private payment schemes will increase.

Just as China's comparatively dense upland populations complicate its watershed conservation quandaries, so payments for environmental services hold particular promise for solving them. Realizing this promise will require not only adequate time and resource commitments, but also a high-level willingness to experiment, to facilitate open and honest dialogue about the results, and to improve upon them. This paper examined a subset of payment schemes for environmental services in Anhui, Guizhou, Sichuan, and Yunnan Provinces, and distilled a number of principles and practices that could improve the design and operation of payment schemes for environmental services in greater China as follows:

Design: Function, Financing, and Scale

- Reasonable incentives are key to maintaining environmental services over the longer term.
- Payment schemes require adequate funding to ensure adequate levels of environmental services
- Clear objectives and evaluation procedures can help allocate scarce financial resources.

Operation: Governance and Institutions

- Ensuring stakeholder participation from the beginning can improve acceptability and lower transaction costs.
- Transparency in revenue use and valuation methods is key to gaining public acceptance and maintaining the quality of environmental services.
- Government agencies and local governments should continue to play a central, facilitating role.

Determining Costs and Benefits of Environmental Externalities as an Instrument to Promote Alliances for Development. Fuquene Watershed (Colombia)

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Keywords: Environmental externalities, shadow prices, hydrological modeling, opportunity costs, value chain analysis

Introduction: The watersheds of the Andean Region are characterized by an environmental heterogeneity, that implies special connotations when determining the cost and benefits of the environmental externalities: 1) In tropical watersheds with high altitudinal variations, the costs and benefits caused by environmental externalities could be more important than the ones occasioned at farm level; 2) It is essential to determine through spatial analysis the magnitude of the contribution of land uses to the environmental externality; and 3) Cost and benefits evaluation should be conducted for medium and long term periods in order to capture the effects caused by the interaction climate vs. crop rotations. The project 22 (WFCP) goal is to evaluate the feasibility of creating mechanisms of compensations for environmental services as an alternative for rural development in the Andes. To achieve this goal, part of the methodological approach is focus on the determination of costs and benefits of environmental externalities: 1) Evaluation and quantification of the environmental externality as the driver to incentive economic compensations; 2) Identification of the best land use and management scenarios which increase positive externalities and reduce environmental damage; 3) Determination of opportunity costs of implementing these scenarios; and 4) Evaluation of associated social costs and benefits. These activities contribute to facilitate the negotiation among partners as potential costs and benefits affecting them are quantified and valuated. In this article is presented the case study of Fuquene watershed (Colombia). Through this, a methodological approach proposed to respond to the mentioned aspects is discussed, as its results. Also are presented the alliances that have been built for promoting a promissory land use scenario.

Problematic: The Fúquene Lake provides potable water to more than half a million people downstream. Huge amounts of organic matter are being released into the water by different actors: Potato growers on very steep slopes (above 2900 m elevation), cereal crop growers at lower altitudes, and cattle producers on the flat landscape around the lake. The surface cover by water has been reduced in more than 50% during the last 60 years. The downstream municipalities, whose aqueducts depend on Lake waters are concerned about the future of their water-supply systems.

Results: The project conducted an evaluation of the costs and benefits that distinct management alternatives of farming systems could produced. The analysis was focus on quantifying the sediments produced by the farming systems. It was made through hydrological modeling using SWAT . Based on these results, Hydrological Response Units (HRU) were prioritized. The HRUs were located in the upper watershed and in lower altitudes. This altitudinal gradient implies differences in the production systems and therefore, a variation in the value of the environmental service and in the opportunity costs.For the prioritized HRUs the evaluated scenarios were: production systems with traditional tillage and production systems implemented with conservation farming practices (minimum tillage, direct drilling, and green manures). To achieve this objective a multi-criteria model was developed in which net income is maximized considering temporal variations of farming systems and environmental factors.The findings indicated that net incomes of upper and middle catchment farmers implementing conservation farming schemes are increased as the negative externality is modified positively (a reduction of about 50% in the sediment yield levels). From the standpoint of generating jobs, changes in the management practices in the upper catchment produce a reduction in the contracted labor; however this is compensated with an increase in the levels of employment obtained with the technological change in the middle catchment. In addition, the shadow price of the externality was also calculated. Thus, the shadow price for reducing one ton of sediments was US$ 18 and US$11 respectively, for the upper and middle catchment farmer. The opportunity cost of one hectare if taken out of the current production systems in order to accomplish erosion limits per hectare is US$1578 for farmers in the upper catchment vs. US$1255 for middle-catchment farmers. As shown previously, this cost can be avoided if conservation farming practices are implemented by the farmers. For this reason it was designed a co-financing scheme between the farmers associations, a bank and the project in order to facilitate the availability of the initial investment that could not be covered with the current cash flows of the small farmers. In addition, the value chain analysis demonstrated that when conservation agriculture practices are implemented in upper and middle-catchment, a marginal increment of 40% and 100% in social benefits could be achieved, respectively. These results are being used to initiate negotiations with other potential partners interested in increasing the rural income and/or reducing the lake eutrophication.

Conclusions: The evaluation of cost and benefits related with the production of hydrological externalities depends on a high understanding of the causal relationship between land uses and hydrological variables.

In the Andean Region, economic compensations for environmental services are facilitated when their potential benefits are related with changes on quantity and quality of water.

Sharing Riverine Ecosystems Services Benefits and Costs from Water Transfer Projects: The Case of the Lesotho Highlands Water Project

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Keywords: water transfer projects, ecosystems services, LHWP, Benefits, Costs

Water is often transferred from areas that abound in water to those that are water scarce to augment supply for social and economic development. The assessment of benefits from such transfers often focuses on direct economic, social and environmental impacts. However, these transfers usually have unintended impacts on the rivers from or to which water is transferred. In the case of Source Rivers, abstraction of water can affect the capacity of such rivers to provide support to riverine ecology. In the case of receiving rivers, increased flow can disturb the riverine ecology and capacity to provide ecosystem services with deleterious implications for riverine ecosystem services and the wellbeing of communities deriving livelihoods from such services. This is an externality which in most cases is absorbed as a benefit by the projects intended beneficiaries.

This study uses the Lesotho Highlands Water Project (LHWP) that transfers water from the highlands of Lesotho to the Vaal region in South Africa as a case study, and identifies riverine ecosystems services provided by the rivers dowstream the project dams in Lesotho, discusses methods used to assess and measure impacts of water transfer methods, uses the discussed methods to measure the impact of the LHWP on the capacity of the rivers downstream the project dams in Lesotho to provide riverine ecosystems services and on the availability of such services.

The LHWP in one of the big water transfer projects in the world. The project is aimed at abstracting water from rivers in the highlands of Lesotho, store it in reservoirs and transfer it through gravity to the water deficient Vaal region in South Africa. Before transferred, the water is used to generate hydropower in Lesotho. The Vaal region is the industrial hub of South Africa and the water is meant for industrial expansion and residential use. South Africa pays for the project costs only related to the water transfer component of the project. In addition, it pays Lesotho water royalties for the water transferred. This generates the much needed foreign exchange for Lesotho. The LHWP benefits were initially assessed on the basis of direct social (e.g. number of people to be displaced by the project), economic (e.g. economic growth and employment generation) and environmental (e.g. impact of infrastructure construction on the environment) impacts. It was only after the first phase of the project was completed and the second phase commenced that the implications of the project on the riverine ecology was assessed. This study applies data from this assessment to the methods used to assess and measure impacts of transfer projects on the capacity of riverine ecosystems to provide services to measure the impact of the LHWP on such services in Lesotho.

The results show that the rivers downstream the project dams in Lesotho provide four major riverine ecosystems services, viz., provisioning (i.e. freshwater required by humans and animals for survival), supporting (e.g. support given to riverine ecology like vegetation and fish for growth), regulating (e.g. sand disposal) and cultural and aesthetic. These services are important for sustenance of livelihoods of communities residing within the reaches of the rivers. In addition, the results show that the flow of these services will be negatively impacted by the project with deleterious wellbeing implications for these communities. This impact is estimated at 9 million Maloti (Lesotho currency where 1Loti is equivalent to approximately 0.17 US dollars).

The study concludes that while the LHWP is very important for economic and social development in Both Lesotho and South Africa, it also carries an unintended externality which is enjoyed as a benefit by water users in the Vaal region, South Africa. To ensure that the benefits of the project are equitably distributed, it is important that this externality is internalized by water consumers in South Africa. This could be done through mitigating the effects of the project or through compensating affected communities.

The Hydro-logic of Agroforestry: Fostering a New Appreciation of the Hydrologic Functions of Agroforestry for Improved Policy and Programme Design

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Keywords: agroforestry, negotiation support, watershed management, forestry, land tenure

Presentation of topic and analysis of issue:

There is an active current debate about the roles of trees, forests and agroforests in preventing or enhancing risks of floods, landslides and seasonal water shortages. The debate, and the science that informs that debate, remains quite polarized. On the one hand, many advocates of forest protection and afforestation draw upon received wisdom about the importance of forests for various watershed functions, from flood mitigation to water purification. Policy pronouncements and tree planting programmes across the world have been based on uncritical appeals to this received wisdom. Surprisingly, however, reliable scientific evidence to support the received wisdom is actually quite sparse.

Presentation of results and findings:

Research conducted by the World Agroforestry Centre over the past 10 years shows that agroforestry systems have the potential to generate substantial economic returns for farm families and protect watershed functions. Compared to secondary forests, for example, multi-strata agroforestry systems can generate equivalent environmental services and much greater levels of economic benefit. But not all agroforestry is the same – far from it. Management is important: the hydrologic effects of agroforestry depend crucially on ground cover and litter management. Tree phenology is important: deciduous trees that shed their leaves in the dry season have much less impact on dry-season stream flow than trees that grow year-around. History is important: the beneficial effects of trees on soils accumulate slowly over decades and can last for several decades after land use conversion. Landscape configuration is important: trees in riverine areas have much more important impacts on sedimentation than trees anywhere else in the landscape. And watershed size is important: the larger the catchment area, the less important is land use in any one part of the catchment.

Insights such as these, along with the analyses that underlie them, have immense potential to defuse conflict, structure economic relations, improve livelihoods, contribute to investment planning, and inform policy processes across the developing world. In Indonesia, China and Thailand, for example, scientists and collaborators with the World Agroforestry Centre have used these insights to defuse tensions over land use and land classification in several crucial watersheds, helped to structure economic relations between hydro-power companies and farmers, and provided guidance for multi-million dollar tree planting programmes. In the

Lake Victoria basin of East Africa, research results have helped to clarify the magnitude, spatial extent, and the dynamic pathway of soil erosion and sedimentation. Insights into the long-term benefits of trees have helped to justify significant public investments in landscape restoration. Elsewhere in East Africa, scientific studies have helped to allay fears about the possible impacts of rotational woodlots and stimulated new interest in the use of deciduous trees to jointly satisfy farmers' need for timber and the ecological needs for water.

Conclusion and Recommendations:

Public debates about the merits or demerits of forests and trees in tropical landscapes are important: they shape perceptions among policy makers, bureaucrats and other decision makers. They are also shaped and used by the international press to create sensational headlines – "Trees are evil" or "Deforestation causes massive floods." Agroforestry tends to get caught in the middle of these polarized debates. Sometimes the hydrologic benefits of agroforestry are used to justify the unwarranted conversion of forest land to agroforestry; sometimes agroforestry development is strictly ruled out, even on degraded forest lands. More nuanced understanding of the 'ifs', 'wheres', 'whens' and 'buts' of agroforestry is important for policy and planning processes, even if such nuance does not make the headlines.

Relationship Water-Forest Management as a Sharing Benefit of Natural Resources by communities in the Sierra Juarez of Oaxaca, Mexico.

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Keywords: Management, indigenous communities, Oaxaca, forest-water relation, biodiversity

The Sierra Juarez is located in the foothills of the Sierra Madre Oriental in the state of Oaxaca, Mexico. This region is characterized as being one of the 7 most biological diverse regions in all of the Americas, housing in its extensive forested areas diverse species of pines and 7 species of birds in danger of extinction. The state of Oaxaca is consider as one of the poorest, in contrast of that is the most mega-biodiverse in Mexico. The indigenous communities of the Sierra Juarez, Oaxaca have developed exemplary natural resource management techniques throughout their history, in spite of the fact that they don't have formal environmental education. The communities have the power of to make decisions over the management of their resources as forest and water. Furthermore, the communities of the Sierra Juarez have the organizational capacity to carry out this function as a result of their customary practices of communal decision making. The most important decisions to make in each community are done by the "assembly" and all the members have the responsibility to carry out the obligations that the "assembly" assigns them. To mention the preponderant is to protect and preserve their common properties, in a natural and economical way, in order to preserve them for the future generations.

The results show that the recovery of control over their natural resources has given the communities an increase in economical and environmental benefits that where unthinkable a few years ago. Since last year some of these communities have been favored with payment for environmental services such as: carbon sequestration, protection of the basin, soil protection and biodiversity.

Sharing the benefit to have natural resources is possibly to identify the generation of economical resources from the bottling of water from their springs, growing of mushrooms and ornamental plants, dehydrating fruits, farming of trout, using resin and ecotourism. Also they have been building capacities to used their forest resources being managed in a sustainable way, which also provides important economic benefits to the communities. Under the system of communal organization, is important to notice that they follow a forest management program governed by their technical forest services unit, which establishes which areas are to cut, protected, and reforested, to mention some, considering important to preserve water sources.

It is important to note the close relationship between appropriate management of their forests and the consequent protection of their water-shed basins. It is also important to notice that this relationship between forest and water resources has been treated with enormous respect by the communities. For example, because communities are aware of these relationships, important forested areas near springs have traditionally been protected to recharge their aquifers. In this way, they warranty the appropriate use of the hydric resource. Through the ancestral environmental care of their woods, flora, fauna, rivers and streams, some of these communities in the Sierra Juarez have received international recognition from the Forest Stewardship Council (FSC) through the certification of their forest; which in the long run means they have the international recognition of sharing the benefit to have natural resources. Now is important to give them the opportunity to build capacities to negotiate and know how to re-invest the economic support they get from the government dependences, ONG´s, and also their own resources, by opening new windows that allow them to grow up. They have developed an appropriate system to manage their resources and have applied this to benefit their communities; they recognized their weaknesses and looked for technical advice when necessary.

The passive role women have traditionally played, has been changing and currently they are taking an active part in the economical activities of their communities, plus the fact that they show more responsibility in the development of productive projects, alternative to the forest management. Nevertheless, the constant pressure on natural resources coupled with the difficult living conditions which affect the communities, has put in jeopardy traditional knowledge concerning their culture and environment relating to these communal territories.

It is important to consider sharing responsibilities to the government and private industries located in the Papaloapan water-shed basin, who receive direct benefits from the appropriate management and care of the natural resources; this will, increase the quality of life for these communities and help them to follow their ancestral practices of properly managing their forest and water resources.

The communities of the Sierra Juarez, Oaxaca show an enormous interest to preserve their natural resources, because they believe is the heritage they received and also the one will give to their future generations, this people usually have not scarcity of water, but they know is extremely important to preserve it as a source of live.

Linking Flow, Services and Value - a Checklist and Some Examples

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Keywords: ecosystem services, economic valuation, environmental flow, IWRM, water allocation

Ecological sustainability, economic efficiency and social equity are central criteria of Integrated Water Resources Management. Therefore, protecting ecosystems by providing environmental flows and internalising the market and non-market values of services sustained by such ecosystem are indispensable parts of Integrated Water Resources Management. However, ecosystem services are persistently under-valued and environmental flows are frequently omitted from the decision making process.

One reason for this is the common perception that valuation of ecosystem services and quantification of environmental flows are too complex and too uncertain to be included in decision-making. But as long as decisions are made that affect flow and ecosystems, quantification of environmental flow and valuation of ecosystem services is taking place, whether acknowledged or not. It is of utmost importance that this quantification and valuation is made explicit in order to ensure high levels of information and transparency in decision-making and in order to safeguard poverty reduction strategies.

The paper presents a comprehensive checklist of flow related ecosystem services. Each service is linked to key flow related functions, type of value and relevant valuation method. A review of existing valuation studies is provided and the challenges, particularly in developing countries, are discussed. Furthermore, the paper shows how the checklist has been used to guide Integrated Water Resources Management studies in East Rapti River Basin, Nepal, and Walawe River Basin, Sri Lanka.

Finally, the paper introduces a water allocation tool that includes quantitative linkages between environmental flow, ecosystem services and economic value. The system is based on a hydrological simulation model (MIKE Basin). Each water use, including ecosystems as represented by environmental flows, is linked to an economic value per volume of water used. Thus, the environmental and socio-economic (who wins and who looses) implications of various water allocation scenarios can be evaluated. This may, in turn, be used to clarify incentive structures and explore compensation strategies in Integrated Water Resources Management. The paper concludes by highlighting the fact that valuation of ecosystem services and benefit/cost sharing are problematic when ecosystems services directly support livelihoods of poor people.

Ecosystem Approach as a Key to Management of Wetlands Internalising Costs and Benefits of Wetlands Resources, in Kenya

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Keywords: Wetlands, Sustainable use, Ecosystem Approach, Wise use concept, Tragedy of the commons

Sustainable management of wetland resources in developing countries is one of the most critical and complex issues in modern times. Until recently many wetlands resource users in Kenya believed that wetlands were wastelands despite their immense functions and benefits. They are a common resource mostly shared among Kenya's diverse communities leading to overexploitation; atypical case of "tragedy of the commons". The current status of wetlands in Kenya indicates that 70 % of aquatic ecosystems are degraded, hence a threat to biodiversity. Increased human population, poverty, unfavourable climate and inadequate awareness on sustainable use of biodiversity are key driving forces on the state of biodiversity and ecosystem of Kenyan wetlands. However, if properly managed, these wetlands have proved to be vital lifelines for the poor and pastoral communities especially during long periods of dry spells as is the case today. Through the efforts of various government research institutions and non-governmental organisations, there is a growing awareness on sustainable use of wetlands in Kenya. This is attributed to the domestication of Conventions on Biological Diversity (CBD)'s Ecosystem Approach (a Strategy for integrated management of land, water and biodiversity). Principle 4 of the 12 ecosystem approaches is especially instrumental towards the adoption of wise use concept of wetlands in accordance to Ramsar Convention (1971). Principle 4 of the ecosystem approach states that "Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in an economic context". Any such ecosystem-management programme should; 1) Reduce those market distortions that adversely affect biological diversity; 2) Align incentives to promote biodiversity conservation and sustainable use and 3) Internalize costs and benefits in the given ecosystem to the extent feasible. Hence this paper aims at giving case studies of how wetland users and stakeholders have internalised costs arising from improper use of wetlands resources and how they have benefited from wise use on the other hand. Some of the studies highlighted in this paper include important wetlands of Kenya such as Lake Naivasha, Saiwa Swamp, Tana River, Kenya's coastal wetlands and L. Jipe (a shared wetland between Kenya and Republic of Tanzania). It also discusses various sustainable use policy options vis-à-vis stakeholder involvement in the management of Kenya's wetlands. The results show that ecosystem approach when implemented with involvement of all stakeholders, most wetland users tend to gain more than the costs incurred as a result of misuse. L. Naivasha Riperian Association (LNRA) for example have managed to preserve the integrity of L. Naivasha and the surrounding biodiversity despite major development activities around it. The growers association have been able to internalise some of the costs by developing alternative irrigation methods aimed at saving water and biodiversity. The Lake water quality is also normal according to WHO standards. Forest conservation through Kenya Forest Research Institute

(KEFRI) and Forest Department (FD) in Aberdare, Mt. Kenya and Mau forests has help maintain ground water recharge hence continuous flow of major rivers draining into major water bodies e.g. L. Victoria, Naivasha, Nakuru etc. On the other hand these lakes have continued to support both biodiversity some of which are a major tourist attraction such as Flamingos in L. Nakuru. Cross boarder community initiatives through UNDP has revitalised L. Jipe that was otherwise threatened with complete disappearance. The lessons learned from an ecosystem approach to wetland conservation and sustainable use is that every stakeholder is a “manager” who should consider the effects of their activities internally, on adjacent and other ecosystems. A wetland ecosystem cannot be self-sustaining without taking into consideration other ecosystems such as forests and rivers. Government departments must take lead towards better understanding of ecosystem approach by offering education awareness that target all users at all levels.

Minimum Environmental Flow Requirement for Ecosystem and Its Functioning: A Case Study from Bangladesh

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Keywords: Environmental Flow, Coastal Fisheries, IWRM Practices, Rubber Dam, conflict resolution

A study was under taken to establish the "minimum environmental flow requirement for ecosystem and its functioning" in the coastal belt of Bangladesh. Towards this, first the coastal zone was delineated into appropriate environmental flow regions.

Then a protocol for environmental flow assessment to suite the local needs in the country was developed. Finally, the problem in selected three hot spots were evaluated and the planning and design for intervention to address the concerns were formulated.

Through this study, entire coastal zone of Bangladesh has been divided into four relatively homogeneous environmental flow regions. The regions are mangrove ecosystem region, tidal ecosystem region, estuarine eco-system region and beach eco-system region.

The regions have been delineated on the basis of three national level mapping exercises. These are hydrological zoning by Water Resources Planning Organization, bio-ecological zoning of IUCN and coastal zoning of Integrated Coastal Zone Management Project.

The mangrove eco-system region consists of the Sundarban mangrove forest and adjoining region. The region is situated mostly in Greater Khulna district. The tidal eco-system consists of the active floodplain of the Ganges river and the adjoining meandering floodplains, and is mostly situated in the administrative districts of greater Faridpur and Barisal.

A huge newly accreted mudflat is the main physiographic feature of the estuarine eco-system, which is mainly situated in the districts of Noakhali and Lakshmipur. The beach eco-system lies in the eastern coastline of the country which is characterized by a 100km-long sandy beach facing the Bay of Bengal, extending from Chittagong to Teknaf.

The concept of environmental flow is new in Bangladesh. Therefore, a national level protocol has been suggested for establishment of the concept in Bangladesh. Additionally, a protocol for environmental flow assessment has been developed. The protocol is based mainly on the expert assessment considering the dearth of data regarding demand of the components of the ecosystems.

It is concluded that a unique method that relies primarily on expert opinion and local knowledge, and considers local water management practices could be followed for environmental flow assessment in the coastal regions of Bangladesh till further in depth research activities are completed. The flow assessment protocol proposes active interaction among professionals from different disciplines, and among experts/professionals and local people. Although there may be significant difference of opinion among the experts at the initial stage of interaction, eventually they should be able to reach a consensus on how much flow is required for sustenance of the ecosystem with due consideration to other competing water uses. Local knowledge of flow requirement for different components of the ecosystem should be an important consideration in flow assessment.

Environmental flow requirement was assessed in the Cox's Bazar region, following the protocol developed. The three rubber dams located at Bakkhali, Eidgaon and Sonaichhari where river water is stored for dry season irrigation. These rubber dams are inflated in December-January that virtually deprive the downstream reaches of any water supply and upstream-downstream connectivity are cut off. They are deflated in March-April turning the rivers back to free flowing conditions.

Like these three dams, most of the water sector structures in Bangladesh have been constructed for agricultural purposes. User rights are already established in these structures on behalf of farmers. During the case study, it was apparent that farmers, being mostly marginal and small, are not very willing to sacrifice this water right to ensure environmental flow. However, farmers do recognize the need for fish, which is a principal component of traditional diet. Therefore, fish has been recommended as an indicator species for environmental flow assessment.

In depth study was made for the Bakkhali River Rubber Dam project where the main trade-off of flow was between irrigation water requirement and dry season flow requirement for fish movement to increase the fish production. Preliminary assessment shows that surplus water is available in the study area which can be used as environmental flow. There is also scope for saving water by improving existing irrigation management. The surplus volume and additional volume conserved by improving management practices can meet the environmental flow requirement without compromising the irrigation water requirement.

Flow release requirement was assessed for Golda and Hilsa species. An overall flow release requirement was also assessed for all fish movement. It is calculated that a flow is to be released during night time for 6 to 8 hours per day, 7 days during new and full moon phases.

The downstream pool depth should be about 1.0 m. Required flow release volumes are calculated based on the criteria set forth above. The flow velocity at the dam is calculated based on the required downstream velocity for fish movement. To meet the criteria for fish movement,

a minimum of 15.6 and 45.2 Mm3 of water is to be released for Golda and Hilsa, respectively. Considering both species, the minimum overall flow release volume is 37.2 Mm3.

These requirements are comparable to the surplus volumes calculated for the dam, and can be negotiated for release through the dam. Negotiation with the farmers at the field level and policy and planning level would be the key challenge to establish environmental flow in Bangladesh.

Assessment of Natural and Cultural Resources of two Coastal Communities in Ghana

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Keywords: Fish refugia, resource degradation, byelaws, sanitation, capacity building

The assessment of natural and cultural resources of two coastal communities (Busua and Butre) in Ghana was carried out as prelude study in the bid to formulate community-based management plan of the natural and cultural resources aimed at protecting and enhancing the quality of the environment. In addition, the assessment was aimed at establishing a benchmark for future environmental monitoring (water quality) in the two coastal communities.

For the purpose of data collection, the study team with the full participation of the community residents identified and mapped the natural and cultural resources and carried out reconnaissance cruises on the two lagoons and identified suitable areas to demarcate as fish refugia. The current modalities of the use of resources and the existing policies, laws or byelaws regarding the use of resources were also investigated. Primary data was collected through observations (visual evidence) of available resources and their uses; sampling of water bodies, interviews with key informants and focus group discussions with existing groups in the two communities. The coordinates of the locations of the natural and cultural resources of the two communities were established by the use a Geographical Positioning System (GPS. Secondary data collection involved review of relevant documents and records. Busua and Butre are both in the Ahanta West District and lie along the coastline of the Gulf of Guinea. The areas are located between the latitudes of 1° 53′ W and 5° 57′ W and longitudes 04°48′ N and 04° 45′ N.

The major components of the natural resources comprise of resources occurring on land, the coastal inshore area and marine-open ocean areas. The cultural resources include forts and castle, sacred groves, spiritual dimensions of water bodies and other resources of religious or historical importance. The Natural Resources are categorized as 1) Land Resources comprising 2) Coastal Resources and 3) Marine Resources comprising. The Cultural Resources are grouped as 1) Forts and castles 2) Water bodies 3)Sacred groves 4)Other resources of religious or historical importance.

Discussions revealed that the communities had rich forest cover but due to farming and felling of trees for timber, the forest cover has reduced considerably. Deforestation and hunting activities have led to the loss of monkeys and crocodiles, which used to be common in the areas. Although there is a ban on harvesting of mangroves, most residents of the two communities generally ignore it and continue to harvest for fuel wood and construction purposes. Catches of fish and other aquatic resources, according to the fishermen, have been declining since the last five years. Turtles for example, appear on the beaches to lay eggs between November and January each year and this is when they hunted by the communities. Sanitation in the two communities is poor. Butre community for example has only one public toilet that is inadequate and drainage infrastructure is nonexistent in the two coastal communities. The major source of drinking water for the Busua and Butre communities are boreholes and stream water. During the rainy season, the communities depend on harvested rainwater for household use. Household waste disposal in the two coastal communities is along the lagoons or near the beaches. Wastes from dressing of fish (entrails) are thrown back into the sea and lagoons since the communities believe that this practice minimizes the incidence of snakes being attracted to the dwelling areas. Furthermore, the wastes from the dressing of fish serve as a source of nutrition or food for fish in the sea and lagoons.

The development of natural and cultural laws and byelaws and their enforcement is viewed as necessary for sustainable management. The District has a number of natural and cultural resources management byelaws that are derived from the relevant national laws. The lagoons in the two coastal communities have extensive growth of mangrove along their shores. Mangrove vegetation, especially Rhizophora spp. with their rhizophores increases the diversity and complexity of estuarine and lagoonal systems within which juvenile fishes take refuge and avoid predation. The occurrence of mangrove vegetation in both lagoons provides excellent refugia for fish.

Stemming from the situation analysis of the two coastal communities it may be concluded that interventions are prerequisites for sustainable management of the natural and cultural resources identified and mapped. There is a need for the communities to be committed to the public ownership and management of the natural and cultural resources that abound in their respective communities. This requires the empowerment of the community dwellers by way of capacity building to exert stricter controls to maintain the minimum allowable capacity of the natural resource base of the communities. It is concluded that the two coastal communities of Busua and Butre are being degraded by cutting down of trees for building, fuel-wood extraction, indiscriminate waste disposal (excreta, garbage and greywater) and pollution of the Lagoons and the sea. The situation is threatening the livelihood of the people and the natural resources on which majority of the people depend. The formulation and implementation of management plans for sustainable use of the resources of the communities are therefore imperative.

Monitoring estuarine and marine water quality and ecosystem health: An overview of an established program and its relevance in developing nations

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Keywords: monitoring, ecosystem health, water quality, capacity building, developing nations

Estuaries and marine waters are valuable environmental, social and economic resources, and protecting them has become paramount to ensure their ongoing sustainability. South East Queensland (SEQ) has the fastest growing population in Australia, currently at 2.67 million people and predicted to double in the next 50 years. The waterways in SEQ provide drinking water, wildlife habitat, important ecological services, opportunities for recreational activities and form the foundation for the region's agriculture and seafood industries. The South East Queensland Regional Water Quality Strategy (SEQRWQMS) was formed in 1995 with a whole-of-government, whole-of-community approach to understanding, planning for, and managing the use of the region's waterways and identified a comprehensive ecosystem monitoring program as critical to protecting these assets.

The Ecosystem Health Monitoring Program (EHMP) was first established in 1998 to provide an objective assessment of the health of the region's estuarine rivers and Moreton Bay. This has now expanded to include 292 sites across 18 freshwater and estuarine river systems and 83 sites in Moreton Bay. EHMP uses an outcome-based approach to monitoring; focusing on an ecosystem's response to natural and anthropogenic inputs by using a range of physical, chemical and biological indicators. There is a strong focus on maintaining ecosystem services by ensuring:

- Key environmental processes operate to maintain stable ecosystems;
- Human impacted zones do not deteriorate further and;
- Critical habitats such as seagrass beds do not deteriorate.

Although the freshwater monitoring component forms an integral part to the EHMP, this presentation will focus on estuarine and marine monitoring techniques currently used in SEQ and their applicability in other areas.

The ecological health of Moreton Bay and the estuaries of SEQ is assessed using traditional water quality parameters, complemented by a limited range of biological indicators. Indicators used include total nitrogen, total phosphorus, chlorophyll a, water clarity, dissolved oxygen (all assessed monthly), seagrass depth range (assessed twice annually) distribution of sewage nitrogen (assessed annually) and the presence of a toxic cyanobacteria, Lyngbya majuscula, a seasonal, local problem for both human and ecosystem health. Using a unique system of data analysis over a spatial scale, the vast quantity of data is summarized and presented in a variety of publications accessible to the wider community. While EHMP may not be unique in its monitoring of waterways, the presentation and publication of data is distinctive.

EHMP tailors its publications to suit a variety of groups: local community members, local and state politicians and scientists and technicians working in and around the waterways. The EHMP Report Card is produced annually and assigns a Report Card Grade to each system, not unlike a child's school report card. General public and politicians can use these Report Card Grades to gain a basic understanding of SEQ's waterways. Following the Report Card is the Annual Technical Report which provides further scientific reasoning and detail for each of the grades. The information can be used to advise councils and land managers on areas of declining health, report on the effects of different land uses, and to evaluate the effectiveness of management actions aimed at improving and protecting aquatic ecosystems. Further detail and data are supplied in Monthly Data Reports sent out to government councils and departments to assist them in the day to day decision making regarding ecosystem health. In addition to these reports is the production of newsletters and website, used to provide regular updates on program developments and upcoming events.

Local partners in the EHMP have expressed a desire for greater involvement in the monitoring activity itself, including the data collection component and the interpretation of results. Trained employees participate in capacity building workshops where they demonstrate various monitoring tasks which have been deemed suitable for broader stakeholder involvement. These include physical and chemical parameters, nutrient sampling and seagrass depth range monitoring. Each of these tasks requires minimal equipment, complies with the established EHMP methods and maintains the EHMP's high level of quality assurance.

Many of these sampling procedures have also been applied to monitoring ecosystem health in developing nations. Several members of the estuarine/marine component of EHMP have recently become involved in a project in the Solomons Islands. The broader aim of the project is to develop environmental management initiatives in consultation with local villagers to facilitate the conservation of the marine biodiversity and productivity of Marovo Lagoon, Solomon Islands. Marovo Lagoon, in the Solomon Islands' Western Province, is facing a significant environmental threat to the health of its marine ecosystems due to destructive fishing techniques, intensive logging activities and clearing for oil palm plantations. The marine waters of Marovo Lagoon have been monitored using the same techniques developed in EHMP to assess areas of concern. Marine monitoring methods have also been taught to local villagers so they are able to continue to identify potentially harmful practices, monitor pulse events more frequently and evaluate the effectiveness of management actions taken. By involving the locals in the monitoring activities, they gain a greater understanding of the ecosystem and their impact on it. On a smaller scale, similar monitoring has been carried out in remote areas of Northern Queensland and Fiji.

With simple equipment and basic training, possibilities now exist for inexpensive and effective monitoring programs to be implemented in many remote and developing areas threatened by anthropogenic inputs.

The Experience and Challenge of Community Based Fishery Management in Lake Saroma: Toward Multi-Stakeholder Governance

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Keywords: CBFM, Quality of Environment, Multi-Stakeholder Governance, Sustainability, Lake Saroma

Lake Saroma, which is located at northeastern coast of Hokkaido Island, is the third largest lake (about 150 square kilometer) in Japan. This lake is a brackish water lagoon with two mouths open for the Sea of Okhotsk, where over 400 households enjoy successful aquaculture of scallops and other fisheries. The success of fishery in Lake Saroma attracts the attention of not only fishermen in other areas and fishery experts but also environmentalists, for fishermen's endeavor to increase fishery production while achieving sustainable fishery resource and water quality management in the lagoon. This success also attracts the attention of counterparts in developing countries who are facing with poverty and degradation of quality of environment in wetlands, and some international exchange programs between Lake Saroma and other lagoons have already launched. But Lake Saroma like many other wetlands in the world is now facing with degradation of fishery resources and water quality. This paper aims to examine such experience and challenge of fishery and environmental management in Lake Saroma.

In the lakeside of Saroma, three local fishery cooperatives, Tokoro, Saroma and Yubetsu, seed fries in the lake and release them into demarcated sea surface in Okhotsk, to culture about over 90,000 ton scallops in total (at the year of 2004). Fisheries of scallops in the lakeside of Saroma, mainly consist of open sea fishery run by whole joint management system and community based fishery management in the lake. The former, which is joint management run by all cooperative members, could stabilize fishery management by equitable profit-sharing, as well as maintain the ecological fishery, which emphasizes the niche of fishery in the ecosystem, to use fishing grounds just like upland fields through rotation system. The latter, which is community based fishery management, is fishery management system by setting voluntary total allowable catch (TAC) and individual quota (IQ). Both TAC and IQ in this lake are enforced based on the consensus between each local fishery cooperative and Lake Saroma Aquaculture Cooperative. Furthermore, each local fishery cooperative has been conducted tree-planting activities such as reforestation in the upper river basin and maintenance of forests for fish shelter based on a concept "The forest, the darling of the sea".

Focusing on the community based fishery management in the lake, it could merit mention the role of Lake Saroma Aquaculture Cooperative. Just after the World War II, fishing in the lakeside of Saroma was forced to be prohibited because of fishery resources depletion caused by the national policy of increasing food production during the War. At the same time, management of each fishery cooperative was facing with difficulties due to doubling number of cooperative members absorbing a lot of demobilized soldiers. Under such conditions, compensation for allocation of fishery rights was paid to each fishery cooperative. In 1952, three local fishery cooperatives invested all amount of the compensation to set up Lake Saroma Aquaculture Cooperative in order to stabilize management of each fishery household through building community based fishery management in Lake Saroma. This aquaculture cooperative is a unique organization of fishery managers in Japan. The aquaculture cooperative is conducting not only aquaculture resources management, but also environmental research and monitoring of the lake, R & D of aquaculture technology, education and training for fishermen, and broader environmental preservation activities.

Lake Saroma is now facing with degradation of water quality and fishery resources. Chemical Oxygen Demand, which indicates organic contamination in the water, has been increasing over ten years in the lagoon and exceeding the water quality standard for marine fishery. Total nitrogen and phosphor also have been increasing and often exceed the water quality standard for semi-closed water area in these years. Under these conditions of declining water quality in the lagoon, red tide caused twenty three percent deaths of fries of cultured scallops in 1998 and habitats for scallops and echinoids are decreasing year by year. Seeking for water ecosystem preservation and sustainable fishery in the lagoon, one association and one committee have been set up in 2001. The Consultative Association for Environmental Preservation in Lake Saroma includes three municipalities and three local fishery cooperatives along the lake, Lake Saroma Aquaculture Cooperative, and governmental and research institutions in Hokkaido prefecture and Hokkaido Development Agency as members, while the Supporting Committee for Environmental Preservation in Lake Saroma includes seven scholars and experts as members. Research activities of the association and committee for four years have revealed the effectiveness and importance of current community based fishery management in Lake Saroma as well as the need to control the inflow load of organic contamination from upper rivers, where animal industries are developing.

The aquaculture of scallops in Lake Saroma provides us a successful model of community based fishery management and ecological fishery. It should be noted that local fishery cooperatives and the Lake Saroma Aquaculture Cooperative are playing the significant role of sustainable fishery in the lagoon. But the lake like many other wetlands in the world is now facing with degradation of water quality and fishery resources. It should be examined how to build a river basin governance system with a various kinds of partnerships among broader stakeholders toward sustainable community from rivers to the lagoon.

Willingness to pay (WTP) approach, a tool in understanding benefits and cost of degradation of ecosystem

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Keywords: Marsh, Lagoon, Benefits, Ecosystem services, Policy makers

Presentation of topic and analysis of issue : One of the main rivers in Sri Lanka, named as Kelany river drains into Salt water wetlands comprising of Muthurajewela marsh and Negombo lagoon. It is observed that the constant mixing with sea water through tidal exchange, enables Muthurajewela marsh and the lagoon to possess the characteristics of tropical estuary. The Muthurajewela marsh is located in the Western coast of Sri Lanka and lies between latitudes 70 06'N - 70 12N and longitudes 790 49' E - 790 53' E. The Negombo lagoon adjacent to Muthurajawela marsh This ecosystem tolerates salinity level ranging from 18 ppt to 40 ppt. It is also reported that this wet land sanctuary harbours 190 species belonging to 65 families with one endemic species, three nationally threatened species and eleven alien invasive species. Also there are 209 fauna varieties with seventeen endemic varieties and twenty six nationally threatened varieties. Due to the ecological and biological importance of the wet land sanctuary, it was recently named a "protected wet land of the world''. Seven major vegetation, Marsh, Lentic flora ,Shrub land, Reed swamp, Grass land, stream bank make up the flora diversity of Muthurajawela. "Fishing tiger" is another rare species living in Muthurajawela. Mangroves and lentic are the most important environment in the marshy land providing habitats for the migratory birds. Rhizophora mucronata, and Rhizophora apiculata are abundantly found in brackish water in Sri Lanka. Sonneratia alba and Bruguiera gymnoriza are widely seen in fresh water. Species like Excocarica agallocha and Rhizophora anamalae are also thriving among the mangrove forest and also believed to possess medicinal properties. Further ecosystem services operate in intricate and little explored ways that would be very difficult to substitute for using technology. These natural ecosystems help to support society in enormous ways.

It is reported that decayed debris with desirable c/n ratios, fallen from mangrove are source of food for fish in brackish and sea water. Mangrove provides enormous amount of economic and ecological benefits to its surrounding and people around.

Cuttle fish (Gleoxina coaxans) are living freely and are economically valuable. Mangrove environment is a breeding ground for crabs, prawn and different species of fish. This wet land plays an important role in the life cycles of numerous fish species and prawns which migrate from the ocean to lagoon to breed and feed. Young fish and prawns find shelter in the lagoon in between the root systems of the mangroves until they are ready to migrate to the open sea.

This situation contributes to the economic up liftment of small scale fisher folk. Mitigation of floods, protection from storms/prevention of coastal erosion, breeding habitats of edible fish etc are some ecological and economical dimension of biodiversity use. It is reported that this area was mildly affected by the recent Tsunami compared with area with out such ecosystem. However in Sri Lanka, policy makers think that it is better to use the mangrove environment for development rather than conserve it. One way to convince the policy makers is to show the monetary valve of mangrove environment in terms of figures. A method known as open ended method and one and a half bound method (OOHB)was used in estimating a value for WTP (willingness to pay). This method expresses stake holders their consent to restore the

right for conservation of mangrove environment. In this method the following questions were asked from the people (fisher folk) who are using the mangrove environment.
How much are you willing to pay for the conservation of mangrove environment!.

For the second method the question is as follows:
What is your preferred value between 2$ and 3$ as a sign of willingness to pay for the conservation of mangrove environment!. For each method a sample of 350 fisher family was consulted

The study showed that the estimated average value of the individual WTP for conservation of wet lands under the open ended format was 01$ per month per house hold. Using the OOHB bid function , an expected WTP value of 2.6$ was obtained. Assuming that the true WTP is bounded by these figures (01$ – 2.6$) and using the total household number in the district under investigation (500,000)this would indicate gross figure of (500,000$ - 1,321,350$)per calendar month for conservation of wetlands. This does not include the border surrounding districts which might have an interest in conservation of the wetlands. It was also possible to develop a method to separate total economic value as use and non use value. The total WTP was divided into use (direct , indirect and optional) and non use values(bequest value- knowledge that will benefit from the wet land and existence value which occurs due to mere existence of the wet land). Accordingly the aggregated preference for the use value is 0.552 and the non use value is0.448 in conservation of wet lands in the area. Similar studies had been initiated by different researchers in other parts of the world showing the importance o f ecosystems. Costanza et al (1998) have attempted to work out eco system services on per biome basis and arrived at the average annual value of these services to be of the order of US$ 33 trillion (approx. twice the GDP of the world). To this in the same year Alexander et al (1998) arrived at what they call the “worthy” ecological services as a maximum value of US$ 1.8 To 16.3 trillion based on the assumption that only paid out services are accountable, non use and non market values are excluded and subsistence wages of the world subtracted (as equivalent to the minimum services to be rendered by the ecosystem)

It was concluded that the investigation demonstrated the feasibility of initiating empirical explorations to define the population’s willingness to pay (WTP) for conservation of wetlands and the most critical factor in sustainability is likely to be of environmental resources in the production of ecosystem services. The WTP values could also be recommended as an economic tool when policy makers compare the development with conservation of wetland.

Benefits of Ecosystems in Flood & Storm Moderations & the Costs of Degradation: Case Studies of Hurricane Katrina and South East Asia Tsunami

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Keywords: Ecosystems, benefits, flood & storm moderation, cost and degradation

The major objective of this presentation is to assess benefits of ecosystem in flood and storm moderation and costs of degradation with case studies of Hurricane Katrina and South East Asia Tsunami. Globally hydro-meteorological hazards are on the rise. In recent decades, economic and insured damages have increased by manifolds compared to the decade of 1960s. In 2005, only Hurricane Katrina inflicted US$ 125 billions of economic damage in the Southern United States. The insured loss was estimated to be US$ 45 billion.

Engineering failure of New Orleans levees is largely blamed for the Katrina disaster; but favorable environment for such a disaster was created through ecological degradation in the Mississippi River Delta for over a century. Wetlands along rivers and near the coast play a vital role for absorbing and storing floodwaters, and slowing down storm surges. Coastal wetlands in the Gulf Coast have been lost to ill-planned and deadly commercial land developments. Louisiana alone has lost 5,000 square kilometers of wetlands over the past seven decades - an area larger than the state of Rhode Island. This equals 65 square kilometers of hurricane absorbing coast being lost every year. Examples from Bangladesh and South East Asia suggest that ecosystems (mangroves) save lives and property by reducing speed of a cyclonic hazard and associated storm surges. During the 2004 Tsunami, coastal areas with mangrove belts experienced lesser damage than areas without mangrove cover. Natural environment can reduce vulnerability to a great extent as the recently released Millennium Ecosystem Assessment Report concluded "The preponderance of evidence indicates that, in most situations, more emphasis needs to be given to the natural environment and nonstructural measures and less to structural measures (Mirza et al., 2006)."

Reference:

Mirza, M.M.Q. et al. (2006) Flood and Storm Control. In: Ecosystems & Human Well-Being: Policy Responses, Chapter 11, Island Press, 337-352.

Sharing the Benefits of Ecosystem Services and the Cost of Ecosystem Degredation. (Lake Victoria is Deteriorating Now)

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People all over the world depend on the Earth for survival. However human activities can greatly impact the Environment around them and harm its future ability to support wildlife and human populations. As a result, humans and the natural environment are closely linked and only through careful management can both survive.

In many places around the world the relationship between the local people and the surrounding is quite strong. For example in Uganda, Lake Victoria the second largest fresh water lake in the world provides a variety of resources to a very large population in the East Africa. The lake is found astride the Equator between Latitude 03' N and 3.05' S and Longitude 31 35' E and 34 54'E. Its mean depth is 40 meters and maximum is 67 meters whereas it has a maximum length of 400 km and a minimum width of 240 km giving a total surface area of 68,800 square km. The lake is shared between the three countries of Tanzania (49%), Uganda (45%) and Kenya (16%). Precipitation through rainfall contributes (85%) the greatest source of water to Lake Victoria and the rest (15%) comes via inflowing rivers and tributaries in the region.

Besides the large volume of water drained out of the lake for domestic and industrial use, the lake provides food (30 million people live within the lake basin of whom 3 million depend directly or indirectly on fish and fisheries-) as it is a habitat for many species of fish such as Nile Perch, Nile Tilapia and Dagaa as main sources of nutrition and protein. In Uganda some 200,000 metric tons of fish are landed annually form lake Victoria earning the country some US$100million. Additionally it provides materials like sand for building and shells for making decoration materials that are utilized by people from far away the lake. Furthermore, the lake provides an opportunity for people in and around to make money. Many beaches and hotels around and on Islands attract tourism, hence a lot of employment. The lake also absorbs excess water during the heavy rains seasons. Lake Victoria is extremely valuable to the people and as a result, people in the three countries and the lake are critically linked. Despite the enormous economic benefits accruing from Lake Victoria, in Uganda it has been noticed that the lake is faced with major environmental, socio economic threats. These include the misuse of natural resources, destruction of biodiversity, Land degradation, deterioration of water quality and the water hyacinth. Fishing malpractices such the use of chemicals and wrong nets, have caused massive loss of fish biodiversity and other species of organisms in addition to causing rapid changes in species composition. For example some 200 species of fish have disappeared from the lake in the last 40 years alone. Most of the lost species are of the haplochromine, tilapiines and cyprinids. Hence the fishery of the lake has been reduced to three species notably Nile Perch (Lates niloticus), Nile Tilapia (Oreochromis niloticus) and the dagaa (Rastreneobola argenta) – Dr Orach-Meza B.Sc, M.Sc., Ph.D 2005 report. Fish catch per unit has fallen from 30 or more fish per net in the 1920s to less than one fish per net at the turn of the last century. The ever increasing population along the Lake Victoria shoreline (many cities and towns have sprung up- Entebbe, Kampala, Jinja, Masaka and many other small settlements with varying populations ranging from 50,000 to 1 million) has exerted immense pressure on the lakes resources. The majority of these areas have no facilities to treat their sewage and organic wastes. These are released directly into the lake or streams and surrounding wetlands thus causing massive de-oxygenation of the waters. Industrial waste from (Fish processing plants, Textiles, Diaries, Breweries. Tanneries, Light steel industries, Oil and garage businesses) has increased the pollution problem as it is released directly or indirectly into the lake.

Measurements done through the Lake Victoria Environment Management Plan (LVEMP) have indicated pollution loading per day of Nitro-Nitrogen at 28, Ammonia-Nitrogen at 47, Phosphate-Phosphorus at 7, COD at 700, BOD at 190, Copper at 17 and Chromium at 08.

The destruction of Wetlands (swamps- breeding ground for fish) has not only caused the loss of biodiversity but also weakened their buffering and filtering capacity thereby leading to pollution loading from both point and non point sources. Deforestation in catchment areas has left the soils unprotected thus when it rains, the soils are washed by runoff into streams, rivers and finally into the lake. The runoff carries with it soil, silt, rock, crop materials and chemical nutrients in form of Nitrogen and Phosphorus. The impact of this is the siltation and algae build up in the lake.

The Water hyacinth (Eichhornia crassipes) has choked and paralysed facilities and services such as fishing grounds, water supplies and transport, hydro-power generation, tourist sites and fish breeding grounds. Inspite of the above problems however, it has been noted that governments of the three countries that share Victoria, have come up with measures aimed at saving the lake.

The Lake Victoria Environment Management Project was initiated as a comprehensive program aimed at rehabilitating the ecosystem of Lake Victoria for the benefit of the people. Over 7 million trees have been planted in deforested areas adjacent to the lake.

Institutional and human capacity has been improved and through training of stakeholders, good soil and water conservation are being adopted following demonstration of both agricultural and ecological benefits. In addition inventory and characteristics of wetlands in the basin are now known and their buffering capacities are being enhanced through sustainable use practices.

The quality and amount of liquid effluents from industries and towns has been checked, for example the effluent dispersal in the inner Murchison is now known and the treatment plant in Bugolobi has been rehabilitated. A data baseline on input of nutrients

and pollutants has been created and trends are being compiled and reliable data on water balance have been recorded.

However the above achievements alone can not in the long run save the deteriorating status of Lake Victoria. Big beneficiaries such as Water supply companies and Hydro-power generators need to share in the cost of conserving the lake. Furthermore industries and municipalities ought to pay more towards waste treatment since they also use the very water. Governments need to bring back money from fisheries into wide spread education of the people to create understanding, appreciation and conservation of Lake Victoria.

Finally the three Governments have to work together in order to strengthen and enforce existing laws that have been greatly abused so as to effectively protect the lake.

Potential Benefits Associated with Payments for Ecosystem Services in the Columbia River Basin of North America

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Keywords: water quality, soil erosion, shipping channels, surface water, soil quality

Over 150 major crops are grown within the 40,000,000 ha Columbia River Basin. This is an international watershed which includes part of British Columbia in Canada and all of or parts of Washington, Oregon, Idaho and Montana in the USA. This basin produces 15% of the USA's annual grain harvest. When coupled with adequate rainfall or irrigation, soils in this region are highly productive. From a technological and economic standpoint agriculture is very successful in the basin. However, the environmental costs associated with soil erosion (water and wind) from farmland, degraded water quality, eutrophication of lakes and reservoirs, and siltation of shipping channels and reservoirs behind dams is high. Agriculture is the major contributor to water pollution in the basin.

Farmers in the Columbia River Basin have depended on federal crop subsidies and other types of payments to make their operations viable for several decades. However, over the next several years federal farm programs will likely shift emphasis from farm subsidies to payments for environmental services as a consequence of free trade treaty requirements. As this type of payment becomes more common, the Columbia River Basin is likely to see environmental benefits. Even though at present most farms programs are direct commodity subsidies, six programs currently available are basically payments for environmental services. These six federal programs are: the Environmental Quality Incentives Program (EQIP), Wetlands Reserve Program (WRP), Wildlife Habitat Incentives Program (WHIP), Conservation Reserve Program (CRP), Conservation Security Program (CSP), and Conservation Technical Assistance (CTA). Collectively, these six programs account for only a small portion of the federal farm program dollars; however, significant environmental benefits have resulted from these programs both within the Columbia River Basin.

Our poster will do three things: (1) document the current state of soil erosion, surface water quality and reservoirs and shipping channels within the Columbia River Watershed; (2) quantify the positive impact of existing environmental service programs in the basin; and (3) project the watershed-wide positive impacts on reduced soil erosion, improved water quality and open shipping channels based on farm programs being tied to payments for environmental services.

The agricultural technologies exist to greatly reduce soil erosion in the Columbia River Basin; however, reduced erosion is only currently seen on a field-by-field basis because the technology has only been effectively put in place on one quarter of the farmland. With the implementation of payments for environmental services, structural (terraces, sediment basins, gulley plugs, etc) and management (reduced tillage, contour farming, etc) best management practices (BMPs) would be much more widespread and the reduced erosion rates would translate into basin-wide improvements in both soil and water quality.

Payments for environmental services would have a positive impact on both rain-fed and irrigated cropland. In the wetter rain-fed farming areas reduced tillage is the key to reduce soil erosion and consequently improving water quality. Implementation of more efficient irrigation technologies such as conversion from flood to surge irrigation, conversion of flood to sprinkler irrigation, conversion from regular sprinkler to low pressure sprinkler irrigation, and conversion from sprinkler to drip irrigation would greatly reduce soil erosion and enhance water quality on the 3,000,000 ha of irrigated farmland in the Columbia River Basin. We will quantify the potential positive impacts of reduced soil erosion and improved water quality for differing levels of implementation of payments for environmental services based on results from the few existing pilot programs (six conservation programs listed above).

Overall, our poster will project what can be achieved from an environmental standpoint on a basin-wide basis with full implementation of a federal farm program that is based on payments for environmental services.

Industry, community and research collaboration for sustainable water management – some Australian experience

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Keywords: catchment, partnerships, stakeholder participation, ecosystems, agriculture

Australia is a large, diverse continent - geographically, climatically and ecologically. We have vast floodplain systems, ephemeral arid rivers and bountiful northern rivers. Our climate is boom and bust, with the country enduring years of recurrent drought, only to be overwhelmed by flooding rains. Australians have a strong cultural connection with the wide open landscape of the inland, the rural way of life and iconic river systems such as the Murray-Darling and Cooper Creek. Our major river systems (especially in southern Australia) are highly regulated through weirs, levees and dams, as in their natural state they would spend much of the year dry. These river systems have been the lifeblood and driver of rural and regional development, without which the inland would have been uninhabitable. However, agricultural prosperity has come at a price, and many regulated river systems are now demonstrating signs of severe ecological stress such as declining water quality, increasing salt levels and loss of native species.

The presentation will report on Australian approaches to sustainable water resources management. The key characteristics of the Australian approaches analysed here are:

- Active participation of affected stakeholders in research, development and extension;
- Partnerships, co-investment and shared ownership between government and rural industries in those research, development and extension activities; and
- The establishment of catchment (watershed) management organisations across the whole continent with a mandate to take an integrated approach to natural resource management at a catchment or landscape scale.

Australian rural industries and farming communities, as managers of substantial tracts of the landscape, are at the cutting edge of finding innovative approaches to sustaining agriculture, ecology and regional communities. Through case study examples from Land & Water Australia's collaborative research, development and extension initiatives, this presentation will show how co-investment between government and agricultural industries can lead to more sustainable outcomes at farm, community and landscape scale.

Case Study 1:
The irrigation sector in Australia underpins many rural communities and is a significant contributor to the economy. It consumes about 70% of all diverted freshwater resources and contributes about one-third of the value of agricultural production from 0.5 per cent of the land area. However, irrigation impacts on the ecology of streams, floodplains, wetlands and estuaries. The National Program for Sustainable Irrigation is focussing research on critical environmental issues while also aiming to improve the productivity of irrigated agriculture and maximise community benefits. An example is the Goulburn-Broken Irrigation Futures project, where a community-led futures scenario process is being undertaken to help that

community determine its long-term priorities for social, ecological and economic development.

Case Study 2:
The Land & Water Australia National Riparian Lands Research & Development Program has collaborated with the wool, cotton, sugar and dairy industries to develop on-farm guidelines to assist farmers to better manage their rivers and streams for production, ecological and social outcomes. Farmers are trained in the use of guidelines through local facilitators and extension staff. Workshops are held to train these people in delivering what is often quite technically difficult material to landholders. This is achieved by bringing scientist and end-user together so that products can be developed that are underpinned by rigorous science but presented in ways that are tailored for a particular industry.

Case Study 3:
Grain and Graze is an integrated farming systems program which is seeking to connect on-farm production and natural resource management sustainability outcomes with catchment sustainability priorities. It is doing this through funding collaborations between catchment groups, farming systems groups, industry and government research and development.

Environmental Aspects of Integrated Flood Management

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Keywords: Integrated Flood Management, Integrated Water Resources Man, Participatory Approach, Strategic Environmental Assess, Adaptive Management

Flood plains are known to be extremely fertile areas and have played an important role in the development of civilisation. At the same time, occupying flood plains, with economic development and population growth, increases flood risks. While flood control and flood protection, based largely on structural measures, have played an important role in protecting people and socio-economic development in flood plains, they have caused certain negative impacts on the natural regimes of the rivers by altering the flow and sediment variability, fixing the river shape and separating rivers from their flood plains. The adverse impacts of some of these works have raised growing concerns about the sustainability of the approach and have highlighted the need for addressing the negative consequences of the flood protection measures on the environment, and for a shift from flood control to flood management.

This paper presents in brief the basic concepts of morphology and ecology of rivers and its relation to their flood plains in the hydrological cycle, and how these are in large measure driven by the flow regimes. Morphological and ecological connectivity, both longitudinal and transversal, and clean and sufficient water with seasonal variability supporting biological diversity within the river and its flood plain are important variables that determine the characteristics of the natural environment and the ecosystem within it. Such an understanding is the key to evaluating various structural and non-structural options as independent or complementary measures. Through Strategic Environmental Assessment (SEA), one can pre-identify key issues that should be addressed in Environmental Impact Assessment (EIA) and support EIA in screening and scoping. This enables to integrate environmental considerations into decision-making processes not only at project level, but also at policy and planning level in a proactive manner.

Stakeholder's participation forms one of the important pillars of Integrated Flood Management. Financial analysis such as Multi-criteria analysis (MCA) can be effective only if stakeholders are actively involved in the process of evaluating the suite of options. Stakeholder participation is crucial for SEA, EIA and MCA where one can achieve acceptable trade-offs. However effective stakeholder participation requires an enabling mechanism at different levels of the decision-making. Monitoring of the effectiveness of adopted measures forms an important tool for incorporating mid-stream modifications during planning and implementation.

Legally established coordination mechanism makes decision-making process more accountable and transparent. Flood management decisions must take into account not only their effect on flood risks, but also the resulting economic and environmental impacts. In addition, decision-making processes for various other development activities have to take account of their influence on the flood risks since such decisions have potential to affect the hydrological response of catchments and flood plains. Planning at governmental level must be coordinated so that the flood management strategy, which is to be implemented through different departments, is coherent at all levels of public planning, whether national, regional or local.

Integrated Flood Management (IFM) is a process promoting an integrated rather than fragmented approach to flood management. It integrates land and water resources management in a river basin, within the context of Integrated Water Resource Management (IWRM), and aims at maximizing the net benefits from flood plains and minimizing loss of life from flooding. IFM is multi-disciplinary, with a mix of options being used to create a layered strategy appropriate to the given conditions and to balance economic development, flood risk reduction and preservation of ecosystem services. In considering possible flood management interventions, IFM approach advocates for appropriate attention to the environmental impacts that may limit natural productivity and ecosystem health. Integrated Coastal Zone management (ICZM) should also be synergized in IFM, since lower reaches of a river are integral part of a river basin, where freshwater and coastal ecosystems coexist. In order to incorporate environmental considerations in flood management practices, three-way approach of avoiding, reducing, and mitigating the adverse impacts should form the underlying principle to minimize negative impacts at reasonably practical level.

While scientific knowledge about the morphology and ecology is the key to evaluating various options in flood management, knowledge of ecosystem function is, however, frequently inadequate to provide clear answers to management dilemma. A precautionary management approach should be taken into account when information or data available is incomplete, while analysis indicates risks or possibilities of large scale or irreversible environmental consequences. At a practical level, adaptive management is widely recognized as the approach to deal with scientific uncertainty such as ecological impacts or climate variability and change. It should form part of the integrated approach to flood management, through which mechanisms for monitoring, evaluation and feedback can be established. Therefore incremental improvement and consistent follow-up are required for adopting Integrated Flood Management. To give due consideration to the values and services that the ecosystems provide to the community, it is important to ensure stakeholders participation in the decision-making process and put in place an enabling mechanism within an appropriate legal and institutional framework.

Ecosystem Degradation and Associated Costs Due to Groundwater Extraction in Bangladesh

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Keywords: Ecosystem degradation, groundwater, extraction, costs and Bangladesh

The extraction of groundwater in public water supplies, irrigation and industries continues to increase day by day throughout the world in general and Bangladesh in particular. Although the average rainfall in Bangladesh is high (varies from 1.43 m to 4.34 m) during the monsoon season from July to October (with around 80 percent of the total rainfall occurring in this period), but the irrigation is vitally important, particularly during the months of October to May. About 48 percent of the total arable lands of Bangladesh are now under irrigation facilities and most of these lands are irrigated with groundwater that are drawn through deep and shallow tubewells. The area of irrigated land that used groundwater increased from 6% of the total irrigated land during 1972-73 to about 90% of the total irrigated land during 2002-2003. The gross annual groundwater withdrawal throughout the country in 1985 has been estimated to be 7,319 x106 m3 out of which 6,316 x106 m3 (that is 86.3%) was used for irrigation purpose.

There is a significant influence of groundwater quality on the soil and water environment. When water used for irrigation purposes evaporates from plants and soil surface leaving soluble salts and mineral behind, these soluble substances from this groundwater source increase their concentration in the remaining water and/or are also added to the soil. If the content of dissolved substance in the irrigated water is high enough, repetition of this process over a period of years may make the soil salty to support the plants. Again, if enough irrigation water is added to flush these salts which eventually reach the shallow aquifer and will degrade the quality of water. In Bangladesh, high level of arsenic has been detected in 59 out of the total 64 administrative districts. The dependency on groundwater for public water supplies and irrigation would result in adding a huge quantity of arsenic along with other minerals in agricultural fields each year posing a potential challenge to the agricultural sector. In the southern part of the country, the coastal belt, which includes 86 thanas (the lowest administrative unit) of the country, due to pumping of groundwater from the aquifer the saltwater interface is moving inwards and thus, the aquifer reservoir are contaminated with saline water. This salinity in water degrades its quality that required for irrigation, domestic and industrial uses. Again, application of fertilisers, especially nitrogen in agricultural land can add nitrate to groundwater through leaching and direct percolation. In 2003, the total consumption of urea, triple supper phosphate and murate of potash was about 1.5, 0.42 and 0.12 million tons respectively. The use of chemical pesticides to control pests, which is an integral part of modern agriculture, is increasing with time, unfortunately this has created the most adverse impacts on ecosystem. As a result general public health its associated costs have already been affected. This is evidenced by the sudden decrease of open water fish production in Bangladesh.

Groundwater in Bangladesh is generally available in water table (unconfined) aquifer, but in some area groundwater is found under semi-confined or confined conditions as well. They are recharged from local rainfall as well as by lateral inflow from the surface water sources. Potential recharge to underground-reservoir throughout the country is estimated to be 42,500 x 103 m3/year, which is about 14% of the total annual rainfall. The transmissibility of the main aquifers varies from 1.16 x10-3 m2/s to 116 x10-3 m2/s with an average value of 23 x10-3 m2/s. Although the aquifers have vary high transmissibility, the horizontal flow of groundwater is usually very low because of the low groundwater gradient. It is evident from hydrogeological conditions that both surface-water and groundwater systems are hydraulically interconnected in most places within the country, and most of the streams receive a major portion of their flow from the groundwater source during the dry season.

Due to overexploitation of groundwater for irrigation purposes, water levels declined, rendering thousands of suction-mode hand tubewells inoperable during the last three decades. The summary of the study to forecast the decline of groundwater levels in Bangladesh is presented in study, which covers 349 police stations (thanas) out of 486 thanas in Bangladesh during the study period. The extensive use of groundwater eventually diminishes the quantity of water available in many rivers and other standing water bodies. This obviously reduces the growth, feeding and nursery areas of aquatic habitats.

The abstraction of groundwater has also exhausted the soil moisture within the upper shallow aquifer. This effect is predominant in the northwestern part of the country, aridity is emerging as an important phenomenon retarding growth. In addition to agricultural crops, many fruit and deep-rooted trees within this region have been affected due to decline in groundwater. It has been reported that the forest and mango cultivation of this region has been adversely affected and the production has dropped down to about 50% (Khan, 1987). And the most important issue is the possible effect of reduced level of soil moisture that is available to vegetation, particularly to crops and trees.

Thus the extraction of groundwater in Bangladesh and its influence on the ecosystem shall have profound effect on the national exchequer. This study presents the possible consequences and its associated environmental costs that are encountered due to overexploitation of groundwater in Bangladesh. A number of management options are critically discussed and recommendations are made for better utilisation of groundwater to minimise the costs of ecosystem degradation in Bangladesh.

Collaborative Suite, a tool for River Basin's Planning. (Pantanal Project – Brasil, Bolivia and Paraguay -as an example)

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Keywords: Information Technology, Sustainable Development, Ecosystem Services, Collaborativa Suite, foster mutual trust

Presentation of the project/topic and analysis of the issue(s):
Technology, communication and systematized information are incorporated into the "Collaborativa Suite" (weconferencing, voice, images and databanks) as ingredients for the building up Permanent Virtual Dialogues among River basin's stakeholders. The Dialogues are continually performed by the so called Stakeholder's Virtual Communities even if they have or not common interests. The Virtual Dialogues, therefore, focus in Planning the Sustainable Development by Sharing through knowledge building up and the common proposals of action.

The "Collaborativa Suite" is an adapted platform for Stakeholder's Virtual Communities organized to discuss river basin's dialogues in various categories: 1. of Excellency, for discussions of high-level technicians. 2. of NGO's and governments, for dialoguing on institutional aspects, 3. of students and professors, 4. of other stakeholders discussions. This platform is being used on the Pantanal (Brasil, Bolivia and Paraguay) within the water problems as a necessity to solve urgent conflicts resulting on pollution and degradation of this important Planets wetland. The role of large lakes will be at stake in territorial development by sharing values and responsibilities among stakeholders. Important human activities regulations are expected to come in order to minimize conflicts which resulted even in activists dead on the Pantanal.

From the other hand, a conceptual proposal Sustainable Development by Sharing has been advanced and is being taking to the IV World Water Forum (Mexico, March, 2006) as a topic session. This was developed as a result of Environment Ministry of Brasil works and of the La Plata Basin Dialogues which took place in Foz de Iguaçu, Brazil, November 2005. It includes the basic principle of sustainable management of river basins through Ecosystem Services. Human beings are included as one important part of the ecosystem and therefore their economic, social, institutional, political, and territorial organization. Sharing benefits, research and responsibilities will be important to diminish conflict and manage river basins. The relationship between local, territorial (regional) and global notion are important not only from the economic position but from the local organization and well living, related to political and business interests. Dialoguing among Permanent Virtual Stakeholders Communities will mean a new continuous local and regional planning for development.

Sustainable development now constitutes a movement which is not only at global or country level. It has been used, at regional or local level, related to community development (including their families and ecosystems) or single resource development (water, forest or others). On these interpretations the most important ingredient is always the present satisfaction thinking on the future generations as it was discussed in Rio de Janeiro. Therefore, now “Sustainability is not really an “environmental” movement, it is a community movement. It is the concept that humans are a part of the ecosystem, and we need to learn to integrate our economic and social lives into the environment in ways that maintain and enhance the environment rather than degrade or destroy it”.

The recognition of the different dimensions – usages (domestic, industry), agriculture (nature, territorial), values (cultural, social, environmental, and economic), and actors (local, national and international) of water facilitate the adoption of new ethical, ecosystemic and right-based approach of the sustainable water management. This new emerging approach allows to prioritize the right to water which is essential for securing social justice, dignity, equity and peace and its implementation would entitle everyone to sufficient, acceptable and non-discriminatory access while empowering the user communities.

Presentation of the results/findings:
The Permanent Virtual Dialogues could help all stakeholders to better contribute towards the River Basin’s Planning towards Sustainable Development by Sharing.

Conclusions and Recommendations:
If these Dialogues, using the Break through new Information technology tools, could be applied in many regions of the World the conflicts and river basin pollution and degradation could be diminished.

We recommend that “Collaborative Suite” like information technology tools be applied by the river basin stakeholders in other regions of the World.

Preparing the Amazon Ecosystems for the Changing Climate.

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Keywords: Amazon, Atlantic Ocean, Climate Change, Global Warming, River Rehabilitation

Presentation of the project / topic

A catastrophic draught event was reported across much of the north of South America during August - December 2005. This resulted in extensive and irreversible damage in parts of the Amazon river network. The 2005 Amazon draught followed very unusual changes in the Atlantic Ocean's circulatory system that altered typical wind and rain patterns. Many climatic models predict the future desiccation of the Amazon region. This paper discusses dangers of sudden swings in the Amazon's climate and how these risks can be reduced and securing the future of the river system.

Analysis of the issues

The Amazon river network is huge, in some way one could call it as the 'world river'. From August to December 2005, dry northerly winds prevailed and leading to constant sunshine and total loss of the rainfall. The rains normally deliver oxygen and clouds cool down the river temperature. Some tributaries suffered catastrophic oxygen losses that killed all the fish, effectively turning major tributaries into large sewers when the rains resumed. As the water in rivers turned toxic and pathogen-infested, the Brazilian government declared an emergency in the Amazon and flew in bottled water and food into the communities along the afflicted rivers. The disappearance of rain in August was very sudden and severe, although it is known that during this time of year the Amazon rainfall is normally somewhat lighter than during the rest of year.

As the event is very recent, we have not yet received all the minutiae on what was the final cause of death of the fish in the rivers. We can confirm it being associated with the cessation of the rains and also the extent and totality of damages occurred.

Presentation of the results / findings

The sudden and complete cut-off the Amazon rainfall effectively turned a 'rain forest' into a 'dry forest'. Keeping this in mind, we contacted Greenpeace who subsequently placed the Amazon's fire risk as their top campaign priority. We hope that by August 2006 there is a greatly increased forest fire flight monitoring with sufficient standby equipment and manpower to prevent a risk of replicating the 2005 Portuguese fires.

Having addressed one main risk in the future of Amazon led us next to look at what could be done to the river itself to prevent it dying again, remembering that climate models predict a long-term trend of desiccation. The accelerating pace of the climate change is starting to be now felt more acutely, even leading many senior scientists or commentators to declare the climate change situation as 'dangerous', 'irreversible', or 'catastrophic'. Could we link the Amazon event into a broad climatic shift?

What are the elements of the global warming process that seem to influence the Amazon river and might have brought upon the unfolding of the 2005 draught event?

We noticed a unique level of event-connectedness between the Amazon draught and the various highly unusual weather patterns simultaneously seen across the entire Atlantic Ocean: The south Atlantic Ocean had hurricanes the second year running. (There were never before any hurricanes in the Southern Atlantic.) The Middle Atlantic and the Caribbean section conjured up also a record-intensive hurricane season with 26 major storms. In the Caribbean, the storm-forming blanket of warm surface water thickened due to poor northward outflows. In the northern Atlantic Ocean the Gulf Steam's north branch had a weak flow and the Labrador sub-branch remained stalled. In the northern end of the Atlantic Ocean, the edge of the floating polar ice cap melted to all-time minimum. Its edge retreated to a point where the polar ice cap will soon loose all its land connectivity. We see the above 'coagulation' of the Atlantic climate system as the cause of the Amazon desiccation, an event that will be repetitive, rather than an one-off 'freak of nature', something for us to worry about.

Conclusions

Our findings established that the extremely dry and persistent northern winds observed during the Amazon draught originated within the storm-generating regions in the 'overheated' mid-Atlantic Ocean and the Caribbean where there was a simultaneous record-breaking storm and flash flood incidence. The rain processes separate water vapour from the rest of air. So, the intensified Atlantic storms cause more flash floods in some places, and more severe draughts in other places, mainly amplifying the regional, and seasonal water distribution differences in the future.

Recommendations

The Amazon river systems' inability to adapt to the new seasonal climate patterns in 2005, which led to a complete destruction of some river ecosystems, suggested us to look at water engineering solutions to prevent the risks of more tributaries of such dying. We made a case study to oxygenate the Amazon river to raise its draught-stress threshold during the likely future draughts that may be even worse than today if the Atlantic weather system generates more storms as the world's temperature rises.

We studied a 100 kilometre wide section near the Amazon's mouth. We assumed temperature +30C (when 100% oxygenated water contains 7,6 mg O_2 / litre). The addition of 2,5 mg O_2 / l represents 1/3 of the total, i.e. raising from 70% to 100%. This requires 4 million kg O_2 / day. 2,000 units consume 80 MW / 100 km of river. 1,000 km demand is at 800 MW (1 power station), costing ~500 million euros p.a.

As a result of our calculations it is obvious that several new power stations are required along the rivers. It also follows that as such a new infrastructure is required, and when the capacity constraints the supply of oxygenating units, the planning must be conceived early to ensure that the risk of permanent destruction can be mitigated in time due to many years' delivery time. Because of the global nature of the causes of this desiccation, it is not our recommendation that Brazil should pay for all its upkeep.

Operationalizing Benefit-Sharing: The South African Experience

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Keywords: Benefit-sharing, Negotiations, Sustainability, Trade-offs, Legitimacy

South Africa has a unique political legacy. On the one hand there is the complex impact of Apartheid and the resultant social, structural and resource inequity that took decades (if not centuries) to evolve. On the other hand there is a sophisticated scientific community with considerable capacity for innovative problem-solving. These two elements are manifest most prominently in the realm of environmental management. The smooth transition to democracy that arose from a reasonably peaceful negotiated settlement in 1994, has laid the foundation onto which a national culture of engagement, give-and-take, and nation-building has grown. This has been informed by the scientific community, specifically in the water sector, where pioneering work has taken place on assessing and sharing benefits from natural resources. This scientific innovation has been supported by the vibrant culture of democracy and social equity that emerged after 1994.

The key to this research has been the need to reduce the uncertainty of a negotiated settlement by providing rigorous assessments of complex ecosystem goods and services and cost-benefit analyses of different allocation scenarios. This research has resulted in a number of innovative new tools, with two being of particular relevance. Both of these have been developed by the CSIR as experimental tools for the support of the legal imperatives arising from the National Water Act and National Constitution. These legal instruments revolve around two fundamental pillars – the need for historic redress and the need for balance between protection and use (equity, efficiency and sustainability). These are complex issues because in essence they reconstruct society by redistributing the costs and benefits arising from ecosystem goods and services. If incorrectly dealt with they can re-introduce social instability, so a lot of care and thought has been given to these processes.

These two decision support tools are the ECO² Model (Claassen, 2005), which quantifies ecological and economic costs and benefits associated with different use scenarios; and the Resource Directed Management of Water Quality initiative (RDM-WQ) (Hattingh, 2005), which develops specific resource water quality objectives in support of equitable and sustainable socio-economic development. These instruments function in tandem and involve integration between hard science processes and the softer social and economic imperatives. These applications have proven useful in facilitating negotiations by reducing the level of potential contestation and quantifying direct costs and benefits. This is a significant development in the field because one of the known shortcomings of benefit-sharing literature is the absence of concrete processes or methodologies.

This paper will present both the ECO² Model and the RDM-WQ and will demonstrate how the methodologies can be linked to support benefit-sharing approaches such as the Inter-

SEDE© model that has recently been developed for the Swedish Foreign Ministry (Phillips et al., 2006).

Bibliography

Claassen, M. 2005. Elands Catchment Reserve Assessment Study, Mpumalanga Province. The Ecological Reserve and the Economic Value of the Aquatic Ecosystem in the Elands River. Pretoria: Department of Water Affairs and Forestry (DWAF) & Council for Scientific and Industrial Research (CSIR).

Hattingh, J. 2005. Resource Directed Management of Water Quality: 2nd Edition Management Instruments Series. Water Resource Planning Systems Series, Sub-Series No. WQP 1.8. Draft. Pretoria: Department of Water Affairs and Forestry (DWAF) & Council for Scientific and Industrial Research (CSIR).

Phillips, D., Daoudy, M., Mc Caffrey, S., Öjendal, J. & Turton, A.R. 2006. Transboundary Water Cooperation as a Tool for Conflict Prevention and Broader Benefit-Sharing. Stockholm: Ministry for Foreign Affairs Expert Group on Development Issues (EGDI).

Workshop 8:

Large Lakes as Drivers for Regional Development

Managing Lakes and their Basins for Sustainable Use: the Basing Governance Challenge

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Keywords: basin management, governance, GEF, lake characteristics, sustainability

Natural impoundments such as lakes, wetlands, marshes and ponds are central to human civilization. Among them, lakes are the most dramatic and picturesque features of our global landscape, have the richest endowment of resource values, and are major components of the hydrologic cycle. They sustain human livelihoods, support economic activities, provide habitat for biodiversity, and offer important aesthetic and spiritual values. They also provide buffering capacities against hydrologic and climate fluctuations, as well as being sinks for inflowing materials collected across the basin. Some of these functions and values also may be artificially created through construction of man-made impoundments. The management of impoundments, whether natural or artificial, requires wide ranging considerations of the state of the waterbody itself and its surrounding land basin including the inflowing surface and sub-surface water systems.

The properties of lake basin systems, including their configuration and the resource values they provide, vary widely among them. Whether or not the resources can be used in a sustainable way depends on how they are managed. Left alone, exploitative development of the resource base of lake basins, including their lands and waters, will lead to a wide range of overuse and degradation, invariably degrading water quality and destroying ecological integrity. The causes and effects of these problems may be further compounded through complexly-intertwined natural phenomena in and around a lake. To achieve their sustainable use, therefore, we must keep in mind that lakes are the mirrors of the condition of their basin.

The management of lake basins requires good understanding of the unique behavioral characteristics of lakes, namely their “integrating nature”, “long retention time”, and “complex response dynamics”.

Integrating nature: Lakes are subjected to various phenomena originating both within and outside their basins. The integrating nature of lakes refers to the cumulative, synergistic effects of physical, chemical and biological processes manifested in and around the lakes that affect both their water quality and their ecosystem integrity. For example, the mixing regime at the mouth of an inflowing river to a lake is quite complex, varying from one storm event to the next because of water flows and volumes, and from one season to the next because of differing seasonal temperature differences between the inflowing water and the water in the lake. Another example is that some forms of aquatic fauna and flora may move, or be transported freely within, parts of, or even across the whole expanse of a lake, and together with their complex food web linkages, allow inflowing material to be taken up, transformed and assimilated into their complex ecosystem.

Long retention time: The water in lakes generally has very slow flow rates, and in deeper parts of large lakes, the water may even be completely still, meaning a lake can have a slow flushing rate. The large buffering capacity that can ameliorate extreme hydrological and hydrodynamic events is usually associated with lakes that have large water volume and long water retention times. Formation of complex, diverse food webs and highly-productive aquatic life in many lakes may also be attributable to their long retention time, a property typically not seen in flowing water systems.

Complex response dynamics: Lakes exhibit complex response dynamics, and do not necessarily respond to changes or management interventions in a direct fashion. Nutrient concentrations, for example, can increase steadily in a lake, with no perceptible negative symptoms until a critical nutrient level is reached. After that point, fundamental changes will occur in the structure and function of the lake ecosystem, leading to excessive algal growths, deoxygenation of lake bottom waters, decreased water transparency, and other detrimental impacts that interfere with beneficial human water uses.

In a recent GEF funded project on the state of 28 selected lakes around the world, about half of the management issues described originate within their drainage basins. These issues, both in the basin and at the lake level, were exhibited in both transboundary and national levels in the lakes included in this Lake Basin Management Initiative. In contrast, global management issues were not commonly identified in the briefs, although climate change was believed to be affecting 7 of the 28 lakes. Further, some issues are well-known, but have not received adequate attention, an example being groundwater flows.

Other emerging issues that are less well known, but continue to be of increasing concern, include atmospheric nutrient pathways, climate change, shrinking lake size, trade globalization impacts, and environmental flows. Lakes, because they are components of river basins, must be managed on the basis of IWRM principles, but also with specific consideration of the three defining characteristics described above, and their management implications.

Keeping in mind the that sustainable management of lake basins requires good understanding of the behavioral characteristics of lakes described above, this paper give a brief overview of the governance challenge facing lake basins management.

A Survey of Institutional Features of International Lakes

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Keywords: Lake, Transboundary, International, Institution, Cooperation

This research presents an overview of institutional characteristics of lakes shared by at least two countries. Institutions are critical to averting the negative consequences of scarcity and poor management. These institutional arrangements can foster integrative bargaining among participants of the management regime that create and distribute cooperative benefits. It is therefore valuable to know what institutional features can enable regimes to incorporate diverse interests constructively and create opportunities. Such institutions may also increase the resilience of management regimes' responses to unexpected events. Therefore the institutional arrangements for management of international lakes can be significant determinants of development and of the quality of livelihoods of populations living within their watersheds. This survey provides an outline of the kinds of regimes that have been created and their characteristics. It does not try to compare which ones have been more or less successful, but rather attempts to give an idea of the range of options that have been used in international lake contexts.

The international lakes described in this survey include Lake Victoria, the Great Lakes, Lake Titicaca, Lake Constance, Lake Inari, and Lake Chad. An overview is also given of key institutional features relevant for lakes established by the Helsinki Convention on Transboundary Watercourses and International Lakes. The institutional features described in this survey answer the question of who deals with what, in what way, when and where in these lakes. Key characteristics described relate to participation and access, management instruments, institutional structure, scope of the regime, type of cooperative activities, and financing.

Questions about access and participation must be addressed by the regime. Both who participates and how they participate are not fixed. Decisions about these questions determine both who can participate in the collaborative activities and who is governed by the regime's rules and authority. This study addresses the following dilemmas facing these regimes: How many participants? How many national delegations are there? Does one representative speak for a collective of stakeholders? Or, is each major stakeholder group represented? How diverse are the interests represented? What kind of participation? Is the goal of cooperation joint deliberation, coordinated action, evaluation or integrated planning? The description also describes how participation by civil society, the private sector, scientists and experts, and external international agencies is organized.

The survey describes the key issues facing the regime. When possible, a historical account is given of when the issue was realized and what steps to address it were taken. Towards this, the survey details the types of cooperative activities engaged in, such as monitoring, data exchange, and cost sharing. If the regime is engaged in regional planning, it may also produce a transboundary analysis of critical concerns, identify specific priority concerns, evaluate and report on conditions and progress, stipulate noncompliance procedures, and dispute settlement mechanisms. The variety of management instruments used to regulate activity and implement cooperation are detailed. These include regulation, economic, and infrastructure development. The survey also includes an overview of how the regimes finance agreed upon initiatives.

Each regime must determine an institutional structure to coordinate cooperation. Therefore, the survey describes what the structures are, whether or not a formal cooperative arrangement for joint management is used, what decision-making rules are followed, whether or not legal are rights recognized, and whether or not a secretariat or executive agency is created. The scope of activities addressed by the regime are also detailed. For example, does the scope cover water quality and water quantity, fishing, and/or development? Finally, this research compares key institutional differences and similarities across the different lakes.

By presenting such an overview, this research seeks to stimulate discussion about institutional arrangements in place in different regions. This is a first step towards analyzing the kinds of institutional arrangements that have been able to promote development goals and sustainable use of large lakes.

Allocation of Reservoir Water as Group Decision-making Problem with Complete and Incomplete Information: Djerdap Dam at the Serbia-Romania Frontier

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Keywords: reservoir, purposes, allocation, analytic hierarchy process, group decision-making

The Djerdap Dam has been built in mid-seventies of the last century in the Danube River at the frontier of Serbia (former Yugoslavian republic) and Romania. Since then it serves as one of the most important multipurpose objects within national economy and particularly in its energy and water sectors. Probably the same claim stands for neighbour country Romania. Primary purpose of the dam and reservoir is hydro-electric power generation. Other imposed requirements are related to water supply, navigation, outdoor recreation, tourism developments together with nearby national park, fishing etc. After removing three large concrete bridges‘ crashed parts in the river bed near the city of Novi Sad (approximately 200 km upstream), a new situation emerged related to increased interests in domestic and international river traffic, particularly cargo transports from EU countries toward the Black Sea, sound tourism developments, and others. Some of earlier analyses how to best allocate waters in the huge reservoir were obviously outdated, and required innovation appropriately.

This paper presents main results of a case study application of the Analytic hierarchy process (AHP) in supporting possible group decision-making process related to future reservoir use. Overall goal has been set to establish proper decision-making model which will enable for active participation of different interest groups, and help to identify the best water allocation strategy for the reservoir, having in mind consumptive and non-consumptive water uses, lack of related legislation (such as water rights and fees/charges for water users, polluters, taxes for transport companies, inspection rules), etc.

Assuming that existing problems should be solved in step-by-step manner, in presence of both obstruction and support of different parties and interest groups, we offer an approach that reasonably considers tangible and intangible entities, and is applicable in cases when insufficient information is available or uncertain behaviour of interest groups and their representatives is encountered. An approach is multiobjective and it handles possible conflicts between participating parties such as republic government, electric power generating company, local authorities, responsible water management company, river transport companies, ecologists, various public bodies, tourism organizations, national park administration, etc. Although the conflicts in real-life are presently not so obvious, they are recognizable in very near future, particularly when monetary issues become important

(Serbian economy is in transition, and electric power production sector is about to be privatized).

The problem analysed in this paper is hierarchically structured. A global economical goal is set as to find the most profitable use of reservoir by allocating its water to the following 6 purposes: (A1) electric power generation, (A2) irrigation, (A3) flood protection, (A4) water supply, (A5) tourism and recreation and (A6) river traffic. The alternative uses each is assumed to have certain economic value, and therefore can be evaluated accross 5 economical criteria of different metrics: (C1) gain in national income, (C2) earning foreign exchange, (C3) improvement of the balance of payment, (C4) import substitution (self-sufficiency), and (C5) gain in regional income. With the AHP as a support, a single decision maker first derive weights of criteria after she/he completes pairwise comparisons of criteria at the first level of the hierarchy,. This step is followed by the set of local comaprisons (again in pairs) of alternatives concerning one criterion at a time, leading to the weights of all the alternatives. The final AHP synthesis produces the final weights for evaluated reservoir uses. These weights can be understood as percentual allocation of water to each particular use, and this information can be used accordingly afterwards in negotiation process related to financial issues such as charges, invesments, taxes, fees etc.

The other imortant case is when the same problem is solved by more decision makers representing different interest groups. Because participants usually bring different attitudes, willingness, education and in-deep knowledge of the problem to be solved, varuious scenarios are possible from the group decision-making standpoint. One is how to aggregate their individual behaviour during the decision-oprocess itself (brainstorming leading to consensus for example), or how to aggregate their decisions after the process is finished individually. For later case two sub-scenarios are analysed in this paper: (1) where certain decision makers occassionaly do not want to express their preferences within the AHP methodology, and (2) their judgments are imprecise or uncertain so they should be excluded from the decision-making process, and from all resulting aggregations as well.

Authors believe that this decision-making model offers new opportunities in providing valid planning of the reservoir use in general, and that it may help to create confident negotiation environment in search for most desired economic outcomes.

REGIONAL PARTICIPATION ON THE DEVELOPMENT OF TRANSBOUNDARY WATER RESOURCES: Civil Societies Engagement as tool for development in Nile Basin.

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Keywords: Lake Victoria, Nile Basin, Nile Discourse, Mara, Poverty, Environment

Africa is endowed with considerable large amount of different resources particularly water, mineral, fertile land, forest, wildlife, energy source such as gas and coal and many other related types. Most of these resources are either found within a particularly country or limited to a particular political boundary or across countries. This therefore creates an equal distribution of resources among countries. One of the large shared Lake in Sub Sahara Africa includes Lakes Victoria, Tanganyika, Nyasa. This paper presents a highlight on how best Tran boundary lakes can be used in order to alleviate poverty and conserve natural environment. Water being one of the major resources which is shared among or across political boundaries, its use for development has been constrained by several factors including for example a) political factors such as unwillingness among countries to collaborate; b) differences in economic power among countries; c) differences in development priority among countries; d) political instability within and between regional countries.

In 2002 at the World Summit on Sustainable Development (WSSD) held in South Africa, the international community took an important step toward more sustainable pattern of water management in order to achieve the millennium development goals. Few examples are discussed in this context and they are trying to promote effective stakeholders participation in decision making and practically involvement in the development of Trans boundary lakes.

The Nile Basin Initiative (NBI) Program is a forum which was launched in February 1999 is one of the good examples of a program which is trying to bring development of around 3,000,000 people who live within the Basin and depending on the Nile Water. The basin is characterized by poverty, instability, rapid population growth, and environmental degradation. The Nile Council of Ministers (Nile-COM) is the main policy and guidance forum for the Nile Basin cooperation. The Nile Technical Advisory Committee (Nile-TAC) is responsible to the Nile-COM for the Shared Vision Program (SVP). This program have two major sub subsidiary actions which are Eastern Nile (EN-SAP) currently including Egypt, Sudan and Ethiopia while the Nile Equatorial Lakes Region (NEL-SAP) includes six countries in the southern portion of the basin namely Tanzania, Kenya, Uganda, DRC, Kenya, and Burundi. Lake Victoria Basin countries are therefore five (excluding DRC). There are several development programs which are being implemented or are going to be implemented with NEL-SAP countries. Since these programs were prepared without fully consultations, stakeholders' involvement needs to be taken on board before it is too late. A Civil Societies Engagement process on the Nile was initially funded by CIDA Canada and now by DFID through a Nile Discourse Project was launched in 2001. The main objective of this project is to take on board various CBO within the Nile countries in development and poverty alleviation programs initiated by NBI programs in the region. This paper presents how stakeholders' participation can bring about regional development within the Great Lake (Victoria) countries through NBD project.

Looking in the mirror: How societies learn from their dependence on large lakes

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Keywords: environmental impact, integrated water resources management, lakes, reservoirs, sustainable development

Communities have been attracted by freshwater bodies, which provide a number of natural goods and services, including reliable supplies of water and food (essential proteins, good fatty acids and micronutrients) from the earliest days of sedentary agriculture and village life. Lakes thus offer a certain degree of security to livelihoods, which allow communities to develop and grow, not only in economic terms but also socially and culturally. Through trade and commerce, thriving communities interact more intensely and at increasing spatial scales, often triggered by the relatively low cost of transportation of goods by boat, giving rise to developments that are truly regional. However, the relationship between lakes and the riparian communities is not one-sided. Prosperous communities impact on the lakes that allowed them to develop. The links that exist between lakes and riparian communities are therefore dynamic with strong feedback loops, and must be analysed not only in spatial terms but also temporally/historically. One could argue that the state of a lake reflects and "mirrors" the state of the communities that live off its resources.

The paper reviews the state of a number of large lakes[1] and postulates what this might say about its riparian communities. It considers direct human impacts, such as water withdrawals, changed inflows and outflows, pollution fluxes and the introduction of new species, and investments such as in the tourism sector, but also indirect impacts caused by processes of global change. The paper not only reviews natural lakes but also a few man-made large reservoirs.[2] The paper analyses how communities learn about their dependency and impacts on lakes, and how they respond to changes in the state of their lakes.

There is an increasing interest in understanding the capacity of societies to adjust policies and practices in the face of environmental constraints and ecological limits, among other developments, as it is being realised that without such a "reflexive" capacity institutions cannot learn, evolve and adapt to changing circumstances. Without the capacity to reflect and learn institutions are unlikely to chart the way to a sustainable future. One condition for reflexivity to exist is political, namely the presence of a governance system that respects basic democratic principles, such as allowing (groups of) citizens to influence decision processes. A second condition is of particular relevance to the present paper and relates to science,

[1] We consider reviewing the following: Lake Constance/Bodensee in Europe, Aral Sea in Asia, Chapala in the Americas and Lake Victoria in Africa.
[2] We consider reviewing the following: Itaipu in South America and Kariba, Manantali, Katse and Maguga in Africa.

knowledge generation and learning, because without understanding cause-effect relationships effective adjustments in policies and practices are unlikely.

The paper highlights three factors that have assisted societies to balance the benefits they derive from lakes with the (negative) impacts they have on them. The first factor is related to sound methods of valuation, especially those methods that consider not only use values but also non-use values. The difficulties of comparing these differing values in a quantitative way (commensuration) is discussed as well as the opportunities created by considering people's preferences in trade-off analysis. Apart from the outcomes of economic optimisation models, it is highly relevant to know how citizens would rank scenarios (e.g. higher taxes-lower pollution) and their willingness to pay or to accept.

The second factor relates to regional cooperation and the degree to which political units and administrative authorities are willing to collaborate. Such cooperation may be between nation states or between provinces within a federal government. Here the notion of hydrosolidarity is revisited: hydrosolidarity not only requires that all benefits are shared (which is the overarching theme of this year's Stockholm Water Week), but also that all costs will be equitably borne.

The third factor is related to the knowledge infrastructure and the positive impact of research on policies and practical measures. It is shown that a strong link between local knowledge institutions, such as universities and specialist research institutes, with relevant government institutions is important.

The paper concludes that as large lakes are the receptacle of all the good and bad things that riparian communities produce, they indeed reflect and mirror the qualities and values of those communities. A comparative analysis of the reviewed cases shows that strong institutions are key. Without strong institutional capacity the economic and ecological interests cannot be balanced and development paths may become unsustainable. The importance of the learning capacity of institutions is highlighted and of the presence of an adequate knowledge infrastructure. Research and academic training require strong and continued societal support.

Lombardy lakes – The present and the future

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Keywords: lake management, environmental policies, eutrophication, ecotourism, sustainable development

Lombardy has the richest lacustrine heritage in Italy: its lakes cover 40% of the total Italian lakes surface and 65% of the total volume. There are more than 68 lakes with a surface above 0,2 km^2, 33 of which are natural lakes and 35 are reservoirs.

A lot of these lakes, especially the big ones (Garda, Maggiore, Como, Lugano, Iseo), have a cultural significance: they have natural, cultural and human heritage and are highly attractive on an emotional and economic level.

Their waters offer a wide range of uses and concentrate a high level of human settlement in the surrounding area: most lakes are situated in the pre-alpine area, in a strong urbanised zone with high population and large towns with more than 40.000 inhabitants.

Furthermore, lake water is used for many purposes: irrigation, drinkable water supply, recreational and professional fishing, bathing and navigation.

All these factors put in the past and they're still putting a detrimental pressure on the natural surroundings and the lake itself.

Therefore, it is very important to develop activities focused on one hand on the improving the knowledge and the information about the lakes and on the other hand on the planning and management of natural water resources.

Lombardy Region promoted in 2003 "The Lombardy Lakes Observatory Project" (OLL), in cooperation with ARPA Lombardia, Fondazione Lombardia per l'Ambiente and IRSA-CNR, in order to obtain a general overview of the current quality status, improving the amount of information and data on regional lakes. According to the WFD concepts, a large set of information about morphometric, hydrologic, anthropic, physico-chemical and biological features have been collected in a database (OLL). This database, structured as a tool for limnological data filing and processing, is characterized by an open structure that allows updating; it has been designed in order to answer to the national and regional law requirements, and also in agreement to the requirements of the WFD (2000/60/EC).

In its environmental policies over the past two decades, Lombardy Region authorities have shown particular concern in the lake management and safeguarding. Beginning with the first regional law (1984) regarding sewage disposal, aimed at compling with the requirement of the national legislation, regional authorities have set up and implemented the Water Clean-up Plan and some important eutrophication control measures, such as the adoption of rigorous limit value. In addition to this approach, the regional authorities introduce in 1992 the concept of receptive capacity of the water body and the possibility of fixing limits according to the natural lake characteristics and to the characteristics of the contaminants, anticipating the so-called combined approach of the WFD (i.e. the integration of quality objectives for water with emission standards for water contaminants). The engagement in valorising water resources has been further developed and last year Lombardy Regions published the first regional River Basin Management Plan (RBMP), in accordance with the regional law n.26/03, the national Legislative Decree n.152/99 and in conformity with some requirements of WFD.

The RBMP organizes and makes available to the public all information and data about water resources, subdivided among different river basins.

Regarding the lakes, a new classification of sensitive areas and nitrate vulnerable zones has been made and for each concerned lake a specific modelling has been tested to find the admissible nutrients loading to avoid eutrophication process.

This Plan has established for each lake a maximum achievable water quality objective (ecological objective) and an intermediate minimum water quality objective (managerial objective), to be intended as a P level in lakes close to the P natural in the first case and acceptable for the social use of the water in the second case. In order to achieve these objectives the Plan contains:

- an evaluation of the natural trophic level, using the MEI model,
- an evaluation of the external P loads with direct and indirect measurements,
- scenarios for improving water quality as a function of possible reductions of the P loads,
- a choice of the scenario suitable to the achievement of water objectives.

As a result, for each concerned lake, a quality objective, a time and the measures (with the adoption of very rigorous limit values) to achieve it have been established.

Furthermore, in order to pool and exchange not only knowledge of water quality but even knowledge of ecotourism and sustainable development, Lombardy Region and Research Institute for the Economy and Ecology Applied to Alpine Areas is involved in an European Interreg IIIB project. The project is called “Alpine Lakes Network”, it started in January 2005 and will finish at the end of 2007.

The main object of the project is the creation and also the maintenance of a network of local authorities involved in lake management and sustainable development of lakeside.
The network aims to:

- reach the good ecological state of alpine lakes, according to the WFD;
- promote a sustainable development mainly based on ecotourism;
- increase and broadcast knowledge of lake environment;
- improve the management of lakes and lakeside, the environment protection and the landscape quality.

Concluding, Lombardy’s regional authorities are greatly involved in the management and the protection of surface waters and above all of lakes.

The world's 10th largest lake under threat: Lake Winnipeg, the economic mainstay of Manitoba, Canada.

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Keywords: eutrophication, exotic species, hydro regulation, algal toxins, management plans

Lake Winnipeg, 3rd largest hydro reservoir in the world, now also holds the dubious distinction of the most eutrophic of the 10 largest freshwater ecosystems in the world. It's high productivity is primarily a function of a relatively shallow depth (mean 12m), a catchment area (.96 million km2) to lake surface (24,000 km2) ratio of 40:1, highest within the largest lake group, and excessive nutrients associated with rich prairie soils, extensive crop cultivation and livestock production within the watershed. Phosphorus loading has increased by 30 – 40% during the past three decades as a function of higher precipitation, water yields and drainage works in the Red River basin where flooding of agricultural land is recurrent. Recent growth of intensive livestock operations, spurred on by removal of grain transportation subsidies, and nitrogen based manure management has exacerbated nutrient overloading to Lake Winnipeg.

Total nitrogen to total phosphorus ratios in river loads and modelled lake concentrations have declined, particularly in the last decade, reflecting increased phosphorus loading. As a result, cyanophytes (Aphanizomenon sps., Anabaena sps) now dominate algal community structure, occur more frequently, and in 2005 covered 15,000km2 or 60% of the lake surface. Blue-green algal toxins present in extremely high (3000 µg/L microcystin) concentrations near recreational swimming areas have forced beach closures. Anoxic (< 2 mg/L O2) bottom (16 - 20m) waters resulting from blue-green bloom decomposition have now been measured in the large central basin of Lake Winnipeg and the first indication of cyanophyte-induced changes in zooplankton community structure were detected in 2003. External phosphorus loading was compounded by internal nutrient retention resulting from lake regulation in 1975 that increased summer but shortened winter water residence times.

The rate of phosphorus accumulation in lake sediments has increased by 300% since regulation. While eutrophication has not affected hydro power production, water quality deterioration has impacted lakeshore fishing communities that derive drinking and fish processing water from the lake. The clogging of fishing nets with diatoms or filamentous algae reduces effectiveness and hampers removal of caught fish. The arrival of the exotic rainbow smelt (Osmerus mordax) in Lake Winnipeg around 1990 has likely contributed to record walleye (Stizostedium vitreum) yields since 2001 but increased fishing effort was probably the primary determinant. While the 1° - 2° C warming of Lake Winnipeg observed during the last century likely benefited walleye production, it also enhanced blue-green proliferation which will be additionally stimulated by further climate warming.

The complex of factors influencing Lake Winnipeg deterioration will require a substantial investment in scientific research, watershed best management practices and policy decisions for nutrient regulation and reduction. Compared to the other great lakes of the world, Lake Winnipeg has received little attention principally because fewer (5.5 million) people reside in its vast watershed than in other Canadian lake regions. To facilitate research on this large complex ecosystem, the Lake Winnipeg Research Consortium was established from a collection of 30 agencies including government and university scientists, industry, fishermen, cottagers, and other public stakeholders. Operating independently from government for the past four years, the consortium has raised public awareness by collecting scientific data on the lake crucial for the development and implementation of appropriate nutrient management strategies. The Lake Winnipeg Stewardship Board, created in 2003 by the provincial government as part of a Lake Winnipeg Action Plan, is also working to recommend policy and strategic changes. Recent federal – provincial discussions have outlined a proposal to create a Lake Winnipeg Management Framework modelled after Laurentian Great Lake plans and to draw upon the International Joint Commission experience. The inter-jurisdictional reach of the Lake Winnipeg watershed, the anticipated but uncertain changes in basin hydrology, water needs and economic development will require full engagement and cooperation of all of its inhabitants

The influence of drainage area on the anthropogenic transformation of Vozhe Lake

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Keywords: system “drainage area – lake”, eutrophication, toxification, element migration, chain “soil- water-sediments-fish

The state of lake and its development depend on such characteristics of drainage area as soils, forest and number of tributaries. Anthropogenic changes of drainage area determinate negative processes in shallow lakes especially quickly. In present the deterioration of water quality and biological resources are observed in different water bodies, including the lake under weak human pressure. Anthropogenic transformation of such lakes is of interest for investigation of function “drainage area–lake” system.

Vozhe Lake belongs to the basins of the White Sea and it is located in the north-west of European Russia within Vologda region (at 61’ 36’- 58’21’N, 34’40-47’10’E). Vozhe Lake is large shallow lake (S= 418 км 2, the mean depth = 1, 8 м) formed 10 000 years ago after the digression of the Valdaysky glacier. The lake is located in a marshy area, far away from industrial centers. There is no navigation, timber floating and waste water disposal. However this shallow lake is strong depending on specific features of the vast drainage area and its anthropogenic transformation. In spite of weak human impact on Vozhe Lake the negative processes as eutrophication and pollution are observed. Consequently, the anthropogenic transformation of the lake is accelerated by natural features of the drainage area and atmospheric deposition contributes much to these processes. The drainage area of Vozhe Lake has a big square (S =5870 km 2), many the tributaries (22) and the coefficient of water exchange 3, 5.

The main goal of our investigation was determining of influence of vast drainage system on the subsystem Vozhe Lake. The investigations are connected with ascertaining of functional role of “snow - soil – water – lake sediments – biota” for migration, transformation and accumulation of elements.

Analysis of the problem is based on long-term monitoring (1962–2005) for abiotic indicators of different services, including individual observations during years 2001-2005 (snow, soils, sediments and water).The base of information was created by 6990 measuring of 40 indicators (P, N, pH, humic substances, toxic elements, etc.). The accumulation of heavy metals in different organs (muscular, tissue, gills, liver, kidneys and gonads) of fish species (bream, roach, perch) is analyzed.

The tributaries and precipitations are the main way of inputs of organics and biogenic substances and toxicants in Vozhe Lake. As a result the negative trends are observed, including the toxification (accumulation of heavy metals in sediments, water and fish) and acceleration of eutrophication (over planting, rising of nutrients, and organic substances content) and the changes of fish community structure. Positive tendency is stable dynamics of

ion composition and pH water due to high carbonate content in soil of the drainage area. However in spring in water for a short time the indicator of pH water is lowering because of pH snow lowering up to 5.0.
Migrations of elements, its distribution and accumulation are a "key" mechanism for the system functioning "drainage area–lake". Specifics of functioning of this system are determined by natural peculiarities of drainage area, character of human pressure, shallowing of the lake also.

Mechanical composition, content of nutrients and organic substances and pH of the soils influence on the migration of elements. The rising of the content of phosphorus in the soils determined the rising of P-content in water of river Vozhega and Vozhe Lake. Investigation of 10 elements content in soils and sediments of lake and water of the tributaries and lake showed the same picture of their relation ranging.

Long winter determines significant role of snow for accumulation of heavy metals on the drainage area and it leads to big amplitude of its getting into lake in spring. The distribution of heavy metals in lake depends on the peculiarities of coming elements. As example the concentration of Zn and Cu is more in surface of water. However in spring the content of Zn become low near the bottom comparison with Cu.

The specifics of heavy metals accumulation by different species of fish depends on: distribution of heavy metals in water, accumulation in the sediments, peculiarities of the elements, fish ecology and feeding. The investigation show that roach (planktivorous) more accumulates Zn, Cu, bream (benthivorous) – Pb, Cd, perch (predator) – Cu. Selectivity of accumulation of heavy metals by different organs of fish is observed. There are more toxicants in organs of detoxication (liver and kidneys).

Conclusions. So, drainage area has different influence on Vozhe Lake:

- It stimulates processes of eutrophication and toxification ecosystem. However drainage area is "buffer" against changes pH water and ionic composition.
- Diversity of soils of drainage area determines the redistribution of elements flow to the tributaries and lake. The rate of accumulation nutrients is distinguished in different zones of drainage area. Marshy soils and soils with high content carbonates delay elements. Concentration of heavy metals rises in soils with a high content of humic substances.
- Migrations of elements, its distribution and accumulation are a key mechanism for the system functioning "drainage area-lake".
- Different links of the chain "soil – water and sediments – fish" play different functional role in element migration (soil - accumulation and redistribution; water – transfer; sediments – accumulation; biota – transformation and accumulation).

Tonle Sap Lake, Cambodia: Nature's affluence meets human poverty

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Keywords: Mekong, governance, poverty , sustainability, socio-economy

Introduction: The Tonle Sap Lake of Cambodia is the largest permanent freshwater body of Southeast Asia, and one of the world's most productive freshwater ecosystems. The lake is the major flood regulator of the Mekong River and therefore fundamental for the entire Mekong Basin. Its importance for Cambodia is critical, and the lake and its floodplains form the key driver for regional development in the provinces surrounding the lake. However, despite the affluence of the nature, poverty around the lake remains deep-rooted. The extraordinary ecosystem, rapid population growth, urbanization, poverty, and inefficient governance form a challenging combination for regional development. Successful management of the lake and its resources is crucial for Cambodia and the entire Mekong Basin; and vice versa, due to its association with the Mekong, the future of the Tonle Sap depends not only on local development, but also on the upstream development in other Mekong countries. The Tonle Sap thus has regional significance in two levels; it drives the development for the region surrounding it, and at the same time its aquatic production and flood regulating functions are vital for entire Mekong Region, including also other riparian countries besides Cambodia.

A natural wonder: The lake is known for its rich biodiversity and extraordinary water regime with huge seasonal variation in water level and volume. This variation is caused by an exceptional hydrological phenomenon determined by the Mekong River. During the monsoons, Mekong's water level rises so high that part of the floodwaters run to the Tonle Sap River, causing the river to reverse its flow back towards the Tonle Sap Lake. As a result, the water depth in the lake rises even nine meters and the lake extends over vast floodplains consisting mainly of flooded forests, shrubs and rice fields. This atypical water regime has resulted in an exceptionally productive floodplain ecosystem. The lake is among the most productive freshwater ecosystems and one of the most fish-abundant lakes in the world. Flooded forests and shrubs offer excellent shelter and breeding grounds for fish, and migration of fish and other aquatic animals between the lake and the Mekong is extensive.

Driver for development: The Tonle Sap Area's current socio-economic setting is as extraordinary as its nature. Although being affluent in natural resources, the lake's surroundings are among the poorest in Asia. Area's rapidly growing population, ethnic diversity, seasonal variation of livelihood sources, poor and corrupt management, and unequal access to natural resources rights create a complex web of interconnected social and economic factors that make area's comprehensive development a genuine challenge.

Most of the population in the Tonle Sap Area is heavily dependent on natural resources–particularly rice and fish–and the lake and its floodplain play a central role in providing both.

The lake’s importance, however, extends far beyond its surroundings, and it is approximated that as much as half of Cambodia’s population benefits directly or indirectly from lake’s resources. This high dependency on natural resources is, however, alarming since the services provided by natural resources are in decline. The fish catch from the Tonle Sap River’s Dai fisheries was decreasing three consecutive years 2002-04, and was in 2004 the lowest ever recorded. At the same time it must be noted that fish catch of 2005 was exceptionally high, and that the overall reliability of fisheries statistics in Cambodia can be questioned. Nevertheless, the overall decreasing trend of natural resources seems clear. The trend is also likely to contribute for urbanization as migration from rural to urban areas is closely connected to lack of livelihood options in the rural areas and loss of income due to unexpected natural hazards such as floods and drought.

Challenge for management: The situation in the Tonle Sap Area is a real challenge: the lake is one of the main drivers for the development of the entire country, but at the same time its resources are under a threat of overexploitation and severe degradation. A balanced management of the lake and its resources is therefore vital for both the people directly dependent on its resources and the entire country and region.

Cambodia’s formal governance system is, however, still underdeveloped, corrupted and lacks both human and physical resources. It also suffers from both horizontal and vertical discontinuities. Water-related issues are handled under several ministries with their specific mandates, strategies, ambitions and policies. The share of the informal sector is substantial. Moreover, various NGOs, both local and international, contribute to the governance. Coordination of such system is challenging. Even more challenging is the functioning of the vertical links, from the central government to provincial and local authorities and all the way to villages. The very basic institutional and communication gaps are indicators of disintegration rather than integration and thereby great bottlenecks to balanced development.

Further threats to the lake are due to the escalating development activities upstream the Mekong River, including irrigation development and massive hydropower construction. These are likely to have remarkable impact on water quantity and quality of the Mekong, and consequently of the Tonle Sap. These impacts are poorly known, and the debate seems to be anchored in myth-like arguments for and against such developments, rather than sound scientific outcomes.

The Tonle Sap has a unique role in the regional development of its surroundings in Cambodia, as well as in the entire Mekong Region. It is often considered as the heart of the Mekong River. Besides the physical and ecological entity of the Mekong, the Tonle Sap Lake is in many ways the heart of the social and environmental health of the Mekong Region.

Managing Aral Lake and their Basin for Sustainable Use

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In 1960 the Aral Sea was the 4^{th} largest lake by area. Its area was about 69000 km^2 and volume was 1100 km^3. Level was +53.5 m a.s.l. It was a shallow lake with maximum depth about 70 m. It was a brackish-water lake with average salinity about 9-10 g/l. It was inhabited by a dozen of fish species and about 200 species of free-living invertebrates. Since 1961 has steadily dried due to withdrawal of water for irrigation from its two influents: Syr Dar'ya and Amu Dar'ya. At present the Aral Sea area is only 17000 km^2 (less than 25% from original area). Its modern volume is only 105 km^3 (less than 10% from original volume). At the end of 1980's when the level had dropped by 14 m and reached about +40 m a.s.l. the Aral Sea divided into two water bodies – the Large Aral on the South and the Small Aral on the North. Separation of the Aral Sea resulted in appearance of two lakes with different water budgets. Large Aral continues to shrink and now is about 80 km^3. On the other hand Aral Sea started to increase in volume because a special dike was built in summer 1992 to raise the level. After the Aral Sea division salinity in the Large Aral continues to rise and reached 90 g/l in the Western depression and 160 g/l in the Eastern one. In Small Aral salinity started to decrease and reached now about 15 g/l.

During UNEP meeting in September 1992 that was held in Geneva in UN Palace 4 main ways on conservation and rehabilitation of the Aral Sea were put forward.

1. Conservation and rehabilitation of Small Aral Sea:
   A dike was built in August 1992, but collapsed in spring 1999 when level rose for about 2.5 m higher than it was before. In autumn 2005 a new dike was completed and now level reached +42 m a.s.l. Area of Small Aral now is about 3300 km^2 and its volume is about 29.5 km^3. From Small Aral to Large Aral at present is available an outflow via special spillway. These parameters will be sustainable only if inflow from Syr Dar'ya will be 3.5 km^3/year. Outflow via water-spill should be 1.15 km^3/year. All these positive changes will be accompanied by biodiversity increase. Fisheries and hunting will recovered too.

2. Conservation and rehabilitation of Large Aral Sea:
   at least two projects to save Large Aral are discussed now. According to the first one water from Amu Dar'ya river via Adjibay Gulf reservoir should reach western depression. It would allow stabilizing its level around +33 m a.s.l. Simultaneously the Eastern depression would continue to shrink to a small, residual brine lake. According

to another project water from Amu Dar'ya river via Ak Dar'ya bed would go the Eastern depression. According to this plan Eastern Large Aral should receive water from Small Aral. According to unofficial information in autumn last year a new spillway from Mezhdurechensky reservoir to Ak Dar'ya collapsed. So, it is unclear now by which way to bring Amu Dar'ya water to the Large Aral. Harvesting of brine shrimp cysts (*Artemia* sp.) is quite possible in the both parts of Large Aral. Fishery and hunting are not possible due to high salinity in the Large Aral Sea.

3. Conservation and rehabilitation of delta and deltaic water bodies of Syr Dar'ya River:
   After construction of the first dike in the Berg's strait in summer 1992, Syr Dar'ya delta was moved slightly northwards and some freshwater reservoirs were rehabilitated: Tuschibas, Kamyslybas, Zhalanashkol, Karasholan. Kazakhstan government has plans to restore much more lakes in Syr Dar'ya delta. All these plans are under consideration now. It will allow nearly full rehabilitation of freshwater fishery and hunting.

4. Conservation and rehabilitation of delta and deltaic water bodies of Amu Dar'ya River:
   In lower reaches of Amu Dar'ya a number of freshwater and brackish lakes and wetlands were restored and new reservoirs built. One on the most successful projects is Sudochye Lake restoration. Besides Sudochye, there were a number of other successful projects: Mezhdurechensky, Muynak, Sarbas an other reservoirs. To some degree the restoration efforts brought back fishery and hunting activity to this area.

Lakes as Repositories for Women's Sustained Livelihood at Kodaikanal Hills

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Keywords: Pollution, Preservation, Prevention, Procreation, and Propagation

Presentation of topic and analysis of issue:
- Water is the elixir of life. It is a known fact that water as a resource is not limitless and perennial. Water management constitutes one of the major areas of human interventions full of challenges in the 21st century. Women are water providers and principle collectors since domestic duties fall almost entirely on them, disappearing water sources have meant new burdens and new drudgery for them. Water scarcity implies longer walking for women for collecting water and implies more work and less survival options. It is here that lakes get established as repositories of women's sustained livelihood, particularly in a small hill station like Kodaikanal. This study focuses on the Kodaikanal Lake, formed in 1863, but to-day the lake is under severe threat from anthropogenic activities and its watershed is fast becoming a cesspool.

The paper will analyze:
- The role of the Kodaikanal Lake in regional development
- Strategies to safeguard the lake from pollution and ensure its preservation of its natural vegetation
- Brainstorm preventive methods
- The lake and its outlets, and its role in sustenance of lives of women, in procreation and propagation of life.

Presentation of results / findings:
- The Kodaikanal Lake is highly polluted, and is badly contaminated by construction activity; the water is discoloured, with about 800 toilets in commercial and residential living quarters situated around the lake watershed. The growth of algae in large number leading to algae blooms is threatening to cover the water surface. There is continuous discharge of effluents directly into the lake, leading to reduction of oxygen level needed for survival of other life forms. About 40 automobiles are washed everyday leading to an oil slick on the surface of the water. The collective garbage thrown into the lake, the sunken fiber glass boats that do not decompose, the heavy influx of tourists during summer, the sewage water from hotels and resorts mixing with drinking water, spread of several diseases like leptospirosis spread by the bacteria through the urine and faeces of rats which breed on the garbage dump at Kodaikanal are few of the serious problems facing Kodaikanal Lake. There is now the urgent danger of the Kodaikanal lake which is around 57 acres shrinking into a rivelet filled with sewage and industrial toxic waste. The backlash of all these activities fall on the women, who have no other water source, but the lake water to depend on.

Conclusions and Recommendations:

1. Defining women's role in preservation of the Kodaikanal Lake
2. To draft a master plan involving women to prevent further pollution of the Kodaikanal Lake.
3. Ban use of detergents, washing of vehicles and its traffic around the Lake provide public amenities for public use, to pipe out all the waste out of the lake watershed.
4. Ensure pollutant level is kept low, so as to ensure health and sanitation of women, who are directly the largest users of water for domestic purposes.
5. Ban all building activities by a special Government Order, clearance of all shops and commercial establishments, take meticulous and massive operations to get the lake cleaned up to ensure procreation of healthy babies and ensure the propagation and survival of the humans species.

Africa's Lakes: An Analysis of Environmental Change

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Keywords: Africa Lakes, Satellite Imagery, Environmental Change, Geographic Information System, Population Pressure

According to the WORLDLAKE database, there are about 677 lakes in Africa. All are subject to human-induced pressures as well as natural change. There are 15 transboundary natural lakes that cross the political boundaries of two or more countries in Africa, including Lake Victoria, Lake Chad, Lake Turkana, Lake Tanganyika, Lake Tana, Lake Rudolf, Lake Natron, Lake Malawi, Lake Mweru, Lake Kivu, Lake Kariba, Lake Edward, Lake Chilwa, Lake Albert, and Lake Abe. The extent of water in the manmade Lake Nasser falls with the country boundaries of Egypt and Sudan.

There are 60 transboundary river basins in the continent, covering over 63 percent of the land area of Africa. There are 30 river basins shared by two countries and more than two countries share the remaining basins. The Congo basin is shared by 13 countries, followed by the Niger and Nile Basins with 11 countries, and Zambezi and Chad basins with nine and eight countries, respectively. The Congo, Nile, Niger, Chad, and Zambezi Basins occupy about 42 percent of the land area of Africa and sustain over 44 percent of the African population.

Africa's lakes contribute significantly to socio-economic development of the continent. Lakes are a source of livelihoods and transportation for many African communities. Thus they are drivers for regional development. However, these lakes are undergoing rapid changes due to national policies, human activities and natural events. These changes have altered ecosystem processes and resulted loss of biodiversity, over-fishing, eutrophication, proliferation of invasive weeds, siltation, toxic contamination and over-abstraction of water. In addition, since many lakes are transboundaries, changes in the water and its resources can foment unrest. If they are not managed properly, Africa's lakes, rivers and basins risk over-exploitation, loss of sustainability and civil unrest for future generations.

There is a critical need for valid scientific data and environmental information to enlighten decision-makers and various stakeholders on the changes taking place in and around most lakes in Africa. Periodic satellite imagery vividly captures these changes over large areas and long periods of time. Large water bodies can easily be mapped, identifying changes in their surroundings. This imagery is particularly useful for illustrating human-induced changes across country borders, especially for transboundary lakes. The overall objective of this study is to show various changes within African Lakes in an integrated manner through the use of remote sensing technologies, geographic information systems (GIS), and case studies.

We use satellite images document, assess and vividly show the changes in and around African lake basins over the past several years. Among our results, our study shows

- Effects of growing population pressures – for example
    - Population density is the highest in the Nile Basin, followed by the Niger Basin. The Chad Basin has the lowest population growth between 1960s-1990s.
    - Population growth around Lake Victoria is significantly higher than the rest of Africa. During each decade, population growth within a 100-km buffer zone around the lake outpaced the continental average. This reflects growing dependency and pressure on lake's resources.
    - Lake Victoria's level variation, derived from satellite altimeter measurements, shows a negative height variation trend even after the infusion of water from 1997-1998 flooding. This pattern should be of long-term concern to all East Africa countries and those along the Nile Basin.
    - Lake Victoria was heavily infected by water hyacinth in the1990s. Initially, water hyacinth was controlled by hand, with the plants being manually removed from the lake. More recent control measures include the careful introduction of natural water hyacinth insect predators and some improvements can be seen even from space.
    - Rapid population growth rate continues to create increasing pressure on water resources in Africa, with lakes being the most affected water reservoirs. Africa's freshwater supply including lakes is affected and threatened by both natural phenomena and human factors.

- Unsustainable use of water and land in Lake Chad and Lake Tonga
    - Lake Chad's area has shrunk by 95 percent in the last 35 years, driven by a complex interaction between climate and human causes. Lake Chad's surface area decreased from 22,902 km2 in 1963 to a meager 304 km2 in 2001. Studies reveal that the drastic decline in lake level and area since the 1970s can be attributed in nearly equal parts to the continued decrease in precipitation over the basin and to the large increase in irrigated agriculture.
    - Uncontrolled damming, withdrawal of water for irrigation and climate variability are the major cause of the drying up of Lake Tonga in Algeria.

- Natural hazards
    - Some lakes in Central Africa are known as Killer Lakes, because of the catastrophic scale events that have occurred in these regions. Lakes Monoun, Nyos and Kivu are located in active volcanic areas. For example, a CO2 burst in Lakes Monoun and Nyos led to the sudden deaths of 37 and 1,746 people in 1984 and 1986 respectively.
    - A breach of the natural dam in Lake Nyos seems imminent, with a high likelihood for this to occur within the next five years.

Ideally, our study will serve as a driver for regional development. Hopefully, it will lead nations and the international community to become concerned about Africa's lakes and take actions to mitigate further deterioration and conflicts.

Rejuvenation of Lake – Economic Engine: A Case Study of Kolleru Lake in India

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Keywords: Large Lakes, Ecology, Aquaculture, Environmental Impact, and Delta Systems.

Kolleru Lake is a large freshwater lake in India's Andhra Pradesh state. As an inter-deltaic lake between Krishna and Godavari rivers, it serves as a natural flood-balancing reservoir for the two rivers. The lake is fed directly by the seasonal Budameru and Tammileru rivers, and is connected to the Krishna-Godavari water system by 30 inflowing drains and channels. The lake also serves as an important habitat for 50,000 residents and migratory birds, including the Grey or Spot – Billed Pelican (*Pelecanus philippensis*). The lake was declared a wildlife sanctuary in 1999 and designated a wetland of international importance in 2002 under the international Ramsar Convention.

For centuries this lake used to be a lifeline for the habitations on the fringes and their living styles sustained the lake. Despite statutory protection, a rush for profits from aquaculture over two decades, the lake went through a disturbing phase that ultimately spoiled the delicate ecological balance. Having exploited a loophole in the government order (i.e. permission for limited activity of fishermen cooperatives), and under this guise 43% of the 245 Sq.km lake area were converted into corporate fishponds and 10% into rice fields. This is a clear example of misuse of natural resources under the name of development. As the main threat is in the form of poachers with considerable influence among the policy makers and official machinery, the 2005 floods in the region inundated and waterlogged the area during a couple of weeks. This extreme event put the entire life into a standstill.

The devastating floods indirectly helped to undo the grave situation created by human activity in the name of development (aquaculture). People opinion with the help of powerful media compelled government act firmly. However, the process of undoing is not simple but time consuming and an endless effort for restoration of ecological balance in the lake need to be augmented with scientific approach. This study attempted statistical sampling and model approach to simulate different scenario that may best match that of original eco-environment-economy system of the freshwater lake.

The agricultural encroachments were mostly rice paddies and the rest of the lake was being diminished by water diversions or was infested with weeds like elephant grass and water hyacinth. Pesticides alpha-BHC, gamma-BHC, Malathion, Chlorpyrifos and Endosulfan were present at higher concentrations than Isodrin, Dieldrin and p, p'-DDT.

The spatial representation of the results in the form of maps provides added inputs to the decision-makers. The silt yield map presents potential silt production rate from different levels, thus, depicts the erosion status of them and helps in prioritizing the segments for soil and water restoration measures.

Interestingly, a simulation model, show positive results and the approach here is the step method where in the first step the obstruction bunds in the higher reaches removed and the drained-out wetlands will be planted with suitable species that absorb contaminants in the soil. Similarly, lower reaches will be drained and go for suitable plantations. Dyke like structures for prevention of saline water intrusion shall be placed at the tail end reaches of the lake. Systematic improvement of flora for sustainable growth shall be adopted in and around the lake. Dredging silt to the fringes of the lake rather than into sea may help plantation. Monitoring of land use/cover over a period and people partnership in this episode contribute habit mould and economic sustainability.

Supported by, e.g., a Lake Protection Fund, a several-year project should lay the framework for the data, information and processes required to ensure timely and well-informed public policy decisions concerning the use and management of surface and groundwater resources. In so doing, this will support ongoing efforts to develop and implement a management regime to address water withdrawal, consumptive use, fishing methods, diversion and related issues. Major portion of the fund should go for capital projects such as wetland creation, stream restoration, sewer construction and repair, upgrading or repairing drinking water infrastructure, and constructing manure handling and treatment systems. In addition, many one-time projects, such as dam removal or sediment clean up, are also necessary steps in a basin-wide restoration program.

It can be concluded that the restoration of lake is considered keeping ecological balances. A descriptive inventory of the scientific data and models addressing the ecological impacts of current and prospective water use made available. Timely review will be followed by analysis and discussion, with a focus on how results might be reflected in inventory components and accommodated (quantitatively or qualitatively) in any type of decision support system. Biodiversity will be the key to success of the lake system in this part of the country.

Efforts should continue till the Lake Kolleru—the biggest freshwater wetland ecosystem become self-sustaining.

Networking between Networks: Baltic Cities co-operate with Lake Victoria Local Authorities

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Keywords: Apacity Building, Logical Framework Approach, Micro-Project Fund, Environment Pedagogic Center, Twinning

This presentation focuses on successful knowledge transfer methods and co-operation experiences between two distant regional city networks – the Union of the Baltic Cities (UBC) and the Lake Victoria Region Local Authorities Co-operation (LVRLAC). Common denominator for the both networks is shared water resource – the Baltic Sea and the Lake Victoria.

The Lake Victoria Region (LVR) is considered an area endowed with one of the most important shared natural resources by the Partner States of the East Africa Community (EAC) and has been designated as an economic growth zone by the EAC. The LVB however has been severely strained by unsustainable resource exploitation patterns and environmental degradation, contributing to the high poverty levels registered in the region. In 1997, on the initiative of the Mayors of Entebbe (Uganda), Mwanza (Tanzania) and Kisumu (Kenya), LVRLAC was established in response to the awareness of the many varied environmental, economic and social challenges that are facing the LVR and the recognition of the commonalities in the problems facing the Local Authorities around the Lake. LVRLAC has today more than 60 member local authorities from all three East African countries surrounding the lake.

With the objective of strengthening the organizational capacity and draw upon the experience of similar co-operation elsewhere, LVRLAC established a twinning co-operation project with UBC in 2000. This partnership program is sponsored by the Swedish international Development Agency (Sida). Capacity building for sustainable development is one of the five priority areas in Swedish Lake Victoria Strategy adopted by Swedish government in 2004.

Logical Framework Approach (LFA) has been the methodology for objective-oriented planning of LVRLAC activities in LVR as well as for the planning of concrete capacity building steps in the work-plan of LVRLAC/UBC cooperation. LFA is based on the understanding that the project owner (LVRLAC) assumes the main responsibility for the planning process. However, strong assistance (training, experience sharing etc) has been arranged by the experts from Baltic Sea region. LFA has the aim of improving the quality of concrete project operations and can only achieve this if the user has a good grasp of the method and uses it throughout the entire project cycle. For practicing LFA-methodology throughout the entire project cycle and for the "visible" benefit of LVRLAC member authorities a Micro-project Fund was established within the framework of LVRLAC/UBC co-operation. So far three pilot projects have been chosen to be financed from the Micro-project

Fund – Solid Waste Management, School Sanitation, and Women Entrepreneurial and Business Development Skills. Implementation of micro-projects has resulted in enhanced capacity of project management by LVRLAC member councils within regional context. It has ensured greater communities participation in LVRLAC activities through member councils and initiated inter-generational attitude change towards sustainable development and environmental management through school programs. Empowerment of women will in the long run result in enhanced gender mainstreaming throughout the whole LVR.

Another useful capacity building instrument has been the establishment of Environment Pedagogic Centers (EPC) in LVR. First model EPC was open for visitors in Kisumu, Kenya in November 2004.

The main idea of EPC-s is to provide local households and families with simple, inexpensive but at the same time efficient methods for satisfying basic human needs: water purification and heating systems based on solar energy, solar stoves for cooking, dry-toilets and many other methods for improving livelihood of the people in LVR. Key stakeholders involved in EPC model are city councils, local governments, universities, government departments, schools, NGOs, CBOs, Women Networks etc.

Twinning between Lake Victoria and Baltic Sea cities has proved to be successful method of capacity building for sustainable development in LVR especially in the field of urban planning. Good examples of long term partnerships are twinning between Entebbe (Uganda) and Kalmar (Sweden) as well as between Mwanza (Tanzania) and Tampere (Finland). Main achievements of these twinning relationships are described in the presentation.

The methodology of long-range forecast of the level and water balance components of the lakes accounting the periodicities in their time series

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Keywords: Lakes, water balance, time-series, periodicities, forecast

Presentation of the project/topic and analysis of issue: Large inland lakes and seas are significant components of the Earth climatic system, which influence on the water and thermal regimes of huge regions and continents. The specific and sometimes unique biosphere exists there. The inland water bodies are related with different branches of economy such as fishery, transport, health resorting and tourism. The water balance components and level of closed lakes are significantly variable.

The nature and population of coastal areas should adapt to the changes of lake's level. Its increase or reduction causes the variation of coastal line, areas of water surface and islands, salt balance components and natural habitat of land and water plants and animals. The research of variation of lakes characteristics and the development of the methodology of their long range forecasts are an actual for economy, natural management and ecology of regions of their basins.

The project is aimed for the development of the methodology of long-range forecast of lake level and water balance components accounting the periodicities in their time-series. Now the periodicities of lake characteristics are estimated mainly by the methods based on the correlation and spectral analysis. This study reveals the periodicities combining the development of the original physically based model of oscillations of lake characteristics and approximation of lake level and water balance components by sine functions using the method of least squires.

The solution of differential equation of lake water balance permitted to elaborate a mathematical model, where dynamics of mutually related lake characteristics (level, water surface area, evaporation and surface outflow of water) are the response to inflow (river runoff, precipitation and ground-water runoff) oscillation. The oscillation of water inflow causes the variation of lake level, area and water balance components. The extremes of lake characteristics have a time lag, if compared with impact extremes.

The dynamics of lake level, area, volumes of evaporation and surface water outflow is described by the relations of amplitudes of their variations to the respective differences of their values of two equilibrium states caused by the maximum and minimum of water inflow, and by the time delay of lake characteristics to water inflow. The time lag of Caspian Sea and Ladoga Lake characteristics to inflow and relation of their amplitudes were computed in dependence from the oscillation period.

The time-series of level and water inflow of Caspian Sea and Ladoga Lake were approximated by sine functions successively with the unitary period step. The amplitudes, phases and additional constants of sine functions with the least sums of squire differences between the values of observation time series and their approximation were calculated for the each period value.

The dependencies of the least sums of squire differences respectively between the time series of water inflow and level and their approximation functions from the period were computed. The periodicities are revealed near periods where, from one hand, the minimums of least sums of squire differences between time series of lake level and inflow and their approximation are marked, and, from the other hand, the time delay of level to inflow and relation of their amplitudes of approximation functions are close to the model results.

Presentation of the results: With increase of oscillation period, the relation of amplitudes of lake level, area, volumes of evaporation and surface water outflow to the respective differences of their values of two equilibrium states caused by the maximum and minimum of sine function of simulation of water inflow increases from 0 to 1, while time lag of lake characteristics to inflow increases from 0 to upper limit value. For any oscillation period the time lag of Caspian Sea characteristics to water inflow is larger then the time lag of Ladoga Lake characteristics.

The periods of 4, 7, 9, 11, 13, 16, 21–22, 34–36 and 140 years were revealed in the dynamics of Caspian Sea level and water inflow. The significant part of periodicities in time series of Caspian Sea inflow and level are the same periods as global factors. So, the exposed respective periods of Caspian Sea inflow and level of 9, 13 and 16 years are similar to those of length of day variation. The periods of 11, 22 and 35 years are marked in the dynamics of solar activity. The 4 and 31 years periods were revealed in the time series of Ladoga Lake characteristics. When periodicities in dynamics of level and water inflow of Caspian Sea and Ladoga Lake are summed, the sums of squire differences between values of respective time-series and sums of periodicities are sucessively reduced. The sums of periodicities reflect the peculiarities in the time-series of Caspian Sea and Ladoga Lake levels. If the interval of time-series to extent into the future, the sums of periodicities permit to forecast the lakes levels. The comparison of real and forecasted levels of the Caspian Sea and Ladoga Lake shows that real levels are changed according to expectation for next several years.

Conclusions and Recommendations: The forecasts of lake level and water balance components significantly reduce the water related hazards for different branches of economy related with the water and water resources of lake basins. Account of periodicities in the time-series of lake characteristics makes the forecast more precise and reliable.
The application of water balance model for revealing of periodicities in dynamics of lake’s characteristics makes its results more reliable comparing with the methods based on the correlation and spectral analysis only. The periodicities of inflow may be exposed not only statistically but also physically in the respective level periods.

It is expediently to evaluate the periodicities in the time series of all large lakes of the Earth. The comparison of phases and amplitudes of the same periods in time series of characteristics of different lakes makes possible to reveal the geographical regularities in their dynamics. The comparison of periodicities of lakes’ characteristics with dynamics of global factors and climate variability will permit to explore the causes of periodicities and will be useful for advanced forecast of lakes’ level and water balance components.

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Effects of Human Activity to Sustainable Fisheries for Regional Development at Katosi Landing Site, Lake Victoria

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Keywords: Effects, Human, Activity, Sustainable, Fisheries

With 68,800 km and a catchment area of 284,000Km, Lake Victoria is the second largest fresh water body in the world. It is the direct source of livelihood for about 1/3 of the combined population of the 3 East African countries. The lake region consists of Uganda, Kenya and Tanzania who control 45%, 6% and 49% of the Lake's surface respectively.

Sustainable management of fisheries resources can be a pilot to regional development around Lake Victoria. However, a combination of human activities have impacted on the economic potential of the Lake on which majority population in the region depend. As a result, the ounce flourishing fisheries industry is regressing due to a combination of various factors, the results of human activities outstanding. The destruction of the lake's aquatic environment, declining fish stocks and extinction of other species has hampered the growth of the Fisheries industry as a drive for development in the Lake Victoria region. At katosi landing site, such activities, almost typical to all fisher communities around Lake Victoria are rapidly happening causing more urgent need to counteract.

Wetland reclamation for crop cultivation, human settlement and craft industry development is rampant at katosi landing site. This destroys their ecological function of filtering water before entering the lake thus water polluted with human waste and chemical enters the lake directly, destroying water quality for fish survival and destroying fish breeding grounds hence reducing stocks.

Deforestation characterized by tree cutting and forest clearance has had devastating effects on the aquatic environment of the Lake. Increase in human population has pressurized forests for cultivatable land, settlement, timber and firewood. This reduces the absorptive capacity of soils, increasing soil erosion and consequent silting of the lake and all its disastrous effects on fish and aquatic life survival.

Poor Agricultural practices as a diversified activity for the fisher community at katosi due to dwindling fish stocks has aggravated the problem instead. Despite the boost by inorganic fertilizers and pesticides to crop and horticulture farming around the lake to cater for the increasing population, coupled with over cultivation, the soils are weakened and erosion increased. The inorganic chemicals are washed directly to the lake, rendering it unfit for aquatic life survival thus extinction of some species.

Poor hygiene practices and lack of sanitation facilities have caused to constant pollution of the lake by sewerage effluents from the fisher community. Outstanding of such practices is unsafe excreta management due to lack of latrine facilities as well as direct use of the lake waters as excreta disposal ground .Such effluents have big nutrient loads which have increased algae population causing de-oxygenation of deep water grounds thus creating favorable ground for weeds such as water hyacinth, reducing fish species and causing stunted growth of fish.

The growth of the construction industry at the landing site has attracted sand excavators destroying wetland areas as purifying water grounds. More so, this has deterred fish farming activities in low lying areas which the community would have utilized for income generation and dietary improvements. Instead, there has been draining of such areas leaving them as dry excavated ditches with stagnant water that favors mosquito breeding.
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Katosi Women Fishing & Development Association's overall objective is to contribute to poverty reduction in a framework of sustainable development. All interventions by KWFDA are to empower community into sustainable fisheries management to rejuvenate fish stocks and enhance survival of fish species under extinction.

Rain water harvesting as a catch for water which would be surface run off to aggravate soil erosion and its disastrous effects has been emphasized in the fishing community especially for the community closest to the lake.

Agricultural Education through encouraging organic farming has reduced the use of inorganic fertilizers and pesticides as increased application of modern agricultural practices that are environmental friendly are also encouraged and applied.

Manual removal of Water Hyacinth from the lake shores, community Education on the disadvantages and alternative uses of the weed has reduced it on the lake shore line.

Environmental education characterized by various trainings on sustainable use of natural resources and environmental management in addition to afforestation campaigns whereby women are encouraged to grow fruit trees in their gardens as well as planting trees on the side roads to the landing site.

Hygiene education and provision of sanitation facilities at the landing site is reducing sewerage effluents into the lake. Sensitization on safe excreta management, safe water chain, safe garbage and other waste management as well as provision of Ecosan latrines suitable for landing sites has improved the situation.

Advocacy centered activities including dialogue with the local authorities on the effects of sand excavation to the fisheries industry, lake water quality and deterred opportunistic aquaculture activities in the low lying areas surrounding the lake that would have fostered economic and social development.

Other recommendations to foster development in the Lake Victoria region include formation of regional partnerships from the 3 countries that fight degrading human activities by empowering people themselves, intensifying environmental education for sustainable use of natural resources and working for creation of an ownership spirit among fishing communities.
Regional Development on Lake Victoria can be attained through nurturing fishing industry by enhancing a well functioning eco-system that significantly rejuvenates and sustains the currently dwindling fish stocks and species. This poster will highlight the disastrous activities at katosi landing site which are more so typical to many fishing communities in the Lake basin and interventions that to need to be undertaken locally and regionally by stakeholders to control the effects of human activity to sustainable Fisheries to enhance Lake Victoria regional development.

Inflatable Barrier at Ramspol, The Netherlands

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Keywords: lake, polder, inflatable dam, inflow

West- Overijssel is a delta region, which is very important to be protected. Along the rivers are situated the historical towns such as Kampen, Hasselt, Zwolle. Besides there is beautiful nature with rare plants.

In earlier days the IJsselmeer (IJssellake) had a direct link with the Northsea. In 1932 the Closingdike was build and separated the former Southsea from the Northsea. The Southsea had become a lake and was renamed IJsselmeer. In the IJsselmeer a number of polders were build; the lake became smaller and got the shape of a funnel. At its narrowest point two rivers IJssel and Vecht flow into the lake. With high winds from the west, the water from the lake and the rivers all converges to a small area the Zwarte Water (Black Water), threatening the surrounding land and polders. The inflatable storm surge barrier and the limited strengthening of the dikes should raise safety levels to the standards set.

"Higher dikes or close the door": this was the choice presented to the Waterboard in Western-Overijssel at the eastern shores of the IJsselmeer. Or in other words, the choice was to strengthen the 115 kilometres of dike or set up a moving barrier at the location where the water from the IJsselmeer flows into Western-Overijssel. Strengthening all dikes was not a viable option: the cultural and natural qualities of the area would be damaged too much. In addition, the costs would be substantial. Only a barrier would not offer enough safety. It was decided to combine an inflatable barrier with an improvement of the dikes in the Ramspol estuary.

34 types of barriers were available for the protection of Western-Overijssel. The choice was made for an inflatable barrier: a unique barrier with three bellows of rubber cloth. At high water the bellows are inflated with water and air. The inflatable barrier will close of the Black Water at Ramspol within an hour when water levels rise to critical levels due to inflow from the IJsselmeer and the rivers Vecht and IJssel. On average this will happen once a year. For the rest of the year the bellows rest deflated on their foundation in the lake. For that a special threshold is constructed underwater.

The inflatable barrier at Ramspol is unique in more than one sense. With a diameter of 8 meters it is the largest bellows in the world. This type of barrier is only used to control waterlevels under normal circumstances, at Ramspol it is supposed to withstand storms and high tides. In addition, it is the first that is filled with both water and air.

The construction on the inflatable barrier is a unique project, in which different groups work closely together. The Waterboard Groot Salland (WGS) took the initiative and holds responsibility. The Construction Support Service (CSS) of the National Department of Public Works directs the works. The HBW designs, builds and maintains the barrier. The province of Overijssel subsidises the project.

The tasks are as follows:

Waterboard GS:

- Budget control
- Acquiring terrain
- Licences
- Deliberations and negotiations with local and national governments
- Public relations
- Maintenance

CSS:

- Checking constructors documentation (design, planning, certification)
- Technical control on construction
- Accounting
- Random quality checks

HBW:

- Design
- Quality control plans, construction plans, certification plans, and safety plans
- Planning
- Construction

The construction of this uniek dam Ramspol had been was finished in 2002. The inflatable barrier offers sufficient safety levels, has little impact on nature and cultural heritage, is relatively inexpensive and does not interfere with navigation.

Remotely Sensed Data for Support of Monitoring, Management and Protection of Lake Ladoga Coastal Zone and Water Environment

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Keywords: remote sensing, ecosystems, coastal zone, water environment, pollution

Great attention to the studies of coastal zones (CZ) in the recent years is explained by significance of those for the development of the national economy and the vulnerability of the coastal and water environments (WE) to anthropogenic impact. At present the most effective tool for CZ study is the integrated approach on the basis of using of long-term observation data including both traditional and remotely sensed methodology. An advance in the remote sensing (RS) methods and GIS technology development gives a powerful tool for spatial environment data collection, storage, processing and analyses.

This paper is devoted to application of RS methods for study the state and change of ecosystem of the Lake Ladoga, influenced by variability of nature and anthropogenic factors. The efforts for nature-economic systems management and protection must be firstly oriented to peoples living conditions improvement in nearest future and for the next generation. For extracting spatial and temporal characteristics of nature-economic systems, analysis of them ecological state, changes modeling and forecasts making, we need a lot of information.

Lake Ladoga is the largest freshwater lake in Europe and among the largest lakes of the world takes 16 place on area and 14 on volume. Lake Ladoga is the unique nature object and the main source for drinking and industrial water for St. Petersburg region and for the Karelia republic. The mane parameters of Lake Ladoga are: length - 220 km, width - 83 km, surface area 17680 km2, mean depth - nearly 50 m (maximum - 230 m), water volume - nearly 980 km3. Its basin has a complicated system that includes the water catchment areas of the Lakes Onega, Ilimeni and Saimaa (Finland). The water catchment of the Ladoga has in general the area about 260 thousand km2 and extends from north to the south at more than 1000 km, and from west-to-east - almost on 600 km. The 32 rivers, with size longer that 10 km, fall into the Lake Ladoga, and only one - River Neva runs out from. The largest Ladoga inflows are: River Sviri, River Vuoksa, River Volkhov and River Siasi. The time required for renewal of the water in Lake Ladoga is 11 years; this indicates that the ecosystem is rather conservative. River discharge accounts for 86% of water balance input, which implies that catchment processes have a major influence on water quality. Ladoga is one of the northernmost of the world's large lakes with a cold-temperate climate ecosystem.

The RS methodology for coastal and (WE) study is based on a systematic approach to analysis of satellite, airborne and different kind of conventional field measurements. Furthermore, the effectiveness of using air- and space-borne information in regional research and the reliability of the results obtained, are dependent on the level of development of regional databases and knowledge bases, which need to be constantly expanded and revised, including by means of RS research.

On the basis of RS methods can be assessed such water quality parameters as total suspended matter concentration, transparency and surface water temperature; can be identified areas of intensive development of phytoplankton and assessed concentration of chlorophyll-a. RS data are also useful for study of dynamics of surface water. From the infrared satellite data series the duration and spatial variability of thermal front and upwelling events can be examined.

For this study have been used the RS data set obtained during 1975-2002 years from different aerial and satellite systems: RESURS01-N3/MSU-SK and MSU-E, ADEOS/AVNIR, LANDSAT/TM and ETM+, NOAA, SeaWiFS, MODIS and corresponding field observations, including sampling of WE and of bottom sediments. On the large amount of the available satellite images of visible range in the eastern-southern-eastern area of the Lake Ladoga one can see patterns of suspended matter distribution coursed by rivers discharge. This part of the Ladoga is strongly influenced by inflows of polluted rivers. As follows from in situ data analysis, especially high level of hydro-chemical contamination has the River Volkhov and correspondingly it discharge area. In more detail investigation of Lake Ladoga ecosystems have been carried out by VNIIKAM for the southern-eastern part of the lake yearly, during 1977-1990. In framework of this study the impact of waste water loading from the Siasky cellulose-paper enterprise on lake WE and on CZ landscape has been examined.

Changes in landscape of the CZ of Lake Ladoga that occurred during last decades, influenced by anthropogenic impact on environment due to resort infrastructure extension and due to other economic factors, detected on the base of space imagery will be discussed. From the infrared satellite data series the duration and spatial variability of thermal front and upwelling events have been examined. While, the SAR imagery were used mainly for Ladoga ice parameter and water dynamics features study. The correspondence illustrative materials will be presented and the reflected on them water dynamics feature will be discussed in detail.

The results obtained show the usefulness and efficiency of using RS data for:

- solving different environmental problems;
- receiving a new knowledge for CZ and WE of the lake and thus to supply «feed back» of regional Knowledge Base;
- improving visualization of spatially-oriented data;
- organizing operational monitoring of coasts and surface water in the emergency cases (flooding, oil pollution);
- amplifying informational support for decision making;
- optimization of field observations;
- validation of hydrodynamic modeling.

The Largest Lake of Belarus Naroch and Its Regional Problems of Recreation and Tourist Industry

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Keywords: Ecological degradation, Recreational resources, National park, Economical activities, Sanitary conditions

There are more than 10 thousands lakes and about 20 thousands rivers in Belarus. About 57% of country's area belongs to the rivers of The Black Sea basin. Another part belongs to the Baltic Sea basin. Lakes play an important role in surface water balance regulation and form special microclimate and landscape of natural biogeocenosis. Historically, lakes predetermined places of settlements. Now they define the economical way of regional development. We use lake resources in different economical activities and also for creation resorts and recreation zones.

The largest lake in Belarus is Naroch (surface area - 80 thousands km², storage – 710 millions m³). It is situated 140 km far from the capital of the country, Minsk. Surface water inflow of Naroch is formed by 17 small brooks and 1 tributary. Runoff is formed by the river Naroch.

Now there are 9 observing posts in the Naroch basin. National Hydrometeorological Service of Belarus is carrying out hydrochemical, hydrobiological, hydrological and meteorological monitoring of the region. The climate of Naroch region is moderately continental with prevailing of precipitation over evaporation.

More than 60% of total amount of recreational and tourist infrastructure of Belarus is situated nearby the water bodies. According to the master plan of country's resorts allocation a third of them belongs to lakes. The largest resort center in the country is organized in Naroch region. It consists of more then 16 large sanatoriums and health centers. The economics of the region nowadays and in prospect is defined on the usage of natural recreational resources.

The population of Naroch region is more than 45000 people. During the summer vacation period this amount triples. 24% of inhabitants is employed directly in tourist service. That's why the increase of Naroch's inviting features will insure the improvement of citizen's well-being and strength of regional sustainable economical development. Upgrowth of tourist infrastructure will bring an increase of employees number. Finally it can stop a migration process caused by job searching.

At the same time as a result of careless economical activities and uncoordinated tourism since 1970th Naroch region was dramatically affected. Several measures for preventing and saving Naroch ecosystem were not properly helpful. Over a period of many years ecological problem has increased and now it causes anxiety of scientist, government and public society. Decrease of water transparence, increase of suspense concentration in the water, oxygen deficit in the bottom area of the lake cause occasional fish dying out. An intensive obliteration process is taking place there. The problem of cercariaeum in Naroch resort has become widely known. Industrial fishing efficiency has decreased in 3.5 times in comparison with primary amount.

The assessment of ecological impact on a lake ecosystem shows that the main source of biogenic elements is precipitation (about 50%). This level of pollution increases progressively. The agriculture forms around 40% of total amount of pollutants. A great impact of urban population makes also a significant affect on a basin of lake. Regional sewage constructions are under capacity. Recreation and tourism forms 10% of total affect. Analysis of this problem shows that such pollution is critical for ecosystem. It has to be decreased.

Ecological degradation of Naroch region brings unavoidable quality reduction to recreation and finally it turns to local economical crisis. Therefore ecological problems solving is the strategy decision for region development.

In attempts to amending the situation the government issued an order to give to Naroch region a rank of National park. Nowadays 117 thousands hectares of the park consist of forestry, hunting, urbanized areas, industrial objects, recreation zones and water protected areas. The rank of National park determined differentiated regulation of natural resources consumption within the limits of fixed functional park zones. After a 6-years period the increase in the number of wild animals is taking place there. But at the same time statistics show that poaching cases have become more frequent.

The main functions of the park besides the maintenance of biological diversity and landscape safety are organization and development of recreation and tourism industry.

Among disadvantages of the park the lack of scientific researches can be underlined. The urgent measures are bioinventory of the natural components and assessment of degradation caused by anthropogenic influence.

The next step in solving ecological problems is going to be "State programme of ecological improving the sanitary conditions of the lake Naroch and nearby region" that should be implemented till 2008. The Programme consists of 31 composite measures such as

- Assessment of ecological situation of the region and development of the projects to optimize natural resources management;
- Reduction of lake pollution;
- Normalization of parasitological conditions;
- Equipping of resort's infrastructure and improvement of the sanitary conditions;
- Carrying out complex ecological monitoring of the region;
- Holding actions to propagandizing and popularizing the rules of regulation and protection of National Park among citizens and tourists.

Local agricultural companies will reorient their industry to put out ecologically clean products for distributing it mainly in Naroch region.

Gradual rising of recreation's rate on Naroch could be possible in case of balanced redistribution of recreational load among the nearest lakes resorts in the same region.

According to the fact that the total amount of amateurish fishing on Naroch is commensurable with amount of industrial fishing the last one can be banned in near-term outlook.

All these measures will improve sanitary conditions of Naroch region and draw investments into regional economy.

Bottom sediments in the pollution control program for Lake Ladoga

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Keywords: Lake Ladoga, pollution control , sediments, bottom types, contamination

The more industrialized society becomes, the more important it will be to have adequate systems for pollution control. Lakes have a more complex and fragile ecosystem than rivers. They do not have “self cleaning” ability, and therefore they readily accumulate pollution.

Contaminated bottom sediments and associated decreases in water quality are major problems for aquatic systems. Sediments can be regarded as a bank of environmental information. Most polluting substances are not distributed in natural waters in free form, but are associated to various sediment particles. The particles govern the spread pattern of contaminants in the aquatic environment and the may regulate to some extent the potential ecological action. Sediment samples can reveal which areas are polluted and unpolluted, which substances contaminate and how much. These are good reason for the attractiveness of the sediments in aquatic pollution control programs.

During 1989-96 extensive sedimentological studies were performed in Lake Ladoga, which is the largest lake of Europe. Ladoga is one of the 15 largest freshwater reservoirs in the world. The state of the environment in the Ladoga area affects the life standard of several million people living in 258,000 km2 of the lake watershed area, which includes a great part of the Russian North-west and eastern Finland. Lake Ladoga also plays the key role in industrial and drinking water supply to St. Petersburg with its five million inhabitants. Moreover, the state of the lake directly affects the water quality in the Neva River, Gulf of Finland and the Baltic Sea in general.

The main tasks of the investigations were:

- to determine a character and degree of sediment contamination;
- to rank the importance of various processes, regulating the spread of these contaminants;
- to generate a better understanding of the susceptibility of large lakes to external forcing.

Lake Ladoga is one of the final parts of large-scale transformations of substance flows. The high degree of urbanization of the Ladoga region has resulted in a sharp increase of waste volume: 280, 000, 000 m3 of crude or not enough refined drains flowed the lake annually till 1990. The basic sources of pollution are pulp and paper mills, metal industries, sewage and agriculture. Anthropogenic factor renders an increasing influence to processes of lake sedimentation and environment. Therefore the estimation of input of polluting substances, the revelation of ways of transportation and location of zones of accumulation (intermediate and final) are rather urgent for the Ladoga.

The number of a dangerous from the point of view of their influence on ecosystem substances, both of natural and anthropogenic (phenol, heavy metals, radionuclides Cs-137 and pesticides)is revealed in the bottom sediments of the lake. Based on the comprehensive analysis of sedimentological characteristics, conditions of sedimentation and main features of lithodynamics are characterized. There are quite clear relationships between dynamic conditions at the lake bottom, on one hand, and physical and chemical peculiarities and pollution of the sediments, on the other. The contaminants are predominantly attached to loose fine and organic-rich sediments that are common for accumulation areas. At the same time, the conditions of sedimentation in the zones of transportation can vary frequently, and at times rather heavily for the most mobile geochemical substances, such as, for example, manganese, phosphorus and iron, which quickly react to changes of chemical "climate", caused by fluctuations in the redox potential.

The integrated sediments assessment approach allowed to define hot spot areas in Lake Ladoga. Contaminants are concentrated mainly in the deposits of the northern and the central parts of the lake. In the southern part of the basin, despite high antrophogenic loading, due to specific patterns of hydrodynamic mode a transportation of the most of contaminants northward to the main zones of accumulation takes place. This basis, in turn, will help to support making environmentally sound decisions, and to develop strategies for concentrating adverse affects and Lake Ladoga aquatic system management.

Arnasay Lake System; One example for Large Human Made Lakes of the Aral Sea Basin - Hydroecology, Biodiversity and Bioproductivity Studies

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Keywords: Aral Sea, Amudarya, Syrdarya, Hydroecology, Biodiversity

The large human made lakes in the basins of main rivers: Amudarya and Syrdarya became very important for biodiversity conservation and fishery after the Aral Sea almost disappeared from the territory of Uzbekistan. Recognizing this fact environmental protection agencies, fishery authorities and scientific community of the Central Asian countries have taken measures to protect these hydroecosystems from unsustainable exploitation. The largest and best-suited water body in Central Asia for this kind of activities is the Arnasay Lake System (ALS) in the middle reach of the Syrdarya River. It belongs to a new category of large lakes formed on peripheries of irrigated territories as a result to divert collector-drainage waters (CDW) into natural depressions without outflow (e.g. lakes Sarikamish, Dengizkul, Ayaskala, Shorkul, and others).

The natural depression now covered by the ALS was filled in 1969 with water during a devastating flood season. About 22 km^3 were diverted from the Syrdarya River during an emergency discharge. During 1970-1980s no water discharges into the lake system occurred but its area remained constant at about 175.000 ha because during this period the lake system received a substantial amount of water each year (2.5 km^3) through CDW waters from agriculture. However, the water mineralization increased manifold – from 1-2g/L to 6-18 g/L. Since 1991 emergency water discharges occurred frequently and today is the area of ALS about 500.000 ha. In general rose the water level from 239.37 to about 247 m S.L. which means more than 7 m. The water has depth amounting to maximum 27 m and is slightly saline between 1.5 – 8 g/l with an upper limit of 15 g/l at one place close to the desert.

ALS is highly preferable for fisheries and provides the local population with a variety of cheap fish products and local people with employment. In the 1980`s the fish catch amounted to 2000-4.500 tons each year, which decreased now to only about 1000 tons/y. Fish productivity is about 3 kg/ha, which is very low for such southern water body. But detailed studies of environmental conditions, biodiversity and bioproductivity had never been conducted thus far and no basis for a sustainable fishery planning exists up to now.

The Institute for Environmental Systems Research of Osnabrueck University, Osnabrueck, Germany, the laboratory of Hydrology and Environment, University of Pierre and Marie Curie, Paris, France and the Laboratory of Hydroecology of the Institute of Water Problems of Uzbekistan Academy of Sciences, Tashkent, Uzbekistan have cooperated within the INTAS ARAL 1039 Project since 2002. Since 2003 joined a fourth team from the Institute of Ecological Problems, Kazakhstan National University, Almaty, Kazakhstan the study group.

At the end of 2003 the partners decided to combine there scientific and research potential in order to accelerate and deepen studies on ALS. This unique Consortium was supported by the French Foreign Ministry via the "EcoNet" Program. The main research objectives within the cooperation were following:

1. Studying the biodiversity in the ALS, environmental demands and morpho-physiological state of commercial fish species populations;
2. Examining the environmental and ecotoxicological situation in the ALS - the sources and migratory ways of pollutants, pollution rate of various ecosystem components: water, soil, sediments, plants and fishes;
3. Investigating the amount, availability and diversity of food organisms and testing food enrichment strategies for the ecosystem;
4. Developing measures to intensify biodiversity conservation and fishery in the ALS with special attention to quality parameters of ecosystem compartments;
5. To enter obtained data into the data bank on hydrology, hydrochemistry and hydroecotoxicology for the ALS with further integration into GIS.

The contents of chlorinated hydrocarbons (hexachlorcyclohexanes (HCCH) -isomere, HCCH - isomere, HCC - isomere, DDT, DDD, DDE) and phosphocarbon (actellic, basudin, dursban, carbophos, metaphos, phosphamide, phenitrothion) have been determined in the water samples by gas liquid (GLC) and thin layer chromatography (TLC). The presence of organochlorinated and phosphocarbon pesticides in the samples of water was undetectable.

Fish species distribution in different parts of ALS was similar. Carp, roach, bream, goldfish, common asp, catfish or welses, sander and pike-perch are native species. Three alien species (Amur snakehead, Amur goby and western mosquitofish or topminnow) were found as well. All species had good characteristics of growth and condition in comparison with known facts about these species. There were no big differences in the coefficient of asymmetry between different species of fish. It varied from 0 to 0.31. This means, that the present environmental conditions are good enough for the development of investigated fishes. The external morphology, feed requirements and development of the majority of the specimens studied: carp (Cyprinus carpio), roach (Rutilus rutilus), goldfish (Carassius auratus), bream (Abramis brama) and pike-perch (Sander lucioperca) were normal. Rare occurrences of pathological changes in gill and liver of pike-perch and carp, and in liver of roach were observed.

All data collected, including biodiversity and bioproductivity of aquatic plants, phytoplankton, zooplankton and fish populations were analyzed, in comparison to earlier studies. All data were entered into the data bank on hydrology, hydrochemistry and hydroecotoxicology for further integration of the ALS data into our GIS collection.

The results can serve as a base for nature and biodiversity conservation measures and the development of an integrated ecosystem model to evaluate different management options for the enhancement of sustainable fishery and fish productivity as well as other human needs around the ALS and other large analogical hydro-ecosystems.

Lakes basin management in Venezuela: A case study from the Valencia and Maracaibo Lakes

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Keywords: basin management, development, Valencia Lake, Maracaibo Lake, Venezuela

The Valencia Lake is located in the central-north part of the country, which is the most densely populated. The lake surface is 350km2, 39m deep and its catchment area. 2,646 km2. Lake Valencia is the largest natural freshwater lake of Venezuela. It is located in the central-north part of the country, which is the most densely populated. Lake Valencia lies on an east-west tectonic depression between two ranges of mountains: Cordillera de la Costa on the north and the Serrania del Interior in the south.

The Maracaibo Lake, which is one of the biggest lakes in the world and the biggest one exposed the sea, has a surface area of 13.500 km2, and an approximate length of 160 km from North to South and 120 km from East to West. It is located in northwest Venezuelan state of Zulia.

The lake basin is one of the most important in the country in terms of cultural heritage, ecological diversity and economical conditions. The economy of the lake includes the location of the most important oil infrastructures of the country; one million barrels per day are extracted in the lakebed by means of hundreds of oil drilling platforms. Fishery is the second largest economical activity on the lake, and the main activity for most of the population living near the lake.

The lake has since 2004 been victim to the spread of the lenna spp, commonly called duckweed. The latest reports indicate that duckweed covers 2,025 km2 of the Maracaibo lake surface, which corresponds to 15% of the total surface. To combat the growth of the duckweeds the government has invested 300.000 US$, plus they established infrastructures of PDVSA and Municipalities, planning to invest 2,000,000 US$ more in the near future all coordinate by the Ministry of the Environment and the Natural Resources. Is necessary to take into account that it is impossible to remove every plant by mechanical means and that re-growth is inevitable.

Environmental problems stem from the heritage of old practices from the last century, in which only the extraction of the resources was considered, with little consideration for sustainability or environmental risk. In the case of the Valencia Lake the government had created in April 2005 a Unique Authority coordinate for the Ministry of the Environment and the Natural Resources, an had assigned 75million US$ for its rehabilitation.Incoming untreated wastewater from domestic, agricultural and industrial activities of about 2 million people contribute to eutrophication, contamination and salinization of the lake. The use of the lake as water source for domestic activities and for irrigation is restricted by the high salt content (electric conductivity ca. 2000 micro mhos cm- 1). Commercial fishing and recreation are also very limited by the precarious sanitary conditions of the water. Permanent algal blooms, high fish mortality, stench, etc. prevent the practice of aquatic sports and tourism

The new Venezuelan policy recognize that efforts to prevent pollution in the lakes basin is of interest for all the players and participants that interact in any way with the lake environment, including oil companies, farms, fishermen, nearby communities, and the central and local governments towards a joint effort amongst these groups for their mutual benefit, and for the sustainability of the lakes resources.

All the actors are participating together with the Unique Authority in the plans for its remediation and sustainable development. Rivers and ravines effluents into the lakes are known to have high amounts of pollution coming form fertilizer, pesticides, herbicides and organic materials from nearby farms.

In addition, some chemicals used in the oil industry to clean the tanks and deposits are sources of pollution, which in some cases are not controlled, causing these chemicals to go directly into the lakes.

Studies of concentration levels and sources are needed, which includes monitoring of nutrients, organic matter, heavy metal, inorganic and organic pollutions and sedimentation in the lakebed, rivers and ravine effluents.

This first step of information collection will then be coupled with GIS for the final processing of the data, which will assist in the forthcoming decisions concerning subsequent actions.

Sustainable Management of Development in the Lake Victoria Basin

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Keywords: effluent, habitat, environmental impact assessment, ecosystem, industry

Topic Presentation and Analysis of Issues: Lake Victoria is the largest fresh water Lake in Africa. This study is conceived to examine the impact of the Lake in the regional development of the area and examine the problems that have resulted from the regional developmental activities around the lake. This paper makes then makes recommendations on how to tackle those problems to ensure the sustainable use of Lake Victoria water.

Lake Victoria water is used for multipurposes including: transboundary communication and trade between the three East African Countries; Kenya, Uganda and Tanzania, that all share the lake. Large vessels travel on the lake transporting human, agricultural products and manufactured products form other areas delivered through the lake. The abundant water provides an ideal habitat for fish like the tilapia and other species. Many educational and research institutions have been set up in the Lake Victoria basin studying various aspects of lake development. The terrestrial ecosystems in the Lake Victoria basin rely on the influence of lake water moisture in to stabilize the climate of the region. Many industries have been set up in Lake Victoria basin including food processing and textiles. Lake Victoria provides employment to millions of people who would otherwise be idle. The Lake Victoria has greatly aided the economic productivity to of the region in multiple ways.

Discussion of Findings: Despite the vital and central role that Lake Victoria plays in the development of the entire basin, this study finds that the pollution of the lake has reached crisis proportions. The rapid growth of various cities around the lake has attracted the influx of a large population of people laying much strain on housing. With so many people living so close together have also led to a rise in the crime incidents in the area. The people who live in the lake Victoria basin regularly lack clean water and proper sanitation services. Industries empty untreated effluent directly into the lake and that is having serious effects on the fauna and flora of lake. The fish being caught in the lake have deformed bodies of distended belies which make them easy prey for predators. The rising human population around the lake leads to over-fishing and contamination of the lake thus ruining their own economic prospects.

Analysis of the fish revealed the presence of chemicals indicating that the contamination of the lake was having an impact on the fish in the water. Consequently, there has been a decline in the amount and the quality of fish being produced from Lake Victoria in the past five years.

This study found that most of the cities around Lake Victoria have poor sewage disposal. In Kisumu City, for instance, residents dump garbage into the drainage systems from where they are washed into the lake. As a result there has been a rise cases of typhoid in the region. The high population has heightened the problem of employment in the area. As a result, a high number of people have also turned to prostitution and Kisumu in Kenya; Mwanza in Tanzania are among the cities with the highest number of AIDS cases in East Africa. The presence of a large lake in this region in turn provides an ample breeding ground for mosquitoes and so malaria is a constant problem in the lake region. A lot of lives are lost each year in the Lake Victoria Basin due to malaria.

Lake Victoria is a centre of activity and this has led to the spread of water hyacinth, which has clogged the lake and further decimated the fish populations. The water hyacinth has also led to a rise in the number of snakes and interfered with the aquatic food chain and in the lake. The water hyacinth has further made water travel difficult for canoes and boats, threatening the livelihoods of fishermen. Lake Victoria plays a vital role in the provision food and contributes towards elimination of poverty in the region. But as demands for adequate quality resources escalate, there is need to devise new approaches that that set realistic goals to mitigate problems arising from the developmental activities. Regular evaluation of the utilization of the lake water will ensure that the developmental activities do not jeopardize the ability of the lake to sustain the fauna and flora in the lake and its entire basin in the future.

Policy & Future Research Recommendations:

1. Reorient Lake Victoria water resource management and planning towards sustainable development.
2. Partnership between local authorities and communities to ensure sustainable management of the resources.
3. Eliminate the use of lead fuels in vehicles and industries whose air pollution causes mental retardation in children.
4. Promote dialogue, better governance and political stability for sustainable development in the region.
5. Ensure that water engineers install the drainage facilities required to provide clean piped water.
6. Regulate the amount of fish that is removed from the lake.
7. Industries should be required to treat all effluent before being released into the lake.
8. Stop any dumping of garbage into the drainage systems including the lake.
9. Build better road network to enable easy movement of service vehicles for fighting fire, ambulances and police services when needed by the rising population.
10. Build hospitals equipped with good outreach programs and the right medicine for treating malaria, typhoid and AIDS.
11. Carry out extensive Environmental Impact Assessments before setting up any new industries in the lake region. Carry out regular research to ensure that various demands do no rise beyond the capacity of the lake to sustain the population of humans, wild fauna and flora that depend on the lake Victoria water.

Lake Victoria

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Keywords: Lake Victoria, riparian states, policies, livelihoods, economic profiles.

Presentation of topic and analysis of issues:
Lake Victoria is 2nd largest fresh water lake in the world. The three East African countries Kenya, Uganda and Tanzania surround it. Due to its vast fish resource human pressures from the riparian states and their respective livelihood activities mount threat on sustainability of the lake water resource and its ecosystem. The threat is due to changes in water quality, quantity and subsequent ecosystems. Lake composition has continued to be influenced by such livelihood activities as farming both at the lakeside and also from the surrounding watersheds with negative effects on the silt loaded at river mouths. Some of the negative impacts the lake get could be emanating from upper catchments where communities least associate with the lake, but nonetheless their farming or economic activities directly affect the lake water composition. The lake water as a resource has fueled mushrooming of processing and production factories within the bordering townships, some of which lack sewerage systems and release raw sewage directly into rivers that feed the lake, thus affecting the aquatic life in the water and surrounding wetland resources negatively. The negative impacts are experienced in low fish catches and also in extinction of some popular fish species that used to inhabit the lake.

The quality of the lake water is directly a product of the livelihood activities of the lake communities from the riparian states. This proposes to discuss lake Victoria as a huge natural in the Eastern African countries whose potential has hot been optimized due to inadequate applications of protocols, mandates and policies that remain in document form and not translated to affective implementation to enhance the harnessing of the lake potential by stakeholders. The paper proposes that while policy framework is state committal to addressing issues of responsible utility of the lake resource, the riparian states all have information gaps that respective nations should address at national levels before they handle them with regional policies for sustainable development. Issues of ownership and demarcation dominate the inter-state debates in areas of fish and water resources and often result into trans boarder conflicts.

Many international communities and development partners including Sida Sweden have taken keen interest in lake Victoria from international community perspective; their humanitarian pooling of resources could be enhanced by the reviewing policies, protocols and mandates that the riparian states have put in place as compared with back up in country efforts to make the management of the lake sustainable.

Comparative discussion between policy and practice in sustainable utilization of lake Victoria as a common resource should involve capacity building of the directly affected Lake communities to make them own the Lake as their key developmental resource so that they will be part of drafting strategies of resolving those threats that are facing the Lake.

The integrated transboarder measures will only prove effective when they are backed with clear time-framed mitigation and management activities that are evaluated and monitored to ensure measures that are supported on good will and good intent from the international communities help in changing the bottom line poverty levels for the lake dependent communities and cause no donor fatigue on the part of the international communities. Such activities while they require policy blessing are best planned from the perspectives' of the actual fishers, farmers and traders whose direct activities affect the Lake water composition. As things stand, one might be tempted to say that riparian states use the lake in hope that it is an everlasting resource that does not need care to support their sustainable development. The goodwill shown so far is very energizing but capacity building to bridge the information gap among those who should act would go along way in influencing behavior change of the riparian communities to make them draw environmentally friendly strategies that are workable and sustainable in their respective state. Recommendations for respective nations and for regional collaboration will be made on the visually most cost effective measures of using the resource for cost effective and sustainable development of all the riparian countries and their developmental partners from the international communities in a win-win situation.

Large Lakes as Drivers for Regional Development: A Case Example of Lake Chad Basin of Nigeria

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Keywords: basin resources, fish/crop farming, floodplain/wetlands, socioeconomic development, population density

The Lake Chad Basin of Nigeria is found in the northern part of the Country, covering an area extent of 179,300km2. It is located in the transaction zone between the Sahara Desert and Savannah grassland. The area has an average annual rainfall of 150mm. the Lake Chad Basin is characterized by three aquifers whose formation is attributed to the dynamic nature of the Lake. The major rivers of the lake Chad Basin in Nigeria include River Hadejia, Jamare, Yedseram, Ngadda etc.. Water supplies for domestic, agricultural and industrial needs are mainly by impoundment of these rivers. The urban area of Kano, Kaduna, Gashua etc. obtain their water supply for socioeconomic development through this means. The water lands (Fadamas) in the area experience shallow flooding at peak inflow during the rains. The floodplains and the wetlands provide a wide range of resources necessary for socioeconomic development. There resources include fertile agricultural soils, fisheries, grazing, fuelwood, non timber forest product (hunting).

The major population density in the basin is mostly concentrated in the urban areas of Kano, Madugri, Kaduna, Katsina etc. this population depends on the resources of the basin for sustainable livelihood and general development. The wetlands and floodplains are of international significance. They have been extensively cultivated and harvested by hand. Irrigation agriculture is also practiced to generate foreign exchange. The resources of the Basin have created employment and income for the inhabitants. Over exploitation of land and water resources of the basin in pursuit of means of livelihood and general development exacerbates ecosystem degradation. Rapid desert encroachment, drought, erosion, are in progress. Water scarcity, poor hygiene and sanitation occur. Southward migration of people in search of fundamentals of survival is common. This has resulted in dislocation and ethic conflict that are often fatal. Over grazing and bush burning results to destruction of fertile farmlands, this retards agricultural yield. The dense population peculiar in the southern part of the Basin especially in the urban cities has facilitated major socioeconomic development in terms of road network, infrastructure, water scheme projects, power supply, schools and hospitals. Fish farming, animal husbandry, crop farming serve as the major source of income and nutrition to the rural and urban areas of the basin such as Kano, Madugri, Sokoto, Gasgua, Kaduna .The most common grown crops include rice, cotton, groundnut, millet, onion, cassava, garden egg etc. cotton is the most important cash crop. Flood recession cropping system is common place and the rural dwellers totally depend on the basin for sustainable livelihood. Agricultural practice on the fertile floodplain of the Basin provides food supply to different parts of the country especially during the dry season. Local food crops grown in the area are transported to the commercial cities of Onitsha, Aba, Lagos, Abuja. Mineral of economic deposit such as kaolin, gravel, diamond, gold, petroleum abound in lake Chad Basin of Nigeria though poorly utilized. These mineral deposits where exploited in the neighboring countries serve as major source of forign exchange.

There is need for a holistic approach of the exploitation and management of the mineral resources of the Lake Chad Basin in Nigeria. Expertise advice and monitoring in the management of the resocurces of the Basin is essental. Planting of trees and construction of a artifical wind breakers is important to contain desert encroachment. There is need for water scheme project for portable water supply, improve hygiene, sanitation and general health condition especially in the rural areas of Lake Chad Basin of Nigeria and also promote agriculture. Mechanized farming should be practiced for optimum cultivation of the floodplaina and wetlands to increase crop production and generate income. Government incentives is recommended for the purchase of modern fish gears to increase fish catch, provide nutrition generate income and for sustainable development in the Lake Chain Basin of Nigeria and environs.

Workshop 9:

Safe Water Storage and Regulation during Floods and Droughts

Focusing on the Ethiopian Water Towers

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Keywords: Ethiopia, highland, reservoirs, irrigation, hydropower

Ethiopia is a country of great geographical diversity. Altitude ranges from 110 mbsl (meters below sea level) to 4620 masl (meters above sea level) while mean annual temperatures range from about 0oC in the highlands to about 40oC in the lowlands. About 43% of the country is classified as highland (above 1500 masl). About 85% of the people are living in these highland areas where mixed agriculture is the main practice. The larger proportion of the country (about 57%) is lowland occupied by about 15% of the population and pastoralism is the main activity of the people.

The rainfall of the country is associated with high spatial and temporal variability. The mean annual rainfall in the southwestern highlands is over 2500 mm while it is less than 100 mm in the eastern lowlands. About 90% of the annual runoff goes to the rivers that flow into neighbouring countries and that is why Ethiopia is known as the "water tower" of North-eastern Africa. On the aggregate the surface water potential amounts to over 110 billion m3/yr. Most of the river flows occur during short rainy seasons. Average flow that is equaled or exceeded for 99% of the time is about 5% of the mean flow. Similarly, natural flow that is equaled or exceeded for 50% of the time is about 15% of the mean flow. It is evident that if it is desired to use make use of the river to a significant level storage facilities must be provided.

Rain-fed agriculture is currently practiced on about 99% of the cultivated land. Most potential rainfed agriculture cropland is already under cultivation. At present, only less than 5% of the 3.5 million hectares irrigation potential has been developed. Similarly, less than 2% of its hydropower potential of 160 thousand GWh/yr has been utilized. Electricity and petroleum covers 5% the total energy supply and the percentage of the population with access to electricity is low, currently less than 6%. About 95% the energy supply comes from fuel wood, dung and crop residues. The wood consumption levels exceed annual forestry yields. The use of agricultural residues and dung as fuel instead of fertilizer leads to diminishing soil fertility, and in turn, lower agricultural productivity and food security problems. In general, intensified degradation of forests and soils is becoming a major concern that requires a special focus of creating large-reservoirs in the highlands (water towers) that could intensify hydro-electric production as an alternative energy source at affordable low cost and irrigated agriculture in order to make use of moisture-deficit lands for crop production.

In the highlands, there are many natural sites convenient to create large reservoirs by building small to medium height dams with relatively low costs. The most important advantage of these reservoirs is their relatively low cost per unit volume of utilizable water for irrigation, hydropower and other purposes Once the storage facility is created somewhere at upstream highland, the water can be used at different downstream sites.

At present, the largest reservoirs existing in Ethiopia are Qoqa, Finchaa, Melka-Wakena and Gilgel Ghibe created by dam heights of 42, 25, 23 and 40 m respectively, providing a total of about 4.4 billion m3 storage. Qoqa reservoir alone made it possible to develop 70 thousand ha. The hydropower stations provide a total of 2050 GWh/yr of firm energy. In general, these reservoirs supply water for more than 90% of the existing hydropower and modern irrigation developments.

Different studies carried out in the past have shown that there are many suitable reservoir sites having very high storage to embankment fill ratio varying between 300 and 2000. Among these, implementation of raising Lake Tana, Baro network and Halele multi-purpose reservoirs deserve special attention. Rasing Lake Tana by 3 meters can create a live storage of 9.1 billion m3 that equals approximately 2.4 times the average annual out flow of the lake. The proposed Baro multi-purpose network of reservoirs consists of four reservoirs Baro, Gumero, Geba and Birbir with storage capacities of 746, 340, 1300 and 950 million m3 (a total of 3.3 billion m3). The proposed Halele dam is 79 m high and the storage capacity of the reservoir is 4.0 billion m3.

The proposed reservoirs (with a total storage of 16.4 billion m3) can provide irrigation water supply for about 1.0 million hectares. Most of these lands are located at elevation elevations ranging between 300 and 610 masl where moisture deficit is severe. This implies that the proposed reservoirs will enable to create irrigated farms to the extent of more than 10 times the size of the existing modern irrigated farms. In other words, the existence of these reservoirs will bring additional size of farmland equivalent to 3 to 5 million ha of rainfed farm in the highland area. Similarly, these reservoirs will enable the generation of a total of about 10 thousand GWh/yr of firm energy with an installed capacity of about 2500 MW, implying that the energy producing capacity of proposed reservoirs is about 5 times the existing capacity of generation.

In conclusion, if Ethiopia makes building large reservoirs in the highland areas (water towers) a political and financial priority, it would avert the current food and energy crisis and then meet the growing demand for food and energy. This approach will have a significant contribution to alleviate poverty and sustain economic growth. Irrigated agriculture can provide employment to millions of poor farmers where other opportunities for work are lacking.

Designing Disaster

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Keywords: interference, design, uncontrolled flooding, recommendations

Discussion:
Worldwide flooding and droughts have raised many eyebrows – is this just nature or are we provoking it? The idea of global warming and melting ice-caps is one topic, but what about us "designing disaster"?

The Sandspruit, was a pretty little drainage line in the 1950's – providing a landscape feature to the farms on its banks. However, today the Sandspruit can be a raging torrent in a man-made canyon, and it is becoming violent.

This once placid spruit with its natural tributaries is now considered an unsealed storm water channel and the water quality reflects that. Society has turned its back, quite literally, on the spruit and engineered it away.
Engineering through concrete channels, gabions and reclaimed land have claimed human life. The engineering does not stop at storm water features. Water about society's perceptions? Sitting comfortably in her 4x4 all terrain vehicle, a woman was swept to her death by the Sandspruit. A year later, and a second woman narrowly escaped the same fate.

The water quality has degraded, the sense of place has degraded, and lush riverine vegetation has been replaced with flood debris and litter. The spruit is an eye-sore. But this is not the only example. This phenomenon is occurring locally, regionally, nationally and internationally.

Together with the Gauteng Department of Agriculture, Conservation and Environment and the University of the Witwatersrand, we are conducting research into the effects of urbanization on the river health and the river environment. Urbanization is affecting the flooding patterns of rivers, but how is this flooding affecting the environment – especially downstream. How is urbanization affecting the microclimate of our cities, how does this contribute to global warming and drought patterns? The research aims to seek site specific recommendations to mitigate these impacts, such as on-site retention ponds to reduce combined storm water flow, using these retention ponds to process or clean the water before it is fed back into the river catchment.

The research will look at two case studies within the Gauteng region of South Africa, monitoring water flows and water quality, as well as other biological indicators, such as changes in fish species and habitats and vegetation. Recommendations will look at individual development sites along the river banks and what are successful mitigatory measures. The research is proposed to continue over the next 3 years, and will take international precedence and cases into consideration.

Improved water security by protecting natural water bodies and waterways in the Indus Basin

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Keywords: water resources depletion, natural water bodies, minimum river flows, groundwater recharge, conservation approaches

The spatio-temporal analysis of the historical data shows that the formal and informal water reservoirs are depleting in the Indus basin. Three main surface dams are silting up. Natural resources are depleting in the fresh water zone in terms of groundwater mining and a loss of flood based valley and wetlands storages. In the saline area, access to the fresh water is threatened because of reduction in flood based ecosystems (lakes, river creeks and delta) and rise of groundwater table. The high quantities of river water is used in the saline high water table areas for leaching and root zone protection, further augmenting the saline effluent and hurting agriculture protection, as the surface drainage systems built over the years have been proved largely ineffective.

About 75% of the 178 bcm average rivers inflows into the Basin occur during 5 high rainfall summer months. More than 70% of the total river flows are diverted through canals. Out of existing flood flows of 42 billion cubic meters available at the tail end of the Indus rivers, about 25% are recommended as essential average downstream flows, 10% are estimated for the environmental and minimum flow diversions to the dry river reaches upstream and additional 5% for maintenance of the barrage ponds and lakes, traditionally replenished from the flood flows but quickly loosing water access. The aquatic and terrestrial water allocations for environment can directly protect ecology, aquatic life and hydrological functioning of the water bodies and waterways.

The groundwater depletion is high and irreversible in the areas where recharge from the natural processes has reduced while high demand is met by higher aquifer pumpage. The zonal water balances over a long period indicate reversible character of the aquifer in some areas. The existing gross aquifer mining of about 6 bcm can be saved through two types of measures. The replenishment of lakes, wetlands and dry river reaches has a seasonal potential of 12 bcm storage. The infiltration from these flows is in the range of 30% and can be further increased in the selected sub-basin because of depleting groundwater and high recycling potential. The areas facing aquifer depletion can be provided with special flood supplies. The new development schemes in these areas needs to maintain positive recharge-discharge balance.

The water logging and drainage limitations of the saline aquifer are the key constraints for protection of the resource base and the low water and land productivity. A very important process is deteriorating water quality of the fresh water systems in the saline zone, caused by the discharge of bad quality effluent into these systems and their reduced access to the fresh recharge. Because of high upstream uses and climate change, probability of medium and high floods are decreasing in all rivers of Pakistan, hence these systems need more defined water allocations. A permanent high water table also constrained natural leaching/flushing of the catchment areas. To check the high quantities of drainage effluents, effective water conservation is essential in the irrigation network including the secondary and tertiary levels.

Analysis shows about 20% of water savings are possible in saline zone, which is in the range of water required for the natural ecosystems. The crop-based irrigation, which has been experimented in the moderate climate and high water supply zones of the basin, has higher potential in the saline lower Indus

There is a scope of rainfall harvesting by maintaining traditional water bodies in the high rainfall zone as well as by the conjunctive water management, i.e increased groundwater use in high rainfall areas and improved supply of surface waters in the low rainfall areas. About 2 bcm water can be activated through this process.

The paper concludes that:

- Using natural resilience of the Indus Rivers system, natural water bodies, lakes and groundwater aquifer can be protected from existing depletion and their role in the management of draught conditions can be enhanced. The flood flows occurring during three to four months can be rerouted across the system with minimum extra burden on the existing system and nominal competition with existing allocations.

- Environmental and minimum rivers flow allocations are directly beneficial for a sustainable natural storage and groundwater recharge in addition to protection of the ecology, drinking water and local small livelihood opportunities. The minimum river flows are essential in some sections of the rivers for the protection of the river courses. The existing drying up of the rivers can be detrimental in case of floods, which have been totally ignored because of a long dry span.

- Groundwater aquifer in the fresh zone can be protected by improved regional water balance through rain harvesting, changes in water allocation towards a better water balance and measures to increase the recharge. This approach will check the existing water conservation approaches. The protection of fresh water lakes and minimizing drainage effluent are essential measures in the saline zone. The approach demands new elements in the system, like water allocation to the lakes, extended remodeling of the secondary and tertiary canals and crop-based irrigation supplies.

- The implementation of appropriate measures need detail local analysis of the sustainability threats and technical options while regulatory actions need to be validated at the basin level. An integration of basin level approach with comprehensive local solution of the water security issues can lead to the selection of good options and long term planning.

Squeezed dry: Implications of Drought and Water Regulation in the Krishna basin, India

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The Krishna River Basin covers 258,000 km^2 incorporating three large states —Karnataka, Maharashtra, and Andhra Pradesh—with a combined basin population of 67 million. The basin of strategic importance in Peninsular India for urban and agricultural water supply and hydropower production. It is also one of the most important rice, cotton, milk and sugarcane producing regions in the country. Between the 1950s and the 1990s, the Green Revolution saw a dramatic expansion of irrigation, which increased food production. Now, of the water available in an average year (78.12 billion cubic meters), 80% is now captured as live storage in reservoirs on the Krishna river and its tributaries. In addition, a significant volume of water is stored in numerous uncounted small reservoirs. The development of irrigation projects and rainwater harvesting schemes has dramatically decreased outflow to the ocean from 28% of rainfall in the first 60 years of the 20th century to a mere 7% over remaining 40. Continued rapid surface and groundwater development throughout the basin has significantly reduced flows reaching the ocean, effectively "closing" the basin. Despite the ruling of the 1969 Krishna Water Disputes Tribunal 'awarding' (allocating) water to the three states Karnataka, Maharashtra, and Andhra Pradesh, water allocation remains complicated due to increasing water demands in the three states for irrigation, urban and industrial uses.

The Krishna basin has a very variable rainfall pattern that decreases with distance inland from both coasts, most dramatically east of the Western Ghats, where precipitation decreases from more than 3000 mm to less than 300 mm over a distance of 80 km. The largest water transfers take place from the Upper to Lower Krishna, so release patterns from Upper Krishna have a significant impact on the lower Krishna, exacerbating or alleviating drought. For instance, in the period 1950-2005, the basin was struck by three severe droughts, notably in the 1971-72, 1984-87 and 2001-2004. The pattern of unfilled reservoirs within the basin changed over the passage of time. During early drought events, almost all reservoirs were impacted by drought irrespective of their location. The recent drought has impacted system storage and resulted in unfilled reservoirs in lower basins, while demands for Krishna river water supplies have continued to increase. The most affected were lower basin reservoirs, Ujjani and Nagarjuna Sagar with no live storage in 2003. Concurrent to the prolonged drought during 2000's and regulation, water use patterns have changed dramatically, with new demands from growing urban and domestic sectors along with higher demands from agriculture. In the case of the Nagarjuna Sagar reservoir, available supplies have been insufficient to meet the agricultural and hydropower demands for which it was designed, and further pressure has been added by the need to satisfy higher value and higher priority (urban water) demands. During water stress periods, canal supplies dropped drastically to 21% of normal supply, and the cropped area decreased by half. The delayed filling of, and reduced water supply to, reservoirs in the lower Krishna has resulted in land use changing from double paddy cropping to single cropping or even following. The near total collapse of inflows to the Krishna Delta also has implications for environmental stability, and salt water intrusion into aquifers already affects part of the Krishna Delta and will probably worsen as outflows decrease.

The drought-induced reduction in available reliable water supplies, combined with a fundamental shift in the demands and priorities within the basin, present major challenges for equitable and rational allocation of water while maintaining the status quo in agricultural water availability. This paper considers the implications of drought in the Krishna basin on operational rules for multipurpose reservoirs. The option of redistributing water from surplus to drought years is considered, and hence the introduction of water management and supporting measures to improve water productivity.

Water between Climatic Changes and Agricultural Requirements - Romanian Case –

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Keywords: rainfall, flood, drought, evapotranspiration, irrigation

Romania is a medium-size country (23.84·106 hectares), located in the south-eastern part of Europe. Its relief is varied, consisting of flood plains, plains, piedmonts, hills, and mountains. The maps of major land forms, regional slopes, and hypsometry point out that the hilly and mountainous lands respectively sloping and steep lands with local relief intensity higher than 200 m. occupy 51.9%, while the level of the waved lands (≤ 8% slopes) represents 48.1%.

Regarding the precipitation regime, Romania is characterized by 3 humidity zones: (i) the humid zone, with annual rainfalls of 600-1000 mm and annual potential evapotranspiration (ETP) of 550-700 mm; (ii) the sub-humid zone, with annual rainfalls of 450-700 mm and annual ETP of 650-750 mm; (iii) the semi-arid zone, with annual rainfalls of 350-550 mm and annual ETP of 700-800 mm, covering the fields from the South, South-East and South-West of the country.

The water resources corresponding to the internal hydrographic network are modest – 37 billion m3/year on average, Romania being situated on the 21st place in Europe considering the water quantity per inhabitant. These resources are showing a deficit during summer, especially in the field zones. The Danube is an important water resource, with an annual average flow of about 170 billion m3 which, added to the interior water sources, ensures annually about 9,800 m3/inhabitant.

Agriculture in Romania remains a significant sector of the national economy in term of area contribution to the GDP and in particular share in the total employment. Romania's total agricultural area is 14.8 million hectare (or 63% of total area), out of which 9.4 million ha are arable land. Agriculture is also an important water user, with a general consumption of about 35% from the total water requirements.

A large variation of climatic conditions (rainfall, temperature) from year to year has a negative effect on yield level and its stability. In order to ensure constant high agricultural productions, during the period 1970-1990 irrigation arrangements were built on about 3.1 million ha, drainage works on 3.2 million ha, soil erosion control on 2.3 million ha and protection against floods for about 0.6 million ha. However, on about 12 million ha of agricultural fields, of which 7.5 million ha arable land (about 80% of the total arable surface), the production capacity of soils is affected by one or more restrictions.

As it was mentioned, Romania is characterized by a temperate - continental climate with excessive phenomena. I have to remark at the beginning, that during the latest periods of time, there were more excessive phenomena that left their prints upon our country's own climate. I advance this idea coming from the entirely special meteorological events which took place, characterized especially during the last decade by numerous draughts years with negative implications upon agricultural crops productions and also excessive rainy years as it happened in 2005. The damage produced during this year have had repercussions especially upon agriculture and people's dwellings, too (thousands of houses destroyed including their outbuildings), mainly in the rural areas as a consequence of floods and landslides produced by rainfalls much larger than multiannual average. Important damage produced also in the infrastructure: roads, highways, bridges, networks of pipes for water supply, etc. It is also necessary to mention the pollution of village wells depriving the population from numerous places of the necessary drinkable water.

Considering the consequences, this year could be considered alike the excessive draughty years, for example 2003, when 2.4 millions tons of cereals were produced, the smallest cereals crop in the history of our country. During the respective year, characterized as "year of climatic extremes", the other crops were also poor. An interesting fact is that the following year, namely 2004, as a result of rainfalls in time, in reasonable quantities, 7.77 millions tones of wheat were produced. The medium production per hectar for this crop, at the level of the country, was 3.870 kg/ha, the largest wheat crop in the history of Romania.

In the scientific papers, three categories of groups of years were identified: (i) excedentary groups, when rainy, very rainy or excessive rainy months are predominant; (ii) poor groups, when draughty or very draughty months are predominant and finally (iii) quite normal groups, when the months which turn off from the normal regime in a sense or another (considering rainfalls) do not exceed 20%. The paper mentions the fact that, after the carried out research, it was found out that the duration of the excess periods generally, is not longer than 3 years while the draughty periods may prolong up to 5-6 years. At the same time, the groups mentioned (even unequal in time) are not accidentally distributed in the evolution of weather; as a rule, the groups of contrary sense are neighbors and after excess periods follows a group of deficitary months and not normal periods. As example, the draughty year - 1861 was preceded by a very rainy year - 1860, and the draught in 1865 was preceded by very heavy rainfalls in 1864, as it happened with the draught in 1898 which was preceded by the rains in 1897.

In connection with the things mentioned above, it is consider metaphorically speaking that "draught is born from rain". It is also mentioned that during most years when important damage in agriculture took place, for example 1904 and 1946, the deficit in precipitation began in the preceding autumn, continuing during the whole cold season, spring and the following year. At the same time, considering the large groups of years, we can notice that the period 1945 - 1953 was the longest draught period ranged between two periods with normal precipitation or in excess.

Romania has soils with high potential of fertility, but I have to make the difference between the potential of fertility and fertility in itself. This happens when we make reference to a fertile soil it means that the respective soil has all production factors that offer this qualification, including the necessary water for plants.

When we analyze the things mentioned above, in the climatic conditions characteristic to our country, we have to interfere energically on this factor, which is extremely important and also conditions the evolution of the other ones, especially by modernizing and extending land reclamation works. Their primordial part is in fact the adjustment of soil humidity regime, for best corresponding to the requirements of the cultivated plants, creating in this way the possibility to implement a sustainable agriculture in the frame of environmental protection.

I insist on the fact that the action should be developed considering the 3 components expressing the main natural disasters: a) floods, namely water excess; b) draught and c) soil erosion, taking into account all hydrographic reservoirs / basins, both of permanent water course and temporary ones. The analysis based on observations, studies and sustainable research should consider each separate basin, but evaluating the possible connection also.

Consequently, for example, the performing of some defending works against floods by damming-ups, corrections of water beds, water accumulations (dam buildings) should also consider the eventual works for draught combat by irrigation, as well as the soils preservation from the respective slopes. In this context, for the existing irrigation arrangements in Romania, we can also consider the change of water source by passing from water supply from the Danube, which needs water pumping at a high level, to the utilization of some inside rivers where this thing is possible.

Climatic modifications that appeared especially in the latest periods of time and are characterized by the amplification of the frequency of excessive phenomena, magnify the necessity to pass to some firm actions whose delay can direct in many situations to some undesirable and unrecoverable consequences.

Operation of three Dams to protect Khartoum City from flood

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Keywords: Khartoum, Nile, Flood, Dams, Operation

Khartoum city, sometimes called the triangle capital city of Sudan, is located at confluence of the Blue and White Niles. It is composed of three cities: Khartoum, which lies between the Blue and White Niles, Omdorman between the White and the Main Niles, and Bahari between the Blue and Main Niles. Also there is a city in an island called Tuti, at the Blue Nile immediately upstream of the confluence of the two rivers (Map). Like other urban cities in the world, Khartoum population is growing rapidly.

In 1956 its population hardly exceeded two hundreds thousands. Now in 2006 it is above six millions. This rapid increase in population has its implications on the water supply, physical planning, land use and flood protection .

The primary focus of this paper is on the flood protection of Khartoum. However other location implications will also be highlighted. The two rivers present the only water source to the city and its peri-areas, directly through pumping from the rivers and/or indirectly by recharging the ground water. The Blue Nile is marked by its marked seasonal flow. Its average flow during the flood period (June-September) is about 50 times the low flow during the rest of the year .

The discharge of While Nile does not follow the same seasonal patterns as the Blue Nile. Khartoum city by its location on the confluence of these two rivers is strongly influenced by their temporal flow pattern, particularly during the flood period. Also the Blue Nile is a source of siltation and causes erosion which affect various activities in and around Khartoum. These activities include river navigation, loss of valuable land due to bank erosion, inconvenience of operation of pumping stations (for drinking water or irrigation) by siltation in some areas and erosion in others.

During the flood season and due to the high Blue Nile flow rates, the Blue Nile waters at its confluence with the White Nile behave as a natural dam that completely blocks the water flow from the White Nile. Not only this, but the Blue Nile water during this period flows back on the White Nile course .

This has its impact on creating backwater flow which causes serious damages to land and house properties adjacent to the river bank. There are three dams, two on the Blue Nile and, one on the White Nile. One of the dams on the Blue Nile is at Roseries, 500 km south of Khartoum, with a storage capacity of 2.2 km^3. The dam is at Sennar, 300 km south of Khartoum with a storage capacity of 0.4 km^3. The dam on the White Nile (Jebel Awlia Dam) is 40 km south of Khartoum and has a storage capacity of 3 km^3.

The operation of the Dam on the White Nile (Jebel Awlia Dam) takes into consideration also the effect of the flood on cities North of Khartoum. Sometimes a trade off is needed between the effect on Khartoum and effect on cities in River Nile and on the White Nile pump Schemes. The irrigation of these pump Schemes depends on the water level in the White Nile which in turn depends on the operation of Jebel Awlia Dam .

Roseries and Sennar Dams suffer from siltation. The Blue Nile, coming from the highlands of Ethiopia, is loaded with siltation during the flood season. The storage capacity of Roseries is now about 60% of its original capacity while Sennar Dam capacity is now less than half the design capacity.

In contrast, Jebel Awlia Dam kept its design capacity as the White Nile is almost free from silt. It originates from the great lakes and passes through forests and marches, so it water is clear.

The operation of these dams should be coordinated to minimize the damage to the cities various activities. This was done during last years flood. This paper evaluates the coordinated operation of the three dams to protect Khartoum during the flood season.

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Qanat as an Optimum System of Water Usage in a Rapid Urban & Rural Development in Shiraz, Iran

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Keywords: Qanat, Shiraz, EIA, Qanat simulation, Safe storage

Qanat is an ancient mode of irrigation in Iran that can be affiliated to the Achaemenian period and it's an eternal friendly system for harvesting groundwater. It is a safe means of water storage and use during major droughts.

The use of Qanat systems for agricultural and municipality for city of Shiraz dates back many decades. Due to an increase in population and city development and use of pumping systems, many existing Qanat systems, especially in the central part of city have been destroyed in last thirty years.

Fortunately, some of Qanats in North and North East of city still are active and the water will be used for agriculture and vegetation purposes. One of the major Qanats that originate from high lands of Shiraz is called koshkebibiche that drain North East of Shiraz and will irrigate the famous gardens in Shiraz.

In this paper, a general survey of location of Qanat systems and its drainage basin was carried out, and then the characteristics of these Qanats such as flow discharge, water quality, structural properties, geology, water supplying resources and environmental attributes were investigated. The Safe Water Storage and Regulation during Droughts is a major benefit of this system.

The major quantitative and qualitative water parameters were measured in each Qanat system in at least two places of mother wells and outlets during low and high flows. The results show that almost all of these Qanats infected by microbial pollutants, but other physical and chemical parameters show that by eliminating pollution sources, we can use the water of Qanats not only for irrigation, but also for drinking purposes.

"CTRAN/W & SEEP/W" software was used to simulate the quality and hydraulic of Qanat conditions during flood and drought. After analyzing the models, we find that:

1) The convergent flow happened toward the section of Qanat.
2) Maximum velocities occur surrounding the section of Qanat & especially in ½ of height of gallery.
3) The particle tracking shows that depending upon location of lagoon; pollutants move toward Qanat via a flume from whole or a part of lagoon bottom.
4) Existing pollution sources in Qanat boundaries will contaminate Qanat after a specified time. The first polluted particle with 1 gr/m3 concentration will reach Qanat after 5 hours, if the distance between pollution source and gallery is 23 meters.

5) qanat systems are a safe means of providing water during droughts.

Finally, we assess the environmental evaluation of the development effects on the qualitative and quantitative conditions of Qanat (EIA). This assessment has been done by matrix method. By using this method, we evaluate the effects of developmental efforts on the environmental attributes. The result shows that the general development in the boundaries of Qanat has no detrimental effects if the rights of Qanat systems will be preserved. Otherwise, Qanat environment will be affected seriously during floods. By demonstrated procedures in this paper, it is possible to omit or reduce the existing problems.

The overall results of EIA show that 3% of developmental effects are positive, 20% are negative, 77% are ineffective, 40% are permanent, and 60 % are direct effects. As can be seen from results of EIA matrix, 11% of developmental effects has positive grade and 89% has negative grade.

In fact, the negative effects overweigh the positive effects which mean if the urban and rural developments take place within the boundary of qanat system without sustainable consideration, the life and well being of Qanat system will be in major jeopardy. The qanat system is the most sustainable means of water harvesting that has survived a few thousand years as a means of water storage for safe use during major droughts. The results of EIA shows that 77% of effects are ineffective, i.e., Qanat are by far the most appropriate technology for groundwater harvesting. The important effects are direct and temporary. Here are the main conclusions of this paper.

1) qualitative and quantitative parameters show that water has suitable quality for drinking purposes and it provide safe water storage during drought.
2) The public participatory nature of qanat systems during last few thousands years shows its sustainability during extreme events.
3) For compatibility between Qanat nature and developmental projects, we should perform EIA in primary phases per each project.
4) If we observe the Qanat rights and boundaries, we can hope that multilateral developments have no detrimental effects on Qanats.
5) For life time continuation of Qanats; Repair and dredging should be part of routine operation.
6) To control loss of water in dry section of Qanat, Qanat-beds can be sealed with clay or concrete hoop (kaval) to avoid water loss.
7) To prevent entering pollutants to Qanat system, the major remedy is to identify and control it.
8) To prevent entering pollutants to Qanat system, the major remedy is to identify and control it.
9) One major sources of Qanat pollution is through contaminated agricultural runoff with pesticides, herbicides, and fertilizers. The suggested remedy is to install the suitable caps for vertical shafts of Qanat where the grounds are under agriculture, gardening and pasture activities.
10) Protecting qanat systems with integrating modern appropriate technology through public participation is a means of harmony and peace in many developing countries in future with water scarcity, especially during droughts.

Evaluation of Reservoirs as a flood mitigation measure in River Nyando basin, Western Kenya

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Keywords: Floods, Reservoirs, Nyando basin, SWAT, Scenario modelling

Floods, which precede usually droughts, ravage the lower parts of River Nyando and River Nzoia basin in Kenya almost every year. Lives are lost, families are displaced and crops, property and infrastructure destroyed. In essence it disrupts the socio-economic activities of the local populace. The flood risks seem to intensify with time because of population increase, land use change and possibly climate change. In 2003 seventeen districts were affected to varying degrees by floods in the country. This left 77 people dead and over 60,000 displaced. The Lake Victoria basin was the most affected with over 50,000 displaced in Nyando, Migori, Kisumu, and Busia Districts, while the Tana River Plains accounted for the remaining 10,000 displaced. The estimated cost of helping affected people stood at over US$ 1,000,000. By 20th May 2004 it was reported in the local newspapers that seven people had been killed 4,000 people had been displaced, 25 schools submerged and 5,000 hectares of cropland destroyed in Nyando District alone that year. However, in this year, 2004 the neighbouring flood prone Budalang'i area in Nzoia basin was spared from the flood havoc. This was due to the protection dykes, which had been repaired. To reverse the flooding trend in the Nyando basin, building flood protection dykes, desilting the mouth of the river and construction of flood retention reservoirs has been recommended, either individual measure or a combination. There is evidence that changes in land use such as deforestation have been taking place in the Lake Victoria basin and this may be contributing to increased floods. Currently, reservoirs have been proposed as flood mitigation measure in Nyando basin by the Kenya Ministry of Water and irrigation. In this study a Geographical Information System (GIS) based hydrological model called Soil and Water Assessment Tool (SWAT) was used to investigate how reservoirs would help reduce floods. Streamflow and climate data for the period 1971 to 1980 was used for model calibration and 1986-1989 for validation. This period was selected based on quality of the data. Other input data for the model included GIS layers of land use, soils and topographic information. This input data were obtained from obtained from various sources, such as the internet and government agencies. After calibration and validation, the model was applied in scenario simulation analysis, where it was run using 1976-1978 data but with the reservoirs in place and the results compared. It was established that the reservoirs proposed by the Ministry of Water could effectively reduce flood peaks in the main Nyando River, where the simulated peak flow was reduced from 60 m3/s for the scenario without reservoirs to 34 m3/s for the scenario with reservoirs at the river gauging station (RGS) 1GD03. However, Ainabng'etuny tributary, whose contribution to the flow at RGS 1GB03 is almost equal in magnitude to that of the main Nyando river at RGS 1GD07 could still contribute enough flow to cause flooding and may need to be reconsidered. If an alternative measure is found for the Ainabng'etuny tributary, the flooding havoc in the Lower parts of Nyando could be reduced. In addition, the building reservoirs would also increase water supply and irrigation potential of the basin. The irrigated area is smaller and some parts like Ahero are using pumped water for rice growing. The proposed reservoirs could increase the possible areas under irrigation up to the sugar belt of Muhoroni and Chemilil. This would have an effect on the local sugar, rice and other agricultural output from the basin. However, reservoirs are costly to construct and maintain. They may also have adverse environmental impacts. On the other hand their existence could be threatened by the heavy sediment loading in river Nyando as witnessed by the deposition which forms a huge sediment plume in the Winam gulf. Therefore there will be a need to undertake conservation measures especially in agricultural lands, which comprise over 80% of the basin so as to reduce runoff and silt loads. With conservation measures in place, the life of the reservoirs would be assured.

Sustainable Drainage Systems (SUDS) - Seizing Opportunity in a Crisis

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Keywords: Sustainable drainage, climate change, planning, water resources management,, drought

This project examines the barriers to the effective Implementation of Sustainable Drainage Systems (SUDS) in the East of England and generally in the United Kingdom. The paper first establishes the environmental benefits derived from using this technology over traditional drainage systems in addressing diffuse pollution, flood risk and water resources management issues. Sustainable Drainage is the practice of controlling, treating and managing surface water runoff as close to its origin as possible prior to discharge.

Data were collected from reports, journals questionnaires, interviews, conference, seminars and participation in consultee presentations in order to elicit information for the study. The study also draws upon the personal experiences of Tapiwa during developer scheme approval processes, legal negotiations and designing SUDS schemes for approval with the Environment Agency and British Waterways. The study presents the outcomes of this consultation process; reinforcing the presence of the barriers to the use of SUDS but most importantly drawing opportunities and possibilities that could sponsor better take up of SUDS technologies. The potential role of policy instruments; such as legislation, taxes, water pricing and planning are also examined.

The paper concludes that there are major challenges hindering the use of Sustainable Urban Drainage Systems as the 'preferred' drainage solution. In order to facilitate better up take of this technology it is necessary to introduce legislative changes and to a lesser extent fiscal instruments that are designed to promote the use and adoption of SUDS technologies and management practices. The role of SUDS in contributing to Sustainable Development, Water Demand Management, River Quality Objectives and also the meeting European Union legal obligations like Water Framework Directive is established. SUDS are also established as the preferred drainage solution to deal with the Climate Change phenomena. There are also variations in the perception to these challenges between the Policy Makers and Practitioners, within the professions, at regional and national levels.

Background

Numerous parts of the United Kingdom are vulnerable to extreme flooding events; in August 2004 flash floods occurred in Cornwall, January 2005 River Eden flooded Carlisle and in June 2005 there were floods in North Yorkshire (ICE, 2005). These and other unrecorded localised incidents disguise the scale of the flood threat to the United Kingdom. Flooding also presents a challenge through over-loading sewers, groundwater flooding and water pollution. Flooding in the East of England is more onerous given that most of the region is at or below sea level. The East of England also has very low rainfalls compared to the rest of the United Kingdom. The current water, wastewater and flood management strategies and policies are not integrated thus compounding flooding and drought issues and associated social and economic consequences.

However the United Kingdom is currently experiencing significant amounts of housing shortages, which need to be addressed. The housing boom in the United Kingdom is thought to be a consequence of demand out striping supply. In order to counter macro-economic instability the Office of the Deputy Prime Minister recommended the need for extensive housing developments requiring between 70 000 to 120 000 new houses each year in order to keep in line with European Counterparts (ODPM, 2004).

Results & Recommendations

The research has established that there are significant barriers to the use of SUDS in the East of England. There are variations in how the Practitioners and Policy Markers view these barriers with the Practitioners indicating most of the issues remain largely unresolved. The Policy Makers responses indicate that their perception is the barriers are not that significant thus having low scores. However there is consensus on what the main barriers are; those pertaining to ownership, adoption, SUDS not being a legal requirement and financial implications for future maintenance and replacement costs. It is also clear that there are other variables that need to be addressed in order to enhance opportunities of using SUDS in the East of England. Notably providing technical support and real-time information to the planning system. The major outcomes of the study were as follows:

- Planning needs to be integrated, informed and proactive.
- Further upstream developments were compounding the surface water and sewer network flooding scenarios.
- Flood risks and water supply risks were seen to be the greatest threats to the East of England Plan.
- SUDS is the best drainage technology to cope with global warming.
- Affluent counties closer to London found it easier to implement SUDS.
- Water supply companies do not regard SUDS and rainwater harvesting as water resources management strategies.
- Portable water is relatively cheap but not abundant. Marginal proposed of 18% per would not generate the necessary change in behavior to limit water use (Water Voice, 2004).
- Water treatment plants and receiving rivers are approaching their environmental limits.
- SUDS offers tangible solutions to flood and water resources management issues.

Transferable Knowledge:

Many of the lessons learnt from this study can be transferable to practical solutions in the developing world. Challenges like the demand for urban housing and the accompanying infrastructural are similar, so too is the threat of climate change resulting in extreme flooding or drought events. Traditional drainage systems based on the rational method cannot deal with proficiently with water pollution, flooding, water resources management and drought issues that are currently presenting themselves. In order to support the use of innovative sustainable drainage design has to be accompanied with planning, regulatory and to a lesser fiscal measures. The study and the availability of SUDS technology makes obvious the need to consider water as an entity providing an opportunity for use in its various forms; for amenity, recreation, irrigation, attenuation, habitat creation, local treatment, ecological flows and groundwater recharge (Environment Agency, 2005). Within each catchment and dependent upon physical characteristics there is scope to manage water in all its forms (rain, surface, portable, wastewater) as a micro-hydrological cycle (hydro-habitat) especially given that developments are occurring much further away from developed sources exacerbating the demands on the natural environment. There is opportunity given that hard surfaced areas especially in high density areas accounts for some 25% to 40% of 'possible' surfaces. The traditional drainage of conveying rain water away from the point of occurrence limits the opportunity to capture the water for the uses mentioned above including even toilet flushing and water for the laundry but at the same time results in extensive erosion, silting and pollution in developed countries were open channels are traditionally used for this purpose. Locally captured water could also supply water for market gardening in poor communities and if managed well help prevent stream bank cultivation.

Floods: Acts of God or human errors magnified by nature

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Keywords: floods, impact mitigation, water quality, sustainable water supply, risk reduction

Introduction - In the recent decades number of natural catastrophic events seems to radically increased. Seemingly high number of such events, namely floods may be result of climate change, unusual meteorological events, like unusual snow falls or rains happening outside "normal" seasons of the year or our false perception imposed upon us by the media stories and easier access to information. Nevertheless, the truth still is that floods are the most common and widespread of all natural disasters. Most communities in the Ukraine have experienced some kind of damaging floods. Floods are the number-two natural disaster in the Ukraine in terms of the number of lives lost and property damage. Floods and water supply - Floods have multiple impacts one of the most important of which is disruption of drinking water supply and sanitation facilities operation and adverse public health and environmental impacts. Therefore, an important aspect of flood impacts mitigation is maintenance of secure water supply and sanitation during flood events. Situation with raw water quality greatly aggravates during spring floods when floods caused by snow thawing and ice melting lead to transport of in the form of the surface run-off polluted matter and garbage into the river. Spring floods are also used, often illegally, to discharge industrial waste waters stored in special reservoirs, e.g. tailing storage facilities, using as an excuse enhanced dilution capacity of a river which develops considerable pollution load on raw water used for drinking water supply.

Flood preparedness – Floods are unavoidable phenomenon but their negative impacts can be avoided or greatly reduced by proper preventive arrangements. Flood readiness of a river basin and to withstand negative impacts of flood events should be based on the following key elements: availability of the basin-wide and national flood control strategy with proven feasibility of proposed flood protection measures; established and well-maintained hydro-meteorological monitoring system as well as non-automatic and/or automatic monitoring network with gauging stations installed at critical sites safe from the probable maximum flood level; availability of improved flood forecasting and modeling systems securing timely warning about coming flood event and forecast of its potential magnitude and spread; public warning system (TV, radio, Internet). Very important aspect is development of potential for predicting possible size of flood inundation zones under different flood forecast scenarios. Important aspect of flood preparedness is improvement of the level of skills and capacity in the organizations dealing with flood monitoring, forecasting and management. Since floods know no state boundaries it is important to have good inter-coordination of flood control measures and data sharing protocol on international level, especially with neighboring countries in case of trans-boundary rivers. Experience shows, greatest damage by floods is a result of poor public awareness, which requires adoption of measures on increase of public awareness in respect to causes of floods and emergency procedures to be followed during floods requires involvement of public in development of locality and time -specific approaches to flood management planning and training for emergency situations.

Water-supply preparedness and protection - Water sources are exposed to a variety of hazards that may damage or contaminate them, but they can be protected against flood disasters by improvements to existing water supplies which can make them more resistant to damage caused by floods. Test of a water utility preparedness (or lack of it) was well demonstrated by flash flood event in Kharkiv (Ukraine) back in 1995 when the city of 1.5 million was left without water for more than 3 weeks. It is useful to distinguish between large-scale urban water-supply systems and small-scale, scattered water facilities. The distinction is in level of technology and the institutional arrangements for management, maintenance, and protection. Whether the affected systems are rural or urban, sanitation surveys may be necessary to identify the main health hazards (World Health Organization, 1997). Also, raw water pollution during floods necessitates use of increased amounts of chlorine to disinfect water but as Ukrainian experience shows very often water utilities do not have sufficient reserve of this reagent which leads to serious health problems during floods. Also important is availability of spare parts, equipment and machinery as well as contingency plans concerning alternative drinking water supply sources and means of water delivery.

Conclusions and recommendations - Water-supply problems arise in all phases of the flood or draught disaster-management cycle. The security of people and property against floods in a river basin can be improved by better flood assessment, warning and response systems. Floods are natural phenomenon but their negative aspects are amplified by neglect of human activities impact which can be forecasted if due attention would be paid to it. Floods are as winter frosts and snowfalls quite normal natural events, but problem is that the people always tend to perceive them as a certain surprised, unexpected event and are frequently are unprepared and unable to cope with their consequences in the least damaging way.

The Egyptian Experience on Setting Measures for Mitigation Strategies to Reduce the Consequences of Floods and Droughts, Associated with Climate Change Uncertainty

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Keywords: strategies, flooding risks, High Aswan Dam, climate change, hydrologic models

The combined effect of rapid population growth in Egypt and rising living standards has led to a substantial increase in food demand. Horizontal expansion of agricultural lands has then become necessary to fill in the food gap. Apart from the small amounts of rainfall on the northern coast and the limited groundwater pumping in the western desert and Sinai, the Nile inflow is the main source of water in Egypt. It is a truism that the Nile is the most important source of water for Egypt, and it follows that the climate change effects will change the water policy in Egypt and will be one of important determinants of the balance between demands and supplies in the future.

Egypt's large and tightly packed population makes the country highly vulnerable to any changes in the Nile flows that associated with climate change. This expanding population will remain concentrated in a narrow strip along the fertile banks of the Nile River and delta. The increasing population density of this area will reduce Egypt's flexibility and options for responding to climate change impacts. Egypt does not grow enough food to feed its current population. Although the Nile River valley contains fertile land, most of Egypt is arid. The government is attempting to convert some of the desert to agriculture, but this new farmland is relatively inefficient and water-intensive. The net result is that the annual increase in population exceeds the annual increase in agricultural production. Egypt's imports of food absorb most of its foreign currency, which is therefore not available for development. If climate change makes Egypt drier or warmer, pressure on agriculture - much of which is dependent on irrigation - would intensify.

The country's water resources are limited. Egypt relies on the Nile for 90% of its water needs, but it cannot control the quantity and quality of this water, which depend on activities upstream. Although it is one of the world's major rivers, the Nile's average annual natural yield at Aswan (south Egypt) is just 84 billion cubic meters. The Nile loses a considerable amount of water to swamp areas and to evaporation during its path through the arid lands of Northern Sudan and southern Egypt.

More water will be needed to fill different future demands in Egypt and other Nile basin countries. Competition among these states for water could escalate even without climate change. If climate change results in increased warming, droughts, and evaporation, reduced flow in the Nile would further exacerbate Egypt's problems, and the country could face an explosive situation.

The Government of Egypt initiated a national development plan aiming to create new communities away from the Nile valley and Delta to absorb a portion of the growing population and to provide job opportunities for the young generations. These development activities will need a sustainable source of water supply. The Government new policy to encourage private sector participation in development will create an increasing demand for water, as the allocation of new investments will increase. According to these changes and the future climate effects, the existing land and water policies should be revised and updated to match the new national objectives and take into consideration the implications of implementing these new changes on water resources management on both the supply and demand sides.

The analysis of historical trends of temperature and precipitation at different regions on the Nile and Egypt showed that there is temperature change on the region but with variable values, the temperature change was higher in northern Egypt than other parts in Egypt and the Nile basin. The relation between precipitation and temperature at different regions on the Nile basin has been studied. It is found that there is no relation at the White Nile, which means that the global warming will not affect much the White Nile. However, for the Blue Nile there was a significant non-linear relation between precipitation and temperature. The relation is developed and used to project the precipitation changes on the Blue Nile till year 2030. Also, the climate scenario generator (MGICC & SCENGEN) used to generate climate scenarios based on emission scenarios and the anomalies of different GCMs. The data is generated at different catchments on the Nile. The main findings through the analysis of different GCMs and emission scenarios that considered the extreme change till year 2030 indicated that the probability of wetting (increase of precipitation rates) is higher than drying. The precipitation change showed that there will be spatial precipitation change on the Nile basin.

A distributed rainfall runoff hydrological model, Nile Forecast System (NFS) and the reservoir simulation model is recalibrated using longer series of historical data and performance of the system in simulated the Nile basin catchement is reevaluated. The analysis showed that the model performs well at Dongala station where it explains more than 90% of the variability of rainfall runoff processes that happens on the Nile basin. Then the historical gridded monthly rainfall data since 1940 till now are used to study the impacts of climate change on the Nile flows. The simulation results shown that the inflow to Dongola will change. These changes have been used to study their impacts on the operation of HAD and the Egyptian water availability till 2030.

Based on the results, this paper presents the Egyptian experience on setting measures for mitigation strategies to reduce the consequences of floods and droughts, associated with climate change uncertainty, and flooding risks, it also examines the impacts of global warming on the Nile basin flows together with the future strategies for operating High Aswan Dam (HAD) to mitigate risks associated with climate change.

Vulnerability of Fadama agriculture to water storage and availability during droughts in the Hadejia floodplain of Nigeria.

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Keywords: Vulnerability, fadama (floodplain), agriculture, water, droughts

Floodplain (fadama) agriculture is critical to survival and economic development in the rural areas of semi-arid Northern Nigeria. This area is experiencing significant climatic and anthropogenic changes that have exacerbated the food insecurity in the region. Most floodplains in this area are suffering from declining rainfall which has forced farmers to shift their attention to floodplain agriculture. The dependence of nomadic herdsmen on this resource (Fadama) brings about additional pressure, competition even conflict. These renewed pressures, coupled with the possibility of an increase in drought occurrences as projected by the Third Assessment Report of the IPCC, could spell disaster for the sustainability of floodplain agriculture and food security in the region. The paper investigates the vulnerability of floodplain agriculture in the Hadejia River valley in north central Nigeria to the effects of droughts, the risks that fadama farmers are exposed to and how they can adapt. The study area is the Hadejia River valley stretching from the Kano area through Hadejia and Nguru to Gashua and covering an area of about 4,000 ha of farmland. About 8,000 farmers from different village areas are engaged in some form of fadama farming along this river valley which forms part of the Hadejia-Jama'are – Yobe River Basin. The entire Basin covers an area of 45,000 km2 and is situated in semi-arid Northern Nigeria. The three main rivers in the Basin are the Hadejia, Jama'are and Yobe rivers. The Hadejia and Jama'are meet in the Hadejia-Nguru Wetlands to become the Yobe River. The traditional farming system in the Basin, particularly in the downstream areas is flood farming. This flood farming depends on residual moisture for the second crop while rainfed farming is relied upon for the growth of the first crop. Since the early 1980s, small-scale irrigation which pumps water from the river and floodplain (shallow wells) has been stimulated in the basin through subsidies permitting the introduction of the third crop during the dry season, while intensifying the cultivation of the second. At other locations, dams have been constructed to store water for irrigation during the dry season. A combination of these activities has increased the productivity and income of farmers in the area.

Primary data were collected forr this study. First was a transect walk to select the villages required for the study. This was followed by a reconnaissance survey to select study units and develop the survey instrument. The questionnaires was then administered to a random sample of 200 farming households, 50 from the the four villages selected. A participatory rural appraisal was also used to ascertain the level of vulnerability of the farmers and focus group discussions conducted to validate the results of the surveys. The paper describes and analyses current vulnerability of Fadama agriculture in the area. It also evaluates current coping strategies and suggests effective adaptation measures to reduce the vulnerability of farming

households. Results show that almost all farmers in the area are male household heads working together with household members. Two household types were identified: (i) farmers that use ground and surface water and employ a combination of traditional methods and new technologies (tube wells and water pumping machines), that is those that use natural water storage systems and (ii) those that use surface water released by government from a barrage (dam) by means of gravity, in this case an artificial (constructed) water storage system. The former category of farmers, although find difficulty in carrying out their activities, in terms of cost of pumping water and other inputs, are less vulnerable because they have some amount of control over their sources of water and they can also use residual moisture along floodplains after the rainy season. This gives them the advantage of cultivating a greater variety of crops and even a second crop using residual moisture at the end of the rainy season, in addition to rain-fed (first) crop and irrigated (third) crop. Conversely, the later category, suffer from occasional delay in the release of water from the barrage and are restricted to a limited variety of crops. In some other instances, too much water is released from the barrage leading to occasional flooding. This even puts the second category of farmers at greater risk. However, both categories have developed coping strategies during past and present droughts. They are also willing to adapt some and even new strategies as adaptation measures against future droughts. The paper, therefore recommend an interplay between the provider (government) and the users (fadama farmers) in the programme to ensure a timely release of water from the storage facility (dam) to the fields (cultivated plots) and at the right quantity. Effort should also be mad to allow sufficient quantity of water to flow through the natural stream to enable farmers downstream to benefit and continue their own activities.

A Community's Combined Efforts to Sustainable Water Resource Management

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Keywords: Australia, Canberra, drought, demand-management, supply

Across Australia, one of the worst droughts on record has affected many towns and cities over the last five years. The capital, Canberra, has been affected not only by decreasing water storage levels caused by the drought, but also by severe bushfires that caused major damage to the region in January 2003.

Water manager ACTEW sources water from two catchments to supply Canberra. One of them, the Cotter catchment, which under normal conditions supplies up to 95 per cent of Canberra's water without a need for filtration, was left severely affected by the bushfires with approximately 95 per cent of the ground cover burnt, along with ongoing risks for water quality and quantity. The recovery process of this catchment is expected to take more than a decade. Googong reservoir in the other catchment, normally only used during consumption peaks in summer, was used extensively during this period and consequently drawn down to all time low levels.

In response to these events and as part of a national water reform, the local government developed a water resource strategy, setting the framework for the long-term management of water resources in the Canberra region. The strategy, Think water, act water, incorporates the nation's latest thinking and ideas for demand management, water efficiency and security of supply. ACTEW is a main participant in the implementation of the strategy.

Social measures

Mandatory water restrictions were introduced in Canberra in December 2002 as the first step in securing water supply during the drought. Over the next three years, Canberra moved through restriction stages One, Two and Three, costing the community $71 million (AUD).
The Canberra community rose to these challenges extraordinarily and consistently met water saving targets, including a 40 per cent reduction in Stage Three restrictions that applied over two summers. In November 2005, ACTEW could finally ease restrictions in light of improved dam levels.

As the community overcame the short-term challenges associated with the drought and bushfire impacts on its water supply, ACTEW now turned the focus to the long-term challenge of meeting the target reduction of per person water consumption of 25 per cent by 2023, set in Think water, act water. This could only be achieved by combining all efforts and working to become water wise across the board.

A set of low-level mandatory restrictions, Permanent Water Conservation Measures (PWCM), were introduced as a long-term demand management tool to assist in achieving these targets.
The aim was to leverage off the high level of awareness raised during the drought and continue some of the sensible, common-sense water use practices that had been adopted. To avoid non-compliance and complacency in the future, introduction of PWCM needed the full support of Canberrans. To overcome this challenge, residents were engaged in the finalisation of the permanent regime through a trial with extensive community consultation over the 2005-

06 summer. The consultation confirmed the community's willingness to forever change their habits, with 93 per cent in support of permanent water conservation.

The PWCM are expected to contribute to an approximate 8 per cent reduction in water use. Other measures, such as water efficiency programs with rebates and subsidies, pricing, the implementation of Water Sensitive Urban Design principles in new developments and ongoing public awareness and education campaigns, will also assist in meeting the 2023 target.

Technical measures
Think water, act water had also identified the need to provide a long-term, reliable water supply in light of predictions for future water demand related to variables such as population growth, climate change, environmental flow requirements, the impact of bushfires, the frequency of water restrictions and achieving the water efficiency targets.

In response, ACTEW initiated the Future Water Options study to examine what would be the most suitable option out of nearly 30 possibilities. It studied in detail three main options, including building a new dam, enlarging an existing dam or transferring water into the region's catchments and reservoirs.

A thorough technical, environmental and planning analysis was undertaken for each option and nearly 2000 residents were in direct contact with the project through a community consultation program.Some innovative ideas came out of the project and lead to ACTEW recommending to the local government that, rather than causing great environmental impact by building a new dam at a cost of up to $250m (AUD), ACTEW could provide the security of supply needed until at least 2023 by increasing the efficiency of its existing infrastructure.

The Cotter-Googong Bulk Transfer project, on which work commenced in early 2005, would transfer water from Canberra's Cotter catchment and, after meeting town demand, use the existing water distribution network to transfer any surplus water to the Googong reservoir, which was still less than half full following the drought years. The $25m (AUD) project was possible due to the high yield of the Cotter catchment where the dams easily overflow after rain, usually during the colder months.

When fully implemented, the scheme would be able to transfer up to 150 megalitres per day, a volume equal to Canberra's consumption on a typical day in spring. The initiative immediately secured the region's water supply for at least the next five years without the need to impose more prolonged, costly restrictions. Even with a repeat of the last five dry years, the scheme would keep the level of the Googong reservoir at 20 per cent higher than it otherwise would be. ACTEW would also consider adding water from the Murrumbidgee River to the transfer system, which would assist in deferring the need for more large-scale infrastructure projects until 2023.

References: ActewAGL (2004). Annual Drinking Water Quality Report 2003-04.
ACTEW Corporation (2005). Future Water Options for the ACT Region – Implementation Plan. A recommended strategy to increase the ACT's water supply. April 2005. Available at www.actew.com.au
Australian Capital Territory Government (2004). Think water, act water. Volume 1: Strategy for sustainable water resource management in the ACT. April 2004. Available at www.thinkwater.act.gov.au

Reservoir Regulation under Conflicting Flood and Conservation Storage Demands

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Keywords: Flood management, Structural measures, Non-structural measures, Conservation storage, Inflow forecast

Presentation of topic: Water is critical for long-term economic development, human health, social welfare and environmental sustainability. The demand of water for various end uses such as irrigation, drinking water supply, industries, power generation, fisheries, navigation, and recreation is ever increasing because of the ceaseless rise in human population associated with increased urbanization, industrialization, agricultural activities and increase in standard of living. All these essentially require storage, diversion, conservation and management of usable water resources and, most important among them being construction of reservoirs and their operation, which balances the temporal and spatial variability of water as available in nature. There is every indication that the need for storages will grow due to anticipated impacts of climate change, which could result in rapid glacial melt and increased variability of rainfall in large parts of the subcontinent leading to occurrence of extreme events of floods and droughts.

Irrigation, domestic, industrial and other demands are best served by conservation storages requiring reservoir to be full during any filling period, whereas, flood management requires empty storage space for absorbing the incoming floods and moderation. The conflicting requirements in terms of storage space requirements could be managed through suitably planned reservoir operation. The storage could be either single purpose or multipurpose reservoir and single or multiple systems. While flood control requires lower reservoir levels, conservation interests require as high a level as is attainable, necessitating a compromise on these uses. In India major floods occur during the south-west monsoon season (June to October). A part of the conservation storage is utilized for flood moderation during various stages of the monsoon, which is filled up towards the end of monsoon progressively, which naturally involves some sacrifice of the flood control interests. Regulation of multipurpose reservoirs shall be based on the priority of one use over the other.

Two cases, one of regulation of single multipurpose reservoir (Ukai dam) and the other of a system of multipurpose reservoirs (DVC System) are presented here.

Single multipurpose reservoir: Tapi is the second largest west flowing interstate river in the peninsular India having a total drainage area of 65145 sq. km, which is of an elongated shape narrowing down beyond Ukai dam. The live storage capacity is 7092 million cubic metre (MCM) against the average annual flow 7195 MCM. During monsoon 1994, the Tapi basin received repeated heavy rainfall resulting in severe flood conditions in the downstream area. Total rainfall was 1060 mm over the basin against the maximum annual rainfall of 1191 mm and the mean annual of 830 mm. The season experienced four main flood waves and the critical one occurred between 6.9.94 and 10.9.94. The 12-hourly average flow into Ukai dam reached 21906 cumec and the instantaneous peak was 25949 cumec between 0500 to 0600 hours on 8.9.94, when the reservoir level was already close to full reservoir level (FRL), higher than the rule level prescribed for that period. Hence, the reservoir regulation became critical with the dam authorities desiring to release the entire inflow in the interest of the dam, which would have resulted in an average outflow of at least 21906 cumec against the present safe flood of 11,328 cumec for Surat city downstream (24092 cumec at the time of design of Ukai project), which would have proved fatal for the city. On the other hand, restricting the outflow would have resulted in rise of the reservoir level, which is to be limited to about 0.3m above FRL due to land acquisition problems above this level.

Under the above limitations, the reservoir was operated optimally, with the help of the inflow forecast system installed. The maximum 12 hour average outflow was contained at 13,956 cumec against the average inflow of 21990 cumec resulting in a flood moderation of 36%. In terms of the peak flows, the inflow peak attained was 25,949 cumec and the outflow peak was 14,870 cumec giving a relief of over 42%, thus averting a major calamity, which would otherwise have occurred, in the absence of the dam. In view of the flood damages that occurred even at this reduced outflow, the warning and danger levels for Surat city have now been reduced from 10.18m and 11.18m down to 8.5m and 9.5m respectively.

System of multiple reservoirs: Damaodar Valley Corporation (DVC) system of reservoirs consists of four dams at Tilaiya, Konar, Maithon and Panchet (with flood storages), Tenughat (without flood storage) and a Barrage at Durgapur. The envisaged principal utilisation of the stored water is for Kharif (June to October) and Rabi (November to March) irrigation, hydropower generation, water supply for industrial & domestic uses and flushing doses during the monsoon season. Total designed storage capacity of first four dams is 3600 MCM with flood retention capacity of 1860 MCM, but restricted to only 1290 MCM due to land acquisition problems in respect of Maithon and Panchet reservoirs.

The bankful capacity of the river Damodar at Durgapur is only about 7,080 cumec, but due to siltation of the river bed and encroachment of the flood plains, the safe capacity below Durgapur barrage has reduced to 3,680 cumec only and, 2,830 cumec in the lower areas where there is heavy rainfall coupled with high tide and spilling of tributary Dwarkeswar. Keeping in view the above limitations, flood damages in the lower valley were minimized by controlling the releases below 2,830 cumec as far as possible. Combined releases from Maithon and Panchet dams are regulated in four slabs depending on the flood reserve occupied.

With planned regulation of reservoirs along with flood forecasting network, it was possible to moderate inflow flood peaks of 14606 cumec to 4536 cumec for 1961 flood, 16726 cumec to 4979 cumec for 1973 flood, 22036 cumec to 4612 cumec for 1978 flood and 17585 cumec to 7121 cumec for 1995 flood. Demands for kharif and rabi irrigation, industrial and municipal supplies, mandatory flushing release, carry over storage in Maithon reservoir and generation of hydro power were managed successfully.

Conclusions and recommendations: Dams play a major role in minimizing flood damages by providing flood cushion and regulation based on sound operation policies supported by well established flood forecasting network as borne out amply by the case studies presented. In addition to the optimal operation of the reservoir, flood forecasting enables issue of flood warning to the people likely to be affected, well in advance of about 48 to 24 hours. Since absolute flood control and protection to all flood prone areas for all magnitudes of floods of different probabilities of occurrence are not techno-economically viable, a reasonable degree of protection from flood losses at economic costs can be achieved by management of flood using both structural and non-structural measures. Constant review of the reservoir operation policies and rule curves are required for optimizing the storage of incoming flood waters in the reservoir so as to control the magnitude of the flood downstream as well as maximize conservation storage.

Impact of Seasonal Changes of the Ecological Condition of Water Storage on Drinking Water Quality

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Keywords: Water storager, seasonal changes, drinking water

Presentation/topic: A considerable part of Ukraine uses storages along the Dnieper River as centralized water supply sources. The cascade of the Dnieper storeges features a high content of natural organic matter (NOM) and its significant fluctuations depending on seasonal phenomena. The content of NOM may reach 55-75 mg•L-1, while during specific periods it may exceed 100 mg•L-1 unlike surface water in other regions of Europe, where NOM ≤10 mg•L-1.

NOM is one of the most critical components of surface water and may control such phenomena as mobility of heavy metals and hydrophilic organic matter in water. NOM, to a great extent, determines the drinking water quality. NOM is a source of organic carbon for microorganisms and consequently the cause of secondary microbial pollution and biofouling of treatment plants and distribution networks, the cause of toxic chlororganic compounds being formed in drinking water. Analysis of the state of a natural water reservoir and reasons for its changes during different periods of the year will enable us in future to forecast changes of technological modes of water treatment plants depending on changes of the aquatic ecosystem condition.

As an object of investigations we selected the Kremenchug Storage on the Dnieper River. Indicators of water quality were determined in the water of the Storage proper and after the water supply treatment plants during the period of 2001-2004. On a monthly basis we determined color, COD, permanganate oxidizability, BOD, dissolved oxygen, content of ammonia, iron, and manganese.

Formation of water quality in the Dnieper River and its storages in the upstream region is determined primarily by the presence of humic matter of marsh origin and its value amounts to XVIII-XIX divisions of the standard scale of color. In the Kremenchug Storages the color varies in the range from XII to XVII divisions. Variation of the water color in a cascade of water reservoirs is related to changes of soil types along the course of the river, formation of NOM of plankton origin, floods or arid summer periods. NOM of marsh origin is an old-formed matter, while that of plankton origin is a newly-formed matter. It determine peculiarities of their behavior in water treatment processes. Analysis of hydrochemical and physicochemical characteristics of water may provide information on the chemical nature of NOM of different origin and its changes in different seasonal periods (during floods or droughty periods). This makes it possible to correlate the process parameters of drinking water treatment during different periods of the year.

Presentation of results. We showed that data on the origin of NOM in water can be obtained by comparing the ratio of color and oxidizability. A higher value of this ratio indicates a predominant content in the water of stable humic substances of marsh origin. The ratio of humic compounds of marsh or plankton origin depends on seasonal or annual climatic

conditions. Humic substances of plankton origin prevail in the period of floods, while humic substances of plankton origin are more abundant during arid periods of the year.
For example, the lowest value of color-to-oxidizability ratio of 2.5-3 was registered in the dry 2002. This fact indicated a predominant content in the water of humic matter of plankton origin. A sharp rise in the ratio during certain periods of 2001 (up to 5.2) and 2003 (up to 5.0) is the evidence of the growing content of humic matter of marsh origin. This statement is corroborated by correlation of these indicators with the rise of ammonia content and the reduction of oxygen content in the water. It is related to the intensive summer rains during this period of the year in the upstream region of the Dnieper River. Owing to rains the overflow land areas were flooded. In order to reduce the area of flooding and prevent the penetration of radioactive nuclides into the water of upper reservoir, its water was rapidly discharged in forced manner. That is why the reservoir was filled with high color waters of tributaries of the Dnieper River from marches of Polesye. The front of Polesye water on its course along the cascade reached the Kremenchug storage. The reduction of water level in the reservoir also contributed to the rise of color of its water resulting in the growing share of the Polesye run-off and reduction of the dilution factor in the storage.

Similar analysis of changes in all indicators of the water quality in the Kremenchug storage was carried out on a monthly basis in the period of 2001 – 2004. The variation and relationship of these indicators was shown to depend on floods or abundant rains. We carried out the performance analysis of water supply treatment plants during the same period of time. It was revealed that indicators of the drinking water correlated with variation of the chemical composition of natural organic compounds during the four years of observations. Hence, the standardized indicators of drinking water were achieved at the level of color-to-oxidizability ratio equal to 2 – 3. As this ratio increased to the level >3, the quality indicators were above the standardized ones. Such analysis was executed in respect of all indicators of the drinking water quality.

Conclusion/recommendations

- Critical analysis of hydrochemical and hydrobiological conditions of water makes it possible to establish the regularities of variation of the water quality during different periods of the year and the reasons of its deterioration owing to natural and anthropogenic factors.
- Processes of self-purification of water in the reservoir should be intensified during different periods of the year by using aeration in the region of drinking water intake.
- Estimation of barrier capabilities of each water treatment process must be linked with changes of hydrochemical properties of water in reservoirs and with due regard for conditions of flood or drought.

Are Floods and Droughts the fate of Turkey?

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Keywords: Storage facility, Critical period, Dead Volume, Active Volume, Operational studies

Before the explanation of drought and flood events in Turkey, it would better to look at the water resource potential in Turkey. The average annual precipitation in Turkey is 650 mm. When we multiply this figure by the Turkey's 780 000 km² surface area, we get 501 km³ water volume. About 274 km³ water volume returns to atmosphere by evaporating from water surfaces. The average annual surface runoff is 186 km³ of which 98 km³ can be developed for consumptive use. Adding the 14 km³ of groundwater safe yield, the total amount of annual exploitable water has been assessed as 112 km³. However, only about 40% of the total water potential is consumed currently thanks to constructed water storage facilities. Turkey targets to develop all exploitable water potential by the year 2030 in which Turkey's population is estimated to reach 115 million. Then the annual available water per capita will fall below critical level 1,000 m³ per capita. This amount seems enough for irrigation, domestic and industrial water supply needs, but it does not occur in the right place at the right time.

First it would be better to understand when droughts occur and what the measures can be for mitigating its effects. In the inner part of Turkey, altitude of the plain land is lower than the surrounding mountainous coastal areas. The ideal picture is that all the surface of Turkey is to be receive necessary amount of precipitation dispersed all the surface area of Turkey, all the years, and within the year. But, the fact is quite different. The distribution of precipitation in Turkey is rather uneven. Turkey is subject to both a continental type of climate characterized cold rainy winters with dry summers and subtropical climate identified by dry summers. Generally 70% of total precipitation falls from October to March and there is little effective rain during summer to meet irrigation needs. The coastal areas receive more precipitation but average annual precipitation in inner parts, which consist of the majority of the land surface, is 250 mm. During the critical period, this figure drop dramatically and may last more than one year. Consequently droughts occur. The first sector to be effected is the agricultural, which is responsible for consumption of about 70% of the water consumption. When data obtained by meteorological stations, observation stations on rivers and on water storage facilities indicate probable critical period, farmers are to be warned not grow plants that summer that need more irrigation. Saving water is especially important in water scarce regions. Therefore modern irrigation systems are to be preferred to traditional irrigation systems. Closed irrigation systems with pipeline distribution systems save 10% of open conveyance canals. In the case of on-farm irrigation, sprinkler and trickle irrigation 30% of wild and furrow irrigation.

Droughts may also result in environmental disasters through land degradation and destruction of fauna and flora. The land becomes dry and wind may cause erosion. Land would tend to become desert if necessary measures were taken. Forestation is important as trees have capacity to hold the land and they have capability to find water from deeper part of the land by means of their roots.

The need to have more water storage facilities is important to mitigate its effects through their operation, that is, by storing water when available and by using during the critical period when it is needed.
The other extreme meteorological event resulting excess of water cause another disasters, that is, floods The average annual precipitation in small coastline regions is 2,500 mm. in Turkey. As these figures indicate, floods are more common in the coastal regions. Rivers in most European countries have regular regimes. Rivers in Turkey have generally irregular regimes therefore natural flow can not be utilized as usable water resources. Rivers in Turkey generally have wild flows varying considerably throughout the year as well as in the course of years. Floods are quite common in Turkey as in many countries in the world such as Chine, India, and South American Countries.

By operating of water storage facilities to hold the amount of the water during the extreme flow, flood hazards would be avoided if necessary number of the dams were constructed on the river basin. as each reservoir on the basin hold water so as to prevent hazards. But there are basins in which there are not dams. In this case, it must be ensured that no building, no roads, and no other obstruction are to built on the discharge area of the rivers.

Due to fluctuations observed in the run-offs during seasons and during the years, it is absolutely necessary for Turkey to construct dams so as to develop its exploitable water potential.

Bibliography:
-Adem Ani Ünal, Chief of Foreign Relations, State Hydraulic Works (DSI) of General Directorate.

-Taner Ercömert, Deputy head of Dams and Hydropower Department, State Hydraulic Works (DSI) of General Directorate.

-Prof. Dr. Veysel EROGLU, Director General of DSI, Water World, Monthly Magazine of State Hydraulic Works (DSI) of General Directorate.

, pp: 42-47 “East Blacksea Region: Turkey’s landslide and flood region, September, 2005.

-DSI 51st Anniversary, annual book of State Hydraulic Works (DSI) of General Directorate.

Second Chart, pp: 15-26, “Land and Water resources”, pp: 39-54, “irrigation”, 2005.

-Mümtaz Turfan, Chairman of the TRCOLD, “Turkish Position Against WCD Report”, 2004.

Irrigation and Flood Control Strategies in southern Indian state

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Keywords: check dams, ground water resource, traditional system, watershed based plans, Basin wise studies

Optimal utilization of the water resources through appropriate conservation and management measures assumes critical importance in sustaining the life support systems. The southern Indian state (Kerala) has 44 rivers and has ample rainfall for about 72,000 million m3 of water every year, only 5.5 % gets stored in medium irrigation and hydro-electric dams. Nearly 40 per cent of the resources are lost as run off causing heavy floods. During monsoons, the rivers get filled up soon after the rain it goes dry again. This is because the annual average water discharge through the river is simply allowed to flow into the sea. In the case of biggest river Bhrathapuzha , about 96-97% of 4000million m3 of water of passes to the sea during monsoon months. Although the country enjoyed normal monsoons through out the period 1989-2000, each of these years witnesses deficient rainfall in anything between 12 and 35 % of the districts. India witnessed one of the worst droughts in 2002 in the past hundred years. The Check dam construction is the cheapest and most effective way for water conservation in this region. The ground water resource is estimated at 7048 MCM. Its ground water levels are falling, its rivers, canals, lakes and backwaters are shrinking, and its people are reeling under a severe shortage of potable water. Priority in resource allocation (69% of total) in Kerala was given for major and medium irrigation projects for rice crops, but not succeeded in increasing the area irrigated or productivity or in returns. Minor irrigation schemes are best suited for irrigation in Kerala, but adequate priority was not given in the allocation of resources. Ground water development also comes under minor irrigation. Around 25 per cent of the ground water resource potential has been tapped and the coastal and low-lying regions of the midland offer good scope for ground water development. Out of the 152 blocks in Kerala, eight have been identified as critical, six as semi critical, two as over exploited and 136 as safe. Traditionally irrigation management has been considered as a departmental exercise without any provision for participatory approach either in the selection of the works or in their execution and management. Local level Water Resources Development and Management through participatory approach to be given a thrust to attain sustainable local self-sufficiency regarding water requirements. Recent communities Irrigation Project with the active participation of the beneficiary communities have drilled 131 bore wells. Several minor irrigation schemes have been taken up recently as local governments have to spend about 40 per cent of their allocation in productive sector. A good number of schemes have not resulted in increasing water availability as undue emphasis was given to protective structures. In flood control, most of the schemes are related to relief work for the affected areas. Flood control works continue to be on conventional lines. The identification and execution of works are on adhoc basis and largely based on public pressure and there is no system for the assessment of needs and priorities. Basin wise studies are required for the identification of flood prone areas. A strategy for water resources development and utilization for irrigation and other purposes envisaged for the coming years includes the revamping of 1st and 2nd generation irrigation projects to improve the current level of utilization by taking into account the changes that have taken place over time and bringing about necessary modifications with the partnership with local governments and user groups. Water resources planning and management to be taken up by the river basin level by aggregate watershed based plans prepared locally. Special focus would be given to revival, conservation and up gradation of local water resources and traditional systems of water management. Ground water exploitation would be based only after proper zonation and with the involvement of farmers at the local level. Technical support for development of groundwater sources and helping farmers for acquiring sources of irrigation on individual as well as self help basis are features included under future programme.

Transboundary Floods: Conflict, Vulnerability and Adaptability

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Keywords: Floods, Vulnerability, Adaptation, Mitigation, Conflict resolution

Topic

Adaptability and vulnerability of societies to floods are still poorly understood. However, record temperature extremes resulting in floods continue to occur, resulting in enormous damage all over the globe. It is therefore highly appropriate to prepare (more) carefully for the wise management of what are in many parts of the world increasingly scarce water resources and acknowledge the potential for catastrophic damage and losses of lives due to the increase of extreme weather events with an impact on water resources. We present a way of examining the nexus of extreme weather events and society's adaptability to it: how vulnerable are societies to changing circumstances, how can societies adapt to changing circumstances, what are the lessons learned and what are the possibilities for cooperation or changes of conflict before or once the situation has changed. Although water-related extreme events strike developed and less developed countries alike, and people may face the same potential risk, they may not equally vulnerable because they may face different consequences to the same hazard. By comparing a so-called developing (Mozambique) and a so-called developed country (the Netherlands), we are able to define these different consequences more precise. The findings of our work would increase the understanding of the links between the occurrence of floods, international conflict and cooperation and international water resource management.

Methodology

First of all, we investigate the global statistics for loss of human life, the number of flood-related displaced people, and the total amount of damage in USD per country. Data on floods is obtained from two databases. The first one is the OFDA/CRED database which contains data on international disasters like floods and is maintained by the Centre for Research on the Epidemiology of Disasters (CRED) in Brussels in cooperation with the United States Office for Foreign Disaster Assistance (OFDA). This database contains a large number of flood events, occurring between January 1975 and the present. The second database, compiled and maintained by the Dartmouth Flood Observatory in New Hampshire, is a global listing of extreme flood events compiled from diverse sources for the period 1985-present. Since this second database lists individual floods, we are able to detect transboundary floods.

We continue the study by investigating how decision-makers and institutions in the case study areas adapted in the past to water-related extreme weather events? It is assumed that this reaction not only depends on past experiences, but also on culture, available resources (money, human) – the level of adaptability - , vulnerability and views of the future. In order to learn from past experiences with water-related extreme weather events and prepare for future ones, literature research and case studies focusing on this issue is conducted. A distinction is made between policy reactions and society responses in the study areas. The focus is on differences of adaptability and vulnerability for the case study areas.

Thirdly, we investigate whether lack of flexibility in treaties to deal with changing hydrologic circumstances cause deteriorating international relations. Previous studies indicated that many treaties between riparian countries of transboundary rivers do not include rules for extreme hydrological conditions such as floods and, though some do, there is still a risk that agreements were made during a wet climatic period and do not include enough flexibility to account for hydrologic changing conditions (Stahl, 2003). Most likely, international water treaties assume normal hydrologic conditions and therefore rarely mention hydrologic extremes like droughts and floods. This lack of flexibility can cause conflicts or deteriorating international relations. Case studies, the Transboundary Freshwater Dispute Database (TFDD) (Yoffe, 2005) and literature research will list and locate treaties that have incorporated and that have not incorporated extreme hydrological conditions.

Findings

First, we discuss the development over time of loss of life statistics, number of floods, and total amount of damages. We will relate the combined dataset to the United Nations Human Development Index (HDI) and show, by means of cross analyses, which a high HDI score does not necessarily result in lower losses of life or less damage in USD. We will show that there is an uneven distribution between developing and developed countries it comes to the devastating results of floods in developing or developed countries.

Second, we present the findings of the literature study which will show how stressors influence different societies, how dissimilar societies deal with floods in the past, present and future and what mitigated and mitigates stress.

Lastly, we talk about why and when climatic variability should (not) be included in international water treaties and theorize about reasons why rules during extreme hydrological conditions are not included. Recommendations are given for future international water treaties in areas with higher vulnerability to water-related extreme weather events.

Living with the Drought: Strategies for Brazilian Semiarid Region

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Keywords: sustainable environment, water management, rainwater harvesting, semiarid development, social inclusion

Brazilian water resources occur irregularly by nature and in inverse proportion from population distribution. The North region – which encloses most of the Amazonian area – has the biggest water availability (38.5%) but the smallest population (less than 7%) while the Northeast possesses only 3.3% of superficial water and accounts for approximately 26% of the Brazilian population.

The Brazilian semiarid is located in the Northeast with an area of about 900,000 km². It congregates a set of singular and disadvantageous characteristics - climatic, geomorphologic, social and economical - resulting in an environment marked by difficulty of access to water. The whole society and regional economy are affected by this.

By the climatic viewpoint, the semiarid is characterized by strong solar radiation, lack of clouds, elevated rate of evaporation, little seasonal variation in temperatures and irregular rainfall regimen with precipitations concentrated in a short period of time. The annual rainfall data ranges from 350 to 800 mm. The risk of desertification for the area is high as only a few perennial rivers and water bodies can be found there adding to the fact that geological conditions for subterranean water storage are unfavorable.

The drought that regularly ravages the area yield serious and lasting consequences. It concurs to the existence of hunger and other important social problems as well as to the dissemination of several diseases. The child mortality index in there is, historically, the country's highest due to malnutrition and consumption of poor quality water. This severe poverty picture leads to compulsory migration in large scale from the rural areas towards the already decayed, overpopulated urban areas.

In an attempt to mitigate this suffering, a program called "One Million Cisterns" (1MCP) was created. This program brings together Brazilian and international non-government organizations (NGOs), as well as Brazilian government. The idea is to promote a sustainable living between people and the Brazilian semiarid. Its specific goals are:

- Generate mechanisms to promote partnership between all the ones involved in the management process and in society control.
- Bring decentralized access to water of human consumption grade to estimated 5 million people.
- Strengthen the civil organizations that take part in the program, to ensure 1MCP will have effective and efficient performance.
- Unleash an educational process based in teaching people how to live with the semiarid and how to form public policies.
- Disseminate concepts and legitimate practices of living and understanding on the ecosystem of Brazilian semiarid.

This program is based on the construction of systems to use rainwater, collected from roofs, floors and natural structures, for human and animal consumption. The cisterns have 16 thousand liters of water capacity, enough to ensure water for the needs of a family (drinking and cooking) in the course of the eight months of dry weather. The cisterns are built by local masons, formed and qualified by the 1MCP along with the families, who are put in charge of excavating, sand and water acquisition and involved in the construction itself. This simple technique, largely disseminated in other world's regions, allows this group of people to be reinserted in society. The minimal survival requisites are guaranteed and the adequate soil exploration techniques are adopted, thus resulting in a pronounced improvement of social and economical conditions. Another consequence is that the role of women and children are significantly altered. The women have the chance of becoming economically active by manually transporting the necessary water and the children can go to school.

The following techniques are used to guarantee supply:

- Traditional cistern: water is caught from roofs and protected surfaces. After treatment, can be used for human consumption.
- Cistern, adapted for agriculture: with a 16 m3 cistern it is possible to use the water for small areas irrigation, where greens or seedlings are cultivated. It's also possible to raise small animals like poultry or bees.
- Water hole: shallow well, for all kinds of uses.
- Subterranean dam: makes good use of running water from rain or small streams available in the area. When the dry season comes, the flooded area keeps moisture thus being available for fruits, greens and annual crops planting. It can also supply water for animals trough digging a well.
- Loam-pit: Developed to store water for animals and for irrigation, complementing annual crops needs.
- Small dam: Cultivation is carried out at its margins, downstream, or at a lower area with irrigation.
- Stone tank: it's a natural cave, carved on large rocks; excellent rainwater collector tank for all uses.
- Mandala: it's a permaculture technology adapted for the semiarid that streamlines and optimizes a small conic reservoir's water use for drip irrigation of horticultures established in its vicinity. These horticultures may also be associated with raising fish and poultry.
- Roadside water harvesting: rainwater that runs on the side of roads is harvested, conveyed, stored and can be used for irrigation.

So far the aforementioned program has been established in 897 towns of the region with the following results:

- 97,300 families involved;
- 87,300 families already qualified in Water Resources Management, Living in the Semiarid and Citizenship;
- 2,800 masons trained;
- 85,600 cisterns built

We can imply from this process that when civil society gets mobilized and joins force it's partnership with government is strengthened and public policies, like the ones aiming semiarid development, are optimized. Numbers are showing, already, that the participative system of the 1MC Program promotes bonds among members of society and gives them directions to get organized to a better social and economical development of the region.

Optimization of Operating Policies of Multi Reservoir Systems Using Genetic Algorithms

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Keywords: optimization, water resources management, multi reservoir systems, operating policies, Genetic Algorithms

Finding optimal operating policies for a reservoir system has been a major area of study in water resources systems for several decades. Various kinds of optimization models are developed as the best tools to identify reservoir operating policies. However, there are some computational restrictions in these models especially in optimization of multi reservoir systems. So they are not able to represent the complex physical and hydrological characteristics of the system adequately.

A Genetic Algorithm (GA) model is proposed in this paper as a new optimization model of multi-reservoir systems operation and has shown to be very promising. This real coded GA is used in a direct search optimization approach and compared this some models of two other main optimization approaches of explicit stochastic optimization (ESO) and implicit stochastic optimization (ISO). In the proposed GA model, the policy parameters are directly optimized using the simulation results of the system as the fitness functions. Hence, the model has some good properties which make it able to optimize different kinds of reservoir systems, even large multi-reservoir ones.

Various forms of operating policies from simple and piecewise linear to more complicated ones like artificial neural networks are considered and optimized by this method. In selecting the operating policy form, the idea of a principle like the principle of parsimony of parameters in time series modeling is approved by the results. A new method is also proposed to define the time variations of policy rules, in stead of the conventional method of separable monthly rules. By this method, the policies are defined as a unique rule in which the operating periods of year is considered as an input variable. All the policy coefficients are considered as a Fourier series in which time of operating is its independent variable. Parameters of these Fourier policies are less in amount. Therefore the optimization computations can be reduced and the optimized policies are more reliable in future operations.

The conventional real coded GA is modified by changing its operators to enhance its computational performance. The idea of some of the modifications is come from Evolutionary Strategies (ES). The modified GA using adaptive normal mutation and blend crossover is remarkably faster and more effective than the conventional one in multi-reservoir systems modeling. Sensitivity of the performance of the model to its executive parameters (like population size of generations or probability of mutation and crossover) and variation of final results in different runs are also reduced in the modified model.

A varying period simulation method is also proposed to evaluate the fitnesses of GA chromosomes faster. Fitness of first generations chromosomes can be evaluated using simulation of a small part of historical time series since GA is exploring the state space of the problem in the start of computations. Length of simulation period would be increased generally in the next generations to get to the whole historical series. Computational time of optimization is therefore reduced by this method and the final results of the model are as accurate as the fixed length simulation method.

The modified GA model is evaluated by two simple reservoir systems with one and three reservoirs and then applied to Dez-Karoon 16-reservoir system as the largest multi-reservoir system in IRAN. In the first two systems, the GA model is compared with some conventional models like stochastic dynamic programming (SDP) and dynamic programming and regression (DPR) to evaluate its advantages. The conventional models however were not able to optimize the 16-reservoir system because of computational problems. Hence the system is just optimized using the GA model to show its capabilities in optimization of large multi-reservoir systems.

The results of simulations using historical data show that the performance of the GA policies is quite superior to the conventional ones. The GA model has shown to be flexible and robust, even in optimizing nonlinear, non-separable objective functions and constraints. It is a promising method for identifying operating policies for complex multi-reservoir systems. The model is very useful especially when the reliability is the objective function of problem or one of its constraints or even in multi-objective optimization.

Enhancement of Groundwater Recharge in Upper Water shed Areas to Improve River Baseflow in water sheds of Sr Lanka

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In recent past, it was observed significant depletion of river base flow in several river basins during drought periods in Sri Lanka. This situation may effect for groundwater regieme of downstream areas. In addition, this situation no doubtedly affect water supply schemes mainly in large scale domestic and irrigation water supplies. The main causes observed as variation of rain fall pattern and some man made activities in these river basins. Meantime water demand for various development activities is being gradually increased and nearly 100 of town water supply schemes suffer from reliable water intakes to cater future demand. Therefore it is necessary to implement sustainable water resources management programme to over come this situation. In this aspect, it is important to implement water conservation program on river basin level. To initiate this concept, sub basins of Deduru Oya river, Sri Lanka, has been selected to study the possibilities of increasing groundwater recharge in upper water shed areas to increase river base flow of downstream areas, specially in dry zone. Due to prevailing geological, geostructurel and geomorphological characteristics of the selected area, which is hard rock terrain, there are possibilities to improve river base flow by improving groundwater recharge, as mentiond above. In this paper it is intended to present some special behavior of surface water and groundwater in the selected river basins and possible approach to carryout groundwater modeling. Groundwater flow pattern in fractured hard rock aquifer areas are considered to prepare conceptual modeling of ground water in order to forcast expected baseflow after increasingt groundwater recharge of upper water shed areas of the river basins.

Integrated Rainwater Harvesting and Management Systems and Complementary Technologies for Sustainable Livelihoods of Pastoral and Agro-Pastoral Communities in Greater Horn of Africa

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Keywords: Water scarcity, drought mitigation, rainwater harvesting and management, integrated livelihoods systems, marginalized communities, poverty reduction

Most of the Greater Horn of Africa (GHA) countries are experiencing profound socio-economic and political problems, the most dramatic being food crisis and disruptive conflicts. In particular, the pastoral and agro-pastoral communities in ASAL, which covers more than 70% of the area, have been experiencing a combination of both short-term, often acute food crisis, and long-term or chronic food shortages due to the negative effect of recurrent drought on their livestock which is the main source of livelihoods. Long-term or chronic food shortages often translate into famine and starvation, requiring emergency food aid. The latter are less obvious, for they are characterised by negative changes in the economic, social and ecological factors and their interrelationships over longer time periods. These crises threaten the stability and existence of the affected communities and economies because their systems are obviously failing to cope, increasing the vulnerability of the people. A number of explanations have been advanced for the endemic food insecurity and poverty in the GHA. Among these, recurring drought and unreliable rainfall are the most obvious. These include: adverse weather and drought; rapid population growth rates that exceed rates of food production; adoption of production systems that accelerate environmental degradation and decline in fertility; retrogressive social organizations, inadequate policies, legislation and institutional weaknesses.

The livelihoods of the pastoral and agro-pastoral communities living in the marginal areas of GHA are periodically affected by recurrent droughts, floods and other environmental disasters. To respond to the critical needs of these communities, Rainwater Harvesting and Management (RHM) systems and complementary technologies have shown positive socio-economic and environmental impacts. Rainfall in these areas is low, annually ranging between 250-800 mm, it is poorly distributed and occur in heavy storms, which some times cause flash floods and loss of human and livestock. RHM systems—collecting, storage and management of surface runoff and floods, especially in water pans or earthdams have proved to be an essential source of much needed water especially for livestock, domestic and micro-irrigation. However, poor sanitation and environmental management leads to deteriorating water quality especially for domestic purposes. This problem was addressed through improved sanitation and environmental conservation to reduce water pollution and soil erosion respectively. Good quality water will reduce water borne and related diseases that mainly affect children.

The project also promoted water management related and complementary technologies such as drip irrigation for vegetable production, rangeland and watershed improvements, bee keeping and honey production, improved sanitation, establishment of tree and vegetable seedlings nurseries, fodder/hay production and management (bailing) and sustainable natural resources management. Therefore, an integrated and multi-sectoral approach to rural development was adopted to bring together various stakeholders working with the same communities and enhance realization of socio-economic impacts.

The overall objective was to establish three community-based pilot sites for promoting integrated RHM systems and complementary technologies with the aim of enhancing sustainable livelihoods of pastoral and agro-pastoral communities in Kenya. Two pilot sites (Isinon in Kajiado district and Wamani in Laikipia district) were implemented through financial assistance from USAID/DCHA/OFDA while German Development Service (DED) funded the other site (Kimalel in Baringo district). The specific objectives were:

- To increase water availability and management;
- To improve sanitation and water quality;
- To improve food security and alternative livelihoods systems;
- To improve pasture and fodder production and management;
- To build the capacity of local communities to ensure sustainable natural resources management; and
- To disseminate information and share experiences among the stakeholders.

The project results have shown that integrated RHM systems and complementary technologies can drastically improve the livelihoods of marginalized communities and make the vast drylands in GHA more productive. The project has been well received by stakeholders due to its verified impact indicators and changed communities' perception. However, replication of the pilot project would not be successful without the participation of relevant multi-sectoral stakeholders. The project results also show that there are economically viable, simple and environmentally friendly initiatives that can address the persistent drought and famine in GHA. The proposed poster will highlight the implementation process and results of the pilot project.

Alluvial aquifers as potential safe water storage in semi arid areas: Case study of the Lower Mzingwane Catchment, Limpopo Basin, Zimbabwe

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Keywords: alluvial aquifer, safe storage, groundwater, remote sensing, Limpopo Basin

Availability worldwide of fresh water for human use is becoming an increasingly difficult resource to ensure and sustain particularly in semi-arid climate. Semi-arid regions are faced with problems of limited surface water resources due to high evapo-transpiration, low seasonal rainfall and vertical seepage losses to bedrock. Studies done in the Lower Mzingwane Catchment, Limpopo Basin in Zimbabwe suggested that alluvial aquifers are potential sources of water. Alluvial deposits are common in the Lower Mzingwane, occurring as a sand filled ephemeral river, with extensive alluvial aquifers distributed along its banks on the lower catchment.

LandSat TM imagery was used to identify alluvial deposits for potential groundwater resources. On the false colour composite band 3, band 4 and band 5 (FCC 345) the alluvial deposits stand out as white and dense actively growing vegetation stands out as green making it possible to mark out the lateral extent of the saturated alluvial plain deposits using the riverine. The alluvial aquifers form ribbon shaped aquifers extending along the channel and reaching over 20 km in length in some localities and are enhanced at lithological boundaries. These alluvial aquifers extend laterally outside the active channel, and individual alluvial aquifers have been measured with areal extents ranging from 45 ha to 723 ha in the channels and 75 ha to 2196 ha on the plains.

The distribution of these aquifers, is determined by the river gradient, geometry of channel, channel width, loss of stream flow by evaporation and infiltration and rates of erosion. Enhancement of alluvial aquifers may be associated with geological boundaries, occurring both upstream and downstream of the geological contact and these enhanced aquifers have been noted to have good storage potential. The lithologies on either sides of the geological contact will exhibit different degrees of resistance to fluvial erosion. The alluvium will accumulate on the less resistant lithology, either upstream or downstream of the resistant lithology. Mazunga Ranch has a resistant lithology (silicified sandstone) downstream and Bwaemura and resistant lithology (gneiss) upstream. These enhanced alluvial aquifers form big pockets, which have great potential for water storage during the dry season and drought years. Estimated water storage potential ranges between 175,000 m3 and 5,430,000 m3 in the channels and between 80,000 m3 and 6,920,000 m3 in the plains Such a water storage potential can support irrigation ranging from 18 ha to 543 ha for channels alluvial aquifers and 8 ha to 692 ha for plain alluvial aquifers. Artificial alluvial dams can be constructed to increase the storage capacity of the aquifer and thereby store enough freshwater for the dry season.

Recharge of the alluvial aquifers is generally excellent and is derived principally from river flow and full recharge normally occurs early in the rainy season. By contrast for lateral plains aquifers, recharge depends on the permeability of the aquifer, the distance from the channel and the duration of river flow. Some alluvial aquifers may be recharged by surface water dam releases during the dry season, such as the Zhove dam on the Mzingwane River.

The water quality of the aquifers in general is fairly good due to regular recharge and flushing out of the aquifers by annual river flows and floodwater. The different grains sizes from clay size to gravel size in the alluvium profile can act as filters making the water free from bacterial contamination. Water salinity was found to increase significantly in the end of the dry season, and this effect was more pronounced in water abstracted from wells on the alluvial plains. During drought years, recharge is expected to be less and if the drought is extended water levels in the aquifers may drop substantially, increasing salinity problems. To avoid salinity problems, integrated water management is needed to utilize the plains and river channel aquifers conjunctively. Abstraction rates and water quality should be monitored to avoid salinity problems of the river channel aquifers during the dry season and drought years.

Evaporation losses from the channel sand beds are initially high, but decline as the water table declines to approximately 90 cm below the sand bed surface. On the alluvial plains with finer grained soil, the evaporation extinction depth may be somewhat deeper. Therefore alluvial aquifers can be good water storages in semi arid regions where high evaporation rates prevail. Currently some of these aquifers are being used to provide water for domestic use - J.Z. Moyo School and Mtetengwe Village, livestock watering and dip tanks - Kwalu, commercial irrigation - Mazunga and Gem Farms, food security scheme - Kwalu Irrigation Scheme and market gardening -. Bwaemura Village. Alluvial aquifers can sustain small-scale irrigation and infiltration galleries and well point systems can be constructed to exploit the groundwater resource.

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Workshop 10:

Extreme Events and Sustainable Water and Sanitation Services

Reconstruction Issues and Lessons Learned by Wastewater Utilities Affected by Hurricane Katrina

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The provision of public sanitation – that is, collection and treatment of wastewater from homes, offices, schools, and other enterprises – combined with sound hygiene behaviors significantly reduces infectious disease. The World Health Organization estimates that, in countries with inadequate water management, improved sanitation can reduce diarrheal morbidity and mortality by 32 percent.

Hurricane Katrina, which struck the U.S. Gulf states in late August, 2005, devastated wastewater utilities that provide essential services to residential and commercial interests. The long-term effect on these utilities is of great concern to local, state, and U.S. officials.

This presentation will describe a study prepared for the Water Environment Federation which documented damage caused by Hurricane Katrina to wastewater facilities in the Gulf region and made recommendations for governments and utilities to help recovery from this hurricane and suggestions to help mitigate damage from future disasters.

Flood Risk Assessment and Management in Ukrainian Part of Tisza River Basin

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Keywords: flood management, hydrometerological network, modeling, risk assessment, public awareness

Background Conditions in Zakarpattya

EU Project "Flood Risk Assessment and Management in Zakarpatska Oblast" is focused on Zakarpatska Oblast (administrative region), which lies in the west of Ukraine. The oblast has an area of 12,650 km2 and a total population of 1,245,000 people. The upper Tisza catchment (the part lying in Ukraine) has a long history of flooding as a result of intense rainfall episodes. The highest level of rainfall occurs in June and the lowest in January and February. However, the melting of the thick snow cover in spring raises the general level of the rivers and if this combines with high rainfall, a flood wave can (and often does) develop. Within 6 - 10 hours, the water from such an event reaches the Ukraine-Romanian border and within 12 - 36 hours it reaches the Ukraine-Hungarian border, with a possible water level rise of 8-10 m. The severity, frequency and economic impact of flood events have shown an increasing trend since the late 1960s. Thus, very large floods have occurred in May 1970, December 1993, November 1998 and the largest of all in March 2001.

Since Ukraine has recently declared its intention to join the EU, and given that the two neighbouring countries are already EU states and Romania is EU accession state, the provisions of the Water Framework Directive will increasingly apply to the control and management of floods in the Tisza River basin. This implies the future preparation of a river basin management plan between the EU member states and the application of environmental and ecological quality tests for any proposed flood mitigation measures.

Present State of Flood Management

The problem of floods and flood management in the upper Tisza basin can be considered at three levels:

- First, there are flash floods that can occur almost anywhere in a matter of hours after sudden localised heavy rainfall, especially if (as in 1998) aging levees break giving way and contribute additional water and rubble to the flow. Flash floods tend to be localised in Ukraine and cause damage mainly in the upper montane reaches of tributaries but can be very dangerous for human life because of their speed.
- Second are the more widespread and economically devastating floods that arise over a few days after sustained rainfall, often combined with snowmelt. These floods also affect the immediate neighbours or (as happened in 2001) can even start in a neighbouring country (in this case Hungary) and spread to Ukraine.
- The third level is devising an appropriate long-term strategy that recognises the fact of the upper Tisza catchment as a flood- prone area and putting in place environmentally sound water management, land-use and economic development policies that will ensure that floods cause minimum impact, with an emphasis on complex approaches to problem solution.

The authorities in Ukraine are concerned with both types of flooding, while the neighbouring countries are naturally more concerned only with the widespread events, and ensuring that they have sufficient warning of them from Ukraine itself. Floods of 1998 and 2001 made the riparian countries elaborate a long-term catchment-wide flood control strategy.

Results of the Project

The Overall objective of the project is to improve the security of people and property against floods in the Tisza River catchment by putting in place better assessment, warning and response systems, while reducing over time the frequency and impact of flood events with a focus on non- structural measures.

The results of the project are grouped in 3 major clusters:

1. Emergency flood forecasting system improved:
    - The completion of a hydro-meteorological and flood monitoring network capable of generating real-time data over the whole upper Tisza basin, designed to be shared on-line with flood management centres in Hungary, Romania and Slovakia. With financial support of the project, 8 automatic hydrological stations and 5 automatic meteorological stations were installed. Therefore, the total number of automatic hydrological and meteorological stations has increased up to 35.
    - A flood forecast model system capable of predicting a widespread flood in upper and middle river reaches with acceptable accuracy and providing a warning of a local flash flood in upper river reaches with improved confidence on basis of MIKE 11;
    - Implementation of a regional digital model for weather parameters forecasting; and
    - Design for a shared real-time on-line hydro-meteorological database between Ukraine, Hungary, Slovakia and Romania.

2. Long-term flood management improved;
    - A review of the existing national Tisza flood control strategy 2003 – 2015, demonstration of the effectiveness of structural measures and practical demonstration of non-structural measures, including restoration of flood plains, of involvement of polders as retention reservoirs in flood management and of public participation in decision-making on flood alleviation measures;
    - A distributed GIS platform capable of deploying likely inundation zones and affected infrastructure under different flood scenarios with an accuracy range of approx. 50 cm in the flood plains; and
    - Staff with enhanced knowledge or skills in flood monitoring, flood forecasting and long-term flood management.

3. Public awareness with respect to flood problems increased:
    - Wider awareness of the underlying causes of floods in the upper Tisza basin, of how to respond in an emergency, and of methods for coping with floods on a sustainable basis. The project has produced 4 videos about floods in Zakarpattya and published 2 brochures on general causes of floods and management of Tisza floodplain as well as schoolbook for children.

Conclusions and recommendations
Taking into consideration the results achieved:

1. Further development of Emergency flood forecasting system: It should include automatization of the remaining manual gauging stations and integration of the system into existing ones in the neighbouring countries (Hungary, Romania, Slovakia)

2. Further improvement of Long-term flood management: It should include
- Technical (coverage by operational hydraulic model the whole river as well as development of water management GIS)
- Institutional (improvement of interinstituioanl co-operation between national institutions within river basin as well as improvement of Ukraine’s participation in ICPDR activities)

3. Continuation of public awareness activities: Taking into account the mentality differences of local population, to develop on-going sustainable programmes of public awareness activities, including preparation of presentations, posters and leaflets.

Implementation of Multipurpose Strategies to Mitigate Extreme Events and Sustainable Water and Sanitation Services in Sri Lanka.

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Keywords: Disaster, Information, Facilitation, Policy, Coordination

The intergovernmental panel on Climate Change has concluded that human activities are altering our climate system and will continue to do so. Over the past century, surface temperatures have increased and associated impacts on physical and biological systems are increasingly being observed. It is very likely to increase the frequency and magnitude of extreme climate variability, affecting water and sanitation services drastically around the world. Indian Ocean Tsunami, Earth Quake in Pakistan, Hurricane Katrina are such examples. Its adverse impact of climate change will be most striking in the developing nations, and their limited capacity to adapt to a changing climate and they are the most vulnerable in the wake of extreme events.(IPCC). The lack of water and sanitation services during rescue and relief operations and failure to restore sustainable services promptly is a serious challenge for water security in the future world.

The tsunami is the worst ever nature induced disaster that affected Sri Lanka. The tsunami affected 2/3 of the costal belt, 31000 lives lost, 5000 missing, 15000 people were injured, a million people displaced. The total lost in the assets to the country is US$ 1000 million or 5 %GDP. Over 8000 houses, 5000 buildings were damaged The cost of production was estimated at US$ 330 million This paper examines how magnitude of the social disasters erupted with water and sanitation services collapsed by the tsunami, and also, explain how humans are vulnerable, when communities are disorganized, institutional arrangements are not fully functioning to cater, water and sanitation services in the wake of such events, and describes how to get rid of these setbacks by mitigating risk and coping with these menace, mother Sri Lanka adjusted her Disaster Mitigation Plans to, cater basic needs; water and sanitation by securing food for affected population, while infrastructures; water, sanitation, rehabilitation are maintaining with peoples participation. International Donor Agencies, including the UN system and bylateral donors, NGOs, private sector and civil organizations played a significant role in providing relief to returning normalcy.

The Implementation of the Recovery Plan. The plan consists with three phases (1). Relief Phase, in the beginning, authorities prepared a rapid participatory damage and needs assessment survey. Regarding the scale and urgency of humanitarian needs, the government deployed armed forces with the relief workers and they work together, removed thousands of corpses, and cleaned up waste materials and sludge. Temporary camps were setup for refugees, but inadequate water and sanitation facilities let them to more social disasters. Women, children, girls have been the most vulnerable, due to lack of privacy, and sexual abuse. Due to lack of proper waste disposal system they were suffer from environmental pollution along with health hazards. Lack of coordination among government authorities and the donor agencies and the survivors and lack of powerful information network are the main hindrance to delay the relief work and rescue operations. 2. Rehabilitation Phase, President Task force for Relief (TAFOR) were formed to accelerate and facilitate post-tsunami rehabilitation by engaging key stakeholders. Here they selected the priorities, in the base of needs assessment survey, agency officials select the priorities, after the consultation with local community, and then start the recovery and reconstruction works, improving the working and living conditions of the people, they can earn by working in the rehabilitation sites. 3. Reconstruction Phase. It will go up to 4-5 years, with the entire social, economic, environmental including water and sanitation will be renovated. It is revealed that much consultation, exchange of information, between and among state officials, donor agencies and stakeholders was necessary to plan and implement the rehabilitation work to resume satisfactory services. As a policy, donor agencies should design and implement their programs, to foster reinforces and supply national and local initiatives, based on the needs of the local population. Yet the same time there are pitfalls to be avoided in mobilizing international disaster aids. So that, The Task Force To Rebuild the Nation was formed, to set the policy framework, and coordinate of recovery activities and progress monitoring. We have to see Spatial Planning also, for it requires a great deal institutional synergy and capacity building, The Capacity Development for Recovery proposed by the UNDP is a important initiative for the sustainable water and sanitation services. They renovate the community based water supply schemes, recovering of costal belt with tree planting while safeguarding the ecosystem via CBOs.

There are many drawbacks, where we have to omit in the future development plans. The Disaster Management Center, could not educate the people about the tsunami. Education and awareness programs will be very important to mitigate the risk. A buffer zone along the costal belt proposed, but it was delayed due to political interference. ICTAD proposal on rainbow pattern, settlement along the costal belt, also cancelled. The routine governmental procedures were not sufficient to deal with the emergency situation. There are many problems in logistics also; Lack of information, data and insufficient communication networks, lack of coordination are main hindrances.

Sustainable recovery plans, specially during search and rescue phase should not be only from hard-solution approach, it must be coupled with soft components also, like good governance, transparency and participatory policies are of the essence to prevent and mitigate the social disasters erupted in the extreme events of the world.

Gender and Water in Disaster Risk Management

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Keywords: Gender, disaster, community, sustainable water, vulnerability

In Bangladesh, household and community responses to extreme recurring events like floods are an indicator of the extent of their vulnerability, the intensity of the hazard, and their level of capacity. The more informed people are ahead of time, the more they can prepare for the hazard and reduce their risks and vulnerability. Flood preparedness is to a very large extent dependent on two elements. One is the ability of relevant national, local and community institutions to harmonize communication flows and levels. The other is determining and prioritizing the content of communications on the basis of users' needs and/or demand-driven priorities. The traditional hydrologic forecasts lead-time is very short, and local people do not understand danger-level terminology. There is no mechanism to relate forecast information to user needs at specific locations.

Men and women have different capacities and vulnerabilities due to their different roles and conditions. Therefore, they are affected by disaster differently. In many contexts, men are better connected to early warning mechanisms due to their movement in public spaces and access to formal and informal channels of communication, such as radio and TV, informal community networks and interaction with officials. Women have limited access to information and knowledge related to disaster risks in the communities where they live. Women are more active with reproductive work, have less mobility in the community and understand hazards less. Women's voices are barely heard regarding risk reduction in policy and decision-making processes.

A gender analysis framework was developed to study different gender aspects related to disasters: roles, access and control of resources and means of communication, and impacts before, during and after disasters. The Harvard analytical framework and the access and control framework were used to make women's roles visible in risk management.

In the 2004 flood, men and women in the community studied, benefited greatly from new mechanisms introduced such as the flag network, microphones in mosques, and drum beating. Some women in the community said that they are now trying to understand the flag network and the importance of information. Gender mainstreaming which enables women's active participation in community-based flood risk management can reduce risk and vulnerabilities and strengthen women and men's capacity to cope with hazards.

To address the need for gender mainstreaming and more effective and user-friendly forms of communication, separate discussions were held with the men and women and local level institutions to hear their inputs and suggestions, using the following:

- Standard dissemination systems e.g., post-mail, written and oral messages;
- Women's views and ideas considered in decision-making regarding risk management;
- Messages delivered to women through beating drums and from women workers in the village. They prefer these mechanisms over others because they have limited movement outside and get information on their own;

- Information sharing from national institutions to community stakeholders;

- Community-level gatherings organized at mosques and marketplaces by politicians or local NGO activists;
- Radio, TV, national and local newspapers disseminating daily information during floods;
- Fax and e-mail if available;
- Easy-to-read maps to identify the extent of flooding;
- Flag network system (red for severe flooding, yellow for moderate flooding, green for normal flooding, blue for increasing water level and white for decreasing);
- Agents to transmit information (imams, teachers, etc.); and
- Effective forms of communication such as microphones in mosques and beating drums.

As a result of this research, which was done in preparation for that year's monsoon season, new forms of communicating flood information were tested. The danger level for river flow was set for every village. Flood warnings in the local language were prepared using different media, including posters, photographs and audio tapes. These were selected as ways of strengthening local institutions and providing access to information in particular to illiterate people regarding such activities as evacuating cattle, crop and emergency food preparedness, and organizing boats for evacuation.

The community is the key resource in disaster risk reduction, and community members are the key actors and primary beneficiaries of disaster risk reduction. Gender mainstreaming in community participation is generally taken to mean that men and women will take equitable responsibility for all stages of the programme, including planning and implementation of risk management.

National and local government agencies should engage and encourage women to participate along with men in implementing projects. They should take into account the different roles and needs of men and women, while planning all stages of disaster preparedness, relief, and rehabilitation. Finally, gender mainstreaming in flood risk reduction needs to be institutionalized

Emergency Sanitation Measures for Disaster Management

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Keywords: Emergency Sanitation (ES), Psycho-social Counselling, Disaster Management, Onsite Sanitation, ES Guidelines

Introduction: The frequency of occurrence of natural disasters is increasing steadily. According to the Emergency Disasters Database, EM-DAT (maintained by the WHO Collaborating Centre for Research on the Epidemiology of Disasters (CRED)), the total natural disasters reported each year has been steadily increasing in recent decades, from 78 in 1970 to 348 in 2004. The loss of life and property that follows is enormous and the survivors in their state of shock can't reconcile easily with the event. At this stage the disruption of services - water, sanitation, electricity etc. wreaks havoc on the disaster-struck people.

WHO studies report that epidemics after natural disasters can claim many more lives than the actual event and are as sinister if not more, than the disasters. Outbreaks of diarrhoea and cholera in the disaster affected areas are a common routine. Unsanitary living conditions in relief camps are conducive to an outbreak of disease, with dead carcasses strewn all around and disrupted water supply pipes, broken hand pumps, and no toilet facilities.

Emergency Sanitation is the provision of low-cost temporary toilet (onsite sanitation) and hand-wash facilities which can, preferably be dismantled at a later date. The pace of construction or setting up such structures has to be very fast so that they can be ready for use at the earliest. These measures are required during fairs/ festivals where a large floating population congregates for a few days and in disaster management in relief camps.

India has witnessed two major disasters in the 21st century. One was the deadly Tsunami that struck countries on the Indian Ocean on 26 December 2004 and the other was earthquakes in Gujarat in 2001 and Jammu & Kashmir in 2005. These natural calamities left in their wake thousands dead and tens of thousands displaced from their homes.

Sulabh International, an NGO working on developing and implementation of cost-effective and eco-friendly sanitation technologies was involved in providing Emergency Sanitation for disaster relief after the 2004 Tsunami and 2001 Bhuj Earthquake. Sulabh volunteers took up the sanitation work in the disaster-struck areas – Bhuj in Gujarat after the earthquake in 2001, and in Tamil Nadu, Kerala and Sri Lanka in 2005 after the December 2004 Tsunami. Toilets were provided to the survivors. Volunteers were trained for the construction of low-cost toilets so that they then help the community to construct these toilets. Survivors were also educated on proper hygiene and sanitation practices. A campaign was carried out to educate and motivate the people on the importance of hand-washing before cooking, eating meals and after going to the toilet. Children from the Sulabh School Sanitation Clubs visited the Tsunami affected Nagapattinam district of Tamil Nadu in India and assisted in psycho-social counselling.

Observations: Governments which do not have concrete Disaster Management plans are left vacillating as to what should be the immediate relief and rehabilitation priorities when hit by a disaster. By the time a plan for water and sanitation comes up, it is already over a week or two since the disaster struck. At this stage, policy makers tend to spend money on semi-permanent/ permanent rather than temporary structures – individual and public toilets, bathrooms and wash-basins. The provision of permanent structures in the relief camps becomes a time taking process as materials and labour have to be procured from distant places. Disruption of rail and road transportation services further delays the process.

Also, in developing countries like India a large percentage of the affected people have no past experience of using toilets (owing to the low sanitation coverage in these countries and people defecating in the open). As such, mere provision of emergency toilet and hand-washing facilities is not enough. It becomes necessary to motivate and educate people to bring about the necessary behaviour change to stop the spread of diseases. They have to be convinced that indiscriminate open defecation near the temporary shelters/ relief camps can lead to several water-related diseases. Others' who had toilets in their homes or used community toilets are so shaken by the trauma that it takes psycho-social counselling and time to get used to the situation. Defecation - early morning ablution is so much a part of the daily routine of a person's life that when it gets affected, it becomes extremely difficult to believe that life is back to normal. The disaster leaves an indelible impression on the psyche of the affected people and once toilets are constructed and people start using them a semblance of normalcy returns.

Sulabh's experience with Emergency sanitation shows that thousands of individual toilets can be constructed in about a week's time, using locally available materials for construction and allowing time for stabilisation and consolidation of the foundation. W.C. Pans can be manufactured in fibre glass or in cement concrete and the superstructure can also be made from readily available local materials. Proper Emergency Sanitation measures can have a lasting effect on people and help in improving the overall sanitation coverage in the region and lead to increased usage of existing facilities.

Recommendations: Given the increasing incidences of natural and man-made disasters, it is imperative for every nation to have disaster management plans in place. Water and sanitation provision with adequate hygiene education should form an essential component of disaster management strategies. A general guideline on materials and methods of construction of individual and public toilets in different geographical zones should be prepared in consultation with agencies involved in the sector. It is also observed that people are more receptive to children and therefore the involvement of children in disaster relief measures is also recommended.

Disappearing Lands: Supporting Communities Affected by River Erosion

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A large part of Bangladesh is delta in formation. The 230 small and big rivers intersecting the country are considered to be most unstable in the world, and are frequently changing their course, thus eroding the lands situated along the river banks, inhabited by millions of people all over the country. Statistics reveal that nearly 7 million people have been displaced by river erosion over the past two decades, and current trends shows that more than a million are affected and nearly 100 thousand are displaced every year. In the process people loose not only their farming land and homestead, but find them completely uprooted from their community, social networks and livelihoods. In a way, the impact of erosion is far more devastating than other natural disasters, as it permanently washes away the land on which their livelihood and structures depended. This affected community having no other means of shelter and living, and are forced to take refuge in unauthorised and marginal lands, living under most deprived and in-human conditions. Those who have no other alternative migrate to cities in search of jobs. They are among the poorest of the poor in the society.

Practical Action Bangladesh (former ITDG Bangladesh) has been implementing since 2004 to address the development needs of the communities, who have been displaced by river erosion and those who are living under the threat of being eroded in the near future. The five year £1.3 million pound project will be implemented in Gaibandha district, a badly affected area. The project is working in close partnership with 5 local NGO's. The project has identified the following as key areas of intervention:

- Strengthening and supporting the capacity of the target community and institutions to cope with natural disasters;
- Providing alternative livelihoods opportunities through, skills development, technology transfer and small enterprise development;
- Develop and support basic infrastructure services (water, health, housing), and enable poor people to access existing government services
- Raise awareness on basic rights of the community, with particular emphasis on land rights and rights of women.

The project activities specifically will provide extensive livelihood skills training and technology support to over 12000 direct beneficiaries, about 800 community extensionists skilled in various trades will be developed and deployed, 4 cluster villages equipped with housing, water sanitation and other health and education services will be established, several refuge shelters, disaster proof housing will be constructed. In total, the project will reach directly 20,000 men, women and children. Practical Action is playing a key role in technology innovation and dissemination, skills training, enterprise development, and other activities related to disaster mitigation, rapid evacuation system and volunteer group development, market access and infrastructure services. Partner organisation is directly playing a direct role in services such as health and education. The project has attempted to take a holistic approach to tackle the poverty situation, mobilising a broad range of interventions to support a sustainable livelihood system among the community.

Latrine in Emergency Relief: The Priority Demand of Women in Bangladesh Flood

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Keywords: flood, latrine, female, relief, priority

Floods are one of the most common hazards and/or disasters. Flood or emergency relief for affected people by the concerned government, national and international development partners and/or communities has been a universal welfare expression over ages. Bangladesh is one of the most flood prone countries of the world. As post-flood diarrhea epidemics continue to be one of the main contributors in public health problems of the country, it is important that the emergency relief strategies be reviewed and appropriately improved. This paper discusses the environmental health experiences gained during the Flood 2004 relief based action research.

The Flood of 2004 affected 39 out of 64 districts in Bangladesh. The duration of flood varied from a few days to over a month in the affected areas. During 2004 Flood: (i) from 4-13 August 24,120 cases of dysentery, 10,670 cases of pnuemonia, and other infectious diseases, (ii) 200,596 tubewells damaged, (iii) 118,181 tubewells repaired/restored, (iv) 831 tubewells and over 2156 latrines constructed in flood centers, reported (4). Medical teams, temporary treatment centers, distribution of food and drugs (including ORS), and strengthening of health education were also included in the relief activities by various organizations. We visited 8 of the worst affected sub-districts within 5 to 10 days of the flood. We gave trainings to relief workers on environmental health measures, distributed limited amount of dry foods, drugs, water purifying tablets (WPT) and installed some latrines and tubewells. We randomly interviewed 86 females and 86 males from shelters, and 18 females from relatives/friends houses.

Most of the houses, roads, tube-wells, bushes and other infrastructures were under water or washed away. Thousands of people were forced to live with relatives/friends whose houses were not flooded, on high roads, in schools or in government buildings. When asked to prioritize the needs, from food, water, latrines, drugs, doctors and other needs, 69%, 58% and 40% of the various females in shelters, females in houses and males in shelters respectively, named latrines as their number one concern. Overall, 55% demanded latrines, 17%, food, 14%, drinking water and the rest listed various items. About 61% of the women in shelter/roads, 12% of the women in houses and 53% of the males in shelter/roads had received some (mostly not adequate) food and required drugs. During or after the flood, the bushes were washed out so that women climbed trees or waited for hours after sunset to defecate. Many women claimed that they barely ate or drank to avoid defecation. The local leaders and relief workers were waiting for the flood water to recede before installation of latrine as there was no not flooded land or did not want to damage a road by constructing a latrine. None had received water -purifying tablets. All claimed that they made special efforts to collect tube-well water and drank it for safety. About 70% collected water from flooded tube-wells and the rest from intact ones. The participants of the training workshops also claimed that latrines were the first priority need for women in the affected areas. Limited level of WPT was distributed. About 40% of the tested WPT had lost potency. The fecal coliform bacteria count in the tested tubewells water samples varied from 'nil' to more than 1000 cfu/100 ml.

Clearly latrine is the highest priority of women during flood. It is recognized that spread of disease from poor sanitation or not sanitary latrine occurs during normal as well as disaster periods. We consider top priority to provide a place for people, particularly women, to excrete during flood. Although more than 90% of the people drink tubewell water, about half of the population do not have access to sanitary latrines during normal period. Provisions for sanitation and safe drinking water are included in the PRSP. Often construction of latrine is undertaken during rehabilitation periods. But relief strategy should be urgently reviewed in both gender and appropriate solution perspectives and in line with the development needs of the country. We strongly recommend that inclusion of installation of latrines, research and development of appropriate latrine technology, and their wide promotion in flood and/or disaster management related activities be given immediate consideration. In worst situation even unsanitary latrines for females should be installed in an accessible location immediately during flood. The disaster teams should include as a priority, like tubewells the stockpiling of materials for construction of latrines in flood prone areas. Also appropriate provisions for washing hands after defecation, and education about hygiene and simple dis-infection of water should be included in relief packages. All those will have demonstration and development implications for sustainable improvement in water and sanitation services.

Ensuring Access to Proper Sanitation during Extreme Events: A Tsunami Perspective

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Keywords: Disaster Management, Internally Displaced People, Emergency Sanitation, Appropriate Technology, Institutional reform

Tsunami wave of December 26th 2004 was undoubtedly the greatest disaster that Sri Lanka had seen in its recorded history, which rendered nearly a million people homeless in the immediate aftermath. Food & Shelter, Medical attention and Sanitation were the three main issues which had to be essentially handled by the organizations looking after these Internally Displaced People (IDPs).

Although the first two issues were successfully coped with, there are evidence to believe that post tsunami relief operations failed to ensure access to proper sanitation facilities for the IDPs in some places. Authors came across few IDP camps at a close proximity to Colombo which had only 1-2 latrines for nearly 1000 inmates. Some temporarily relocated schools with more than 1500 students have no latrines of any kind until now.

Above facts clearly indicated the grave situation which existed during immediate aftermath of the Tsunami with regard to sanitation in IDP camps and related facilities.

This paper is an attempt to delineate and suggest solutions to the critical problems encountered in providing proper and adequate sanitation during refugee situations which underdeveloped tropical countries are frequently experiencing. The authors record the experiences gained in a project to formulate a series of construction techniques for emergency latrines, as a partnership of Government and NGO sector organizations during the Tsunami aftermath. It also discusses how "proper and adequate sanitation" can be ensured through a proper disaster management framework. The paper would critically review the institutional drawbacks and failures which lead to the above mentioned unfortunate situations.

It was identified that the key issues, which should be addressed in providing proper sanitation during IDP situations in tropical developing countries like Sri Lanka are;

1. Developing effective and low-cost the technical solutions to cater for problems faced in different localities.
2. Institutional and structural changes required to incorporate sanitation as a key concern in a disaster management/preparedness plan.

3. Building awareness about the importance of proper sanitation among the IDPs in the aftermath of a disaster.

Technical solutions

Four versions of simple latrine construction methods were developed under this project, each new version being more complete but complex than the former. This series of latrine construction techniques will be referred to as Sri Lankan Disaster Latrine (SDL), for the convenience of reference. To give a better and permanent impression at the field level, it was given a simpler name "Amila" when introduced to the camps. Around 25 pilot units were installed in Tsunami rehabilitation camps around Sri Lanka, after proven success the know-how was disseminated through workshops and publications.

Table 4.2: Costs and comparison of different SDL units

Unit	Description	Merits	Demerits
SDL 1	Emergency latrine with a steel barrel pit, designed to hold solids for 3-6 months and soak the liquids efficiently than the conventional latrine types	Simple, Low-cost, No need to prefabricate, very fast installation (1 day)	Short life time, not applicable to waterlogged conditions
SDL 2	A design similar o SDL 1 but can be desluged and used for longer periods than SDL 1	Simple, No need to prefabricate, durable	not applicable to waterlogged conditions
SDL 3	A simple anaerobic filter toilet prefabricated using steel barrel. This can be applied in water logged sites.	Applied to water logged conditions, Durable	Cost is higher than SDL 1& SDL 3, Pre-fabricated unit, Needs storage space
SDL-Plat	A prefabricated sanitary toilet platform , which caters to the pressing need of lack of skilled labour encountered in emergency toilet installation	Simple, Low-cost, Fast installation	Pre-fabricated unit, Needs storage space

Institutional and structural changes

The government of Sri Lanka passed the National Disaster Management act in August 2005, which is a comprehensive law and a detailed institutional mechanism to prepare for and handle disaster situations. Several initiatives were taken even before this to draft disaster preparedness plans for each district by the National disaster Management Centre of Sri Lanka under UNDP funding. There are several internationally accepted disaster management models and guidelines that are adopted and followed in the tropical developing countries, such as the guideline of the SPHERE program. Authors observe that the prominence given to sanitation in all these presently followed disaster management models in the developing countries is not adequate to handle complex and challenging problems encountered in some localities. Based on their experiences gained on the 2004 Asian Tsunami relief and rehabilitation work the authors suggest a mechanism to incorporate the sanitation into the existing disaster management mechanisms of developing countries. The salient points of the suggested mechanism were;

1. No new organizations will be created for the purpose
2. Pre-disaster training of sanitation volunteers and representatives from local organization on basic sanitation and emergency sanitation techniques
3. Having prefabricated latrine units and sanitation chemicals ex-stock in local centres within disaster prone areas
4. Having a permanent fund dedicated for sanitation in the disaster management centres, national or local.
5. Regular linkup with expert agencies for monitoring and research & development.

Learning from the lessons of 2004 Asian Tsunami effective steps should be taken to lobby institutional support to incorporate sanitation as a focal point in disaster management process. With a combination of appropriate technology and proper management, problems arising due to improper or inadequate sanitation during a disaster can be effectively eliminated even in the developing world.

Management of Impacts of Large-scale Accident at Municipal Waste-water Treatment Plant

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Keywords: crisis management, environmental impact, waste water treatment

Introduction - Described are social, economic and environmental aspects of heavy flood-induced accident at major waste water treatment plant (WWTP) with treatment capacity 1.5 million m3/day in Kharkiv, Ukraine directly affecting water supply to about 2 million people in the city of Kharkiv and surrounding region. Indirectly affected, through water supply sources pollution, was a territory with population of 6 million inhabitants of Ukraine. This accident is considered as the second largest accident, after Chernobyl accident, in modern Ukraine.

Scope of events - As a result of extremely heavy rainfall huge amounts of rain water flooded the territory of the city, including some subway stations as well as pump station of WWTP. The specific feature of this pump station is location of its pumps – at the depth of 40 metes from the land surface inside of reinforced concrete cylinder of 47 meters in diameter with 3 meter-thick wall. Waste water is delivered to the WWTP through deep-laying (30m) tunnel with a diameter of 3 meters.Flood water penetrated through ventilation ducts and openings into main pump station hall which caused complete over-flooding of pumps and, as a result, to cessation of WWTP operation.

Impacts assessment - Termination of WWTP operation led to discharge of huge amounts of untreated waste water to surrounding areas and small rivers .To reduce volume of water coming to the WWTP for treatment, the city authorities had to take radical decision to stop operation of the centralized water supply system of the city. The main objective of this decision was to reduce amount of untreated waste waters entering the Seversky Donets river, which is trans-boundary river crossing the Lugansk and Donetsk Region of Ukraine and going further to Russia (Rostov-on-Don) and ultimately to the Black Sea. The decision to completely cut water supply for a city of 1.5 million inhabitants for more than 2 weeks relied on ability of civil engineers to rapidly restore operation of WWTP. In fact, full restoration of the system workability required about 40 days. The cut-off of water supply caused stoppage of operation of all plants, factories and organization in the city for more than 2 weeks resulting in great economic damage. Only restoration and upgrading of the WWTP operation and city sewerage network required 40 million US$ and is still carried out these days.

Crisis management measures - Crisis management measures were in general sub-divided into the following categories: resumption of the operation of the main pump station at the WWTP; sanitary and epidemiological measures; ecological clean –up of polluted rivers; assistance to population affected by the accident in order to avoid panic; The principal objective was to resume work of WWTP pump station. An urgent delivery of pumping equipment from neighboring regions as well from Russia and EU countries was organized. To remove water from pump station hall installed were more than 20 pumps. Volume of water to be pumped out was estimated at 180.000 m3. Originally it was believed that operation of pumps at the WWTP will be resumed in 3-4 days and population was recommended to make a reserve of water for 3 – 4 days. However, repair works had to be much longer and therefore more than 300 water tanks were mobilized to deliver drinking water for population and hospitals. It took more than 3 weeks to partially resume centralized drinking water supply in the city.

Environmental and health aspects:
Drastic shortage of water in Kharkiv was accompanied by very high air temperature reaching + 35º C which greatly increased probability of occurrence of epidemic diseases such as cholera. In fact, untreated sewage waters were intercepted by three small rivers which served as settling reservoirs for untreated wastes before further moving to the Seversky Donets River. For example, bacterial content in water in of these small rivers - Lopan River was 1.000 times higher than the accepted norm, but at the same time it was only 10 times higher at the Seversky Donets river water during the accident period. Found in the water of the Lopan River was cholera vibrio ,though it did not spread and no case of cholera among population of Kharkiv was registered at the time. To clean rivers from polluted sediments a number of flash discharges of water from the upstream reservoirs were made also in order to increase pollutants dilution capacity of small rivers.

Conclusions and recommendations - The above-described accident is an example of tragic combination of adverse natural event (rain-caused flood) and poor preparedness of the facility (e.g. only 3 of total 9 pumps were in operation at the rain event) on one side and, on the other side it also demonstrated the ability of the city to mobilize resources in the time of challenge, support and solidarity demonstrated by the population, efficient crisis management measures which resulted in the maximum possible at the time reduction of social and environmental damage inflicted in the region by the accident. Recent natural events, caused by climate change show that occurrence of adverse natural events causing accidents at municipal facilities tends to increase which calls for municipal authorities to develop crisis management systems and plans enabling to efficiently cope with such accidents; organize proper training of municipal facilities (e. g WWTP) staff; secure availability of critical stand-by equipment and materials, such as disinfectants as well as to raise public awareness, education and information on causes and impacts of municipal infrastructure accidents caused by natural events or/and human errors.

Exploring a New Approach to Water Systems Rehabilitation in War-affected Cities

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Keywords: Water Supply, Community, Private Sector, War, Urban Areas

War is the most common man-made disaster. In the last 30 years, major armed conflicts caused widespread death and destruction in 51 countries, 92% of them belonging to the developing world. Urban areas have been increasingly affected: during the same period, about 80 million people suffered from war in more than 150 cities of the third world. Modern wars have become predominantly urban because cities represent attractive targets for insurgents who see them as the foundation of political and economic powers. Cities may also be affected by crises unfolding elsewhere, because they attract displaced people seeking refuge.

Water supply is one the most important service to restore after a crisis because its interruption may easily result in disease and death. In cities, it is usually run by public or semi-public utilities. They also suffer from the consequences of armed conflicts such as infrastructural damage, loss of assets and personnel, and impoverish costumers failing to pay for the service. It is a downward spiral, in which even rich consumers become less ready to pay for deteriorating services. This contributes to a lack of funds, which restricts maintenance, thereby creating further deterioration.

Aid agencies are often involved in the restoration of water services in cities affected by armed conflict. This requires that they collaborate with water utilities, creating partnerships meant to ensure that rehabilitation projects are sustainable as a result of institutional strengthening. This is, in principle, acknowledged by aid agencies but the process does not always take place in a satisfactory manner because of concerns such as: independence vis-à-vis the local government; possible corruption and inefficiency problems; and political obstacles. Moreover, agencies and donors sometimes prefer short-term structural rehabilitation to long-term institutional development, for which they don't always feel sufficiently qualified and experienced. These concerns are dilemmas for agencies, worried about the sustainability of their projects but rarely aware of the best strategies to implement a policy that would contribute to achieving it. Consequently, projects may be designed on an ad-hoc basis and lack long-term perspectives.

A research carried out by the authors has documented and analysed this situation looking at a number of water systems rehabilitation operations in six war-affected countries of the developing world. Its objective was to identify how strategic options adopted by the various agencies involved influenced the performance of the rehabilitation projects, with specific attention to two of its most important aspects: coverage and sustainability.

The review of operations in Kabul, Afghanistan and Monrovia, Liberia showed that aid agencies were, in many cases, represented by two very different kind of actors: on the one hand, bi- or multi-lateral donors such as western governments, the European Union or the World Bank were involved in large-scale rehabilitation projects using commercial consulting firms; on the other, aid organisations such as international NGOs, UN agencies and the Red Cross, implementing smaller-scale community-focused projects. While both liaised with the local water utilities, neither significantly contributed to institutional strengthening.

Multi-lateral donors often chose to improve the effectiveness of the service by privatizing it. It was a way of limiting the amount of resources invested in water utilities they distrusted as inefficient and corrupt. However, in war-affected countries, suitable companies are very difficult to find, and they are unlikely to be able to make profits outside the city's wealthiest areas. Elsewhere, aid organisations strived to fill the supply gap by ensuring that those excluded benefited from a basic level of water service. They implemented a number of water projects, involving communities and their representatives, but in most cases, independently from the water utility.

Another of the case-studies, the Haitian capital Port-au-Prince, suggests an alternative strategy. In Port-au-Prince's largest shantytown: 'Cité Soleil', NGOs have funded the rehabilitation of the water network, so that residents only have to fund the operation and maintenance costs. In addition, given the lack of reliable private investors, the community has been trained in the management of the water distribution system in their area. This experience suggests that a pluralistic model should be adopted when considering the rehabilitation of water systems after armed conflicts, whereby certain areas are run by communities while others use a commercial privatisation approach. The water utility, remains the owner of the system but its responsibility is reduced since it only deals with a limited number of customers. Its role is still fundamental, because it ensures water production and quality and have the responsibility of delegating distribution to communities and private companies. It is therefore essential that aid agencies continue to contribute to their institutional strengthening.

Multi-lateral agencies and aid organisations have separate but complementary roles to play, which require that they coordinate their actions and use their resources and skills to contribute to the needs of communities, institutions and private partners. They should also influence the legislative framework allowing changes to take place. The whole process would reconcile delegated services and universal access by ensuring sustainability for a service, also accessible to the poorest.

Effect of Rehabilitation Process of Sewage Treatment Plant on Human Health in Marsh Area of Iraq

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Keywords: Diarrhoea, Health

Missan is an important province of southern area in Iraq, embracing large part of the marshes area, Amara is a city centre of the province contain the main damaged sewage treatment plant. In presence of damaged sewage treatment plant due to last conflict in Iraq, waste water and sewage being disposed directly into the river, thus contaminating the water used for consumption by the community. The incidence of water borne diseases such as diarrhoea, typhoid fever and intestinal worms, is high, especially among children under five years of age. Through emergency programs, IMC is a non governmental organization (NGO) entered to marsh area after war and contributed in rehabilitation of water and sanitation facilities. IMC started with rehabilitation of Amara sewage treatment plant to decrease morbidity cases by improving sanitation system.

Sewage and waste water test appeared improvement in water quality of final discharged product to the river after rehabilitation, otherwise led to decrease water borne diseases in Al-Kahlaa district community in which sewage treatment plant locates in front of the district, according to data obtained by local hospital.

Introduction

Sewage discharge from centralized, water-borne collection systems are a major components of water pollution all over the world.(1).

The total number of people not served with proper sanitation is about 40% (2).Approximately 6000 children die every day from diarrhoeal diseases related to inadequate sanitation and hygiene (3).Escherichia coli is a member of the group of faecal coli form bacteria, cannot multiply in any natural water environment , therefore ,used as specific indicators for faecal pollution.(4).Evaluation of the reliability of indicators is carried by comparison of their incidence and survival in water and treatment processes with that of selected pathogens ,by epidemiological studies on the consumers of water supplies ,by calculation based on the minimal infections dose of pathogens ,and by experiments with human volunteers (5).

Missan province is one of southern Iraqi provinces with total population 850,000 residents suffering from high rate of water borne diseases due to damage of the main sewage treatment plant after last conflict in Iraq, so sewage and waste water discharge directly to Tigris river ,the main river in the city, without any disinfection process. Al-Kahlaa local hospital , the nearest area to the effluent of sewage treatment plant ,suffer from daily reception of diarrhoeal patients due to drinking polluted raw water from Tigris river as a result of absence of water facilities. The most cases of water borne disease comes to the hospital focus among children under five years of age.

Materials and methods

1- By using Environment ministry central lab. in Baghdad, sewage and waste water samples before and after rehabilitation have been tested for chemical and bacteriological parameters.

2-Data of morbidity cases in Al-Kahlaa marsh area was obtained from the local hospital by mobile clinic team on December 2003.
3- IMC is a nongovernmental organization started on December 2004 to rehabilitate Amara sewage treatment plant by expert staff.
Results

Table (1)
Test of effluent water of Amara Sewage treatment plant before rehabilitation.

Item	Specification	Standard limits	Pres. status
1-	PH	6 -9.5	8.5
2-	TDS(total dissolved solids)	< 1500 ppm	3000
3-	T.S.S(total suspended solids	<60 ppm	120
4-	BOD (biological oxygen demands	<40 ppm	80
5-	COD (chemical oxygen demands)	100 PPM	130
6-	So4(sulfate ions	400 PPM	800
7-	CL (chloride ion)	600ppm	600
8-	PO4 (phosphate ions	3 ppm	10
9-	NO3(nitrate ions)	50 ppm	70
10-	CL2 (Free chlorine)	Trace	0
11-	E. coli	< 10 per 100 ml.	> 10

Table (2)
Water borne diseases in Al-Kahlaa district among children under five years of age .

Month	Watery diarrhoea	Bloody diarrhoea	Typhoid fever	Intestinal worms
Oct..2003	180	42	22	236
Nov.	120	45	31	290
Dec.	190	37	20	211
Jan.2004	198	40	38	260
Total	688	164	111	997

Table(3)
Test of effluent water of Amara Sewage treatment plant after rehabilitation.

Item	Specification	Standard limits	Pres. status
1-	PH	6 -9.5	8.5
2-	TDS(total dissolved solids)	< 1500 ppm	1200
3-	T.S.S(total suspended solids	<60 ppm	70
4-	BOD (biological oxygen demands	<40 ppm	40
5-	COD (chemical oxygen demands)	100 PPM	110
6-	So4(sulfate ions	400 PPM	500
7-	CL (chloride ion)	600ppm	600
8-	PO4 (phosphate ions	3 ppm	4
9-	NO3(nitrate ions)	50 ppm	45
10-	CL2 (Free chlorine)	Trace	Trace
11-	E. coli	< 10 per 100 ml.	< 10

Table (4)

Water borne diseases in Al-Kahlaa district among children under five years of age .

Month	Watery diarrhea	Bloody diarrhoea	Typhoid fever	Intestinal worms
Feb..2005	53	12	12	86
Mar.	67	10	15	98
Ap..	60	17	19	103
May.	70	23	18	89
Total	250	62	84	376

Discussion

As shown in table (1) quality of sewage and waste water of final product of Amara sewage treatment plant before rehabilitation process appears chemical and bacteriological parameters exceeds standard specification ,so Table (2) reflex the effect of consumption raw water by the people who use polluted river water by chemicals and pathogens .

While Table (3) shows change in sewage and waste water quality due to rehabilitation of Amara sewage treatment plant which decrease the morbidity cases of children under five years of age as shown in Table (4).

Conclusions

1. Human faeces contain pathogens when escapes in water lead to water pollution.
2. Sewage treatment plan consider as akey factor for posibility of infection by E.Coli ,the main source of diarrhoeal diseases .
3. Human health specially children health depends on purified and sterilized drinking water by water facilities.
4. Human health in Marsh area specially children under five years of age needs more health ,water and sanitation facilities to control decline of community health due to lack of water , sewage and sanitation facilities.

References

1-Matsui,S.(2004).Sanitation and water quality management ,Theory ,practice and policies. Kyoto University ,Graduate School of Global Environmental studies.(a lecture submitted to Iraqi team in Shiga prefecture meeting about water quality management by UNDP on December 2004.

2-Winblad ,U.(2004).Ecological sanitation .stokholm Environment Institute.

3-Matsui,S. and Winblad ,U.(2002).Options for Ecological Sanitation –how sewage works could be mentioned ,IWA leating Edge Conference on sustainability in the water sector. Venice ,Italy.

4-Grabow,W.O.K.;Neubrech,T.E.;Holtzhausen,c.S. and Jofre,J.(1994). Bacteroides fragilis and E. coli bacteriophages, excretion by humans and animals .Water Science and Technology .(Submitted for publication).

5-Regli,S.;Rose,J.B.,Hass,C.N.,and Gerba,C.P.(1991).Modelling the risk from Giardia and viruses in drinking water. Journal of The American Water Works Association ,92.76-84.

Supply of Water for Human Consumption in Extreme Situations and Barren Zones By Means Of Generators by Condensation of Potable Water

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Keywords: Condensation, human consumption, potable water, new technologies, water generators

The objective of this project is to make self-sufficient, for the supply of potable water, towns that so far are dependent on outer help. Supplying high quality water and reducing thereby illnesses derived from consumption of unsuitable water.

We shall guarantee the supply independently of pluviometer levels, weather conditions and water reserves levels.

Our project is based on water generators networks which work in extreme situations where there is no possibility of finding water for human consumption.

It can be arranged in a fixed or mobile way, through the supply of water to isolated centers of population, installing a plant of generators in a fixed place.

The water generators particularity is that they do not need other sources, as the water is obtained from the air, through condensation, and it is designed for extreme climates and barren areas.

In areas with small population we can adapt a generator to the rear of a van and follow a route of distribution of water for human consumption, about 500 liters per day of practically distilled water. Complying with the guidelines of the report WATER FOR LIFE on the minimum quantity required for healthy life that is 15 liters per day, we are able to supply water for towns with more than 30 inhabitants per generator unit. Thus we will increase their number according to the place to be attended to. We have the advantage that there is no need to obtain water from any remote source and in case the drought is over they could be moved to other place. This solution could be adopted temporarily.

On the other hand, we could also install a generating plant with capacity depending on the requirements and having a definitive solution for the supply of potable water we could install as basic unit generators of capacity for 1500 liters/day, easily transportable in case of finalization of the period of water scarcity or the temporary breaking of a camp.

Next we will briefly explain the technology we will use in our project:

It is the production of potable water by means of the AQUAER generator, condensing the absolute air humidity by means of a refrigerating installation. The peculiarity of the invention is that it does not need water from other sources as this is obtained from the air humidity, being possible to work in desert climates.

The water content in the air, as steam, is considerable though apparently looks dry. As an example, we can say that the air at 30ºC and 60% relative humidity contains more than 16 grams of water per kilogram of air. If the temperature is lowered under the dew point, that is the temperature which starts condensation, we will obtain water similar to rain water.
In this case temperature will be cool down to 0ºC, approximately, with a supporting refrigerating installation specially designed to operate in desert climates. The water obtained should be practically distilled and free from bacteria and viruses.

In Namibia, in the district of Walvis Bay it has a cost of (28 Amperes) 30.28 cents per KW/h. The cost amounts to 0.1 cents per liter of water.

The Aquaer Generator can operate with solar energy, whereby the cost per liter would be practically reduced to zero.

Our advice is to install plants with several generators in order to secure definitively the supply of potable water, improving the hygiene and consequently reducing infant mortality.

It is especially useful in places without water resources or with them being contaminated, in refugee camps and catastrophes where drinking water is indispensable.

Development of Environmental Infrastructure for Mumbai Metropolitan Region to Sustain Extreme Events

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Keywords: Environment-Cess, Parivartan, S.W.M., Extreme-Event, M.C.G.M.

Introduction

Mumbai is Economical capital of India with, Population 1, 19,14,393, Latitude 18053'N to 19016'N, Longitude 720E to 72059'E, Average annual rainfall @ 2400 mm, Water Supplied 2950 MLD, Sewage Disposal 2100 MLD, Garbage Generated 7800 TPD including 2000 TPD C&D waste.

Extreme Event

On 26-27/7/05, there was heavy downpour of 944 mm. in 24 hrs. Public life totally stalled for two days, @ 450 deaths, heavy garbage @ 3,50,000 M.T. disposed of in 3 weeks, @ 14,000 carcasses disposed of, 7 pumping stations sub-merged in storm water.

Analysis of the Issue and Initiative Taken

The issue was analyzed and it was decided to concentrate on 3 major areas viz. Improvement of Sewage system, Effective Solid Waste Management, and Improvement of General Sanitation related to slum. To achieve the goal of, Cleaner City a 'PARIVARTAN PRAKALP' was launched with following initiatives.

1. Complete cleanliness on key roads, 2. Elimination of refuse collection spots from major roads, 3. Up-gradation of existing toilet block, 4. Construction of new toilet block, 5. Dattak Vasti Yojana (Slum Adoption Scheme),6. Expansion of organization

7. Outcome base Budgeting, 8. Refuse Transfer Station, 9. Solid Waste Index, 10. Strengthening of Enforcement

11. Preparation of Bye-Laws, 12. Co-ordination and improvement in various waste Management and process contracts.

Results and Findings

Table 1: Improvement in garbage collection & sewer system

Initiative	**Total**	**Targeted**	**Eliminated/Achieved**	**% Achievement**
Elimination of refuse collection spots	4,689	828	865	More than 100
Toilet Up-gradation	804	559	288	51

Installation of community bins	14,200(Indented)	-	9,237(Installed)	65

Table 2 : Complete cleanliness of key roads

Area	No. of spots	Debris lifted	Mopp-ing for litter	Second shift	Cleaning litterbins installed	
			Yes/No	in km.	inkm.	Total Elmn
City	14	7	Yes	36.1	36.1	193
Western Highway	194	128	Yes	67.5	51	78
Eastern Suburbs	126	111	Yes	17.4	0.7	821

Table 3: Status of other initiatives

Initiative	On Track	At risk	Overdue
Construction of new toilet blocks	--	--	Yes
Solid Waste Index	--	Yes	--
Strengthening of Enforcement	Yes	--	--
Slum Adoption Scheme	Yes	--	--
Expansion of Organization	Yes	--	--
Outcome Based Budgeting	Yes	--	--
Refuse Transfer Station	Yes	--	--
Preparation of Bye-Laws	Yes	--	--
Coordination & improvement in Waste Management Contracts	Yes	--	--

Findings of Parivartan Prakalp:

1. Public Campaign consumes substantial time period
2. Private public participation needs to be more.
3. Expenditure for improvement in Sanitation Service is high.
4. House-to-House collection of Garbage should be made more effective.
5. Recycling of plastic should be promoted.

6. Scientific methods should be used to improve landfill sites.

Conclusions and Recommendations

1. It is necessary to have more and more insight into the issue of Environment and Waste Management, as better knowledge will provide solutions for overall improvement.

2. Environmental pollution due to point and non-point sources of emission in the City should be monitored effectively to reduce environmental related occupational diseases such as Byssinosis, Pesticide poisoning etc.

3. It is necessary to introduce 'Environmental Cess', the reason is twofold, one to make the citizens more responsible and two to make services sustainable.

4. Segregation of waste at source should be 'Incentivised'

5. Active participation of the citizens is needed to improve the Environment and Quality of life in Mumbai.

Existing Sanitation and Treatment Facilities in Iraq

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Keywords: Sanitation, Treatment Facilities, Iraq, Sewage Treatment, Water

The current inhuman status of the infrastructure in Iraq is result of wars, weakened financial, technical maintenance and management capacity, and destruction and looting during the recent conflict. The environmental and health risks associated with contaminated water supplies, inappropriate handling of solid waste and disposal of sewage increases the health risks and thereby burden on the already stressed health care system. Rehabilitation of the infrastructure plays a key role in the improving the quantity and quality of sanitation services. As the old systems become obsolete, it is important that the local technical capacity is upgraded through intensive training programmes to a level equivalent of new installed plants. Many Iraqi cities do not have adequate water or sewage treatment plants. And even where there are treatment systems, many have fallen into disrepair from years of neglect. At the same time, water and sewerage systems, with their intricate network of pumps, are constantly strained by regular power cuts. The sewage collection and treatment system served mainly the city of Baghdad and to much less extent some other cities. A large voleum of sewage was discharged to rivers, some estimated that around 300,00 - 500000 tons of sewage a day was being dumped into the Tigris. The non-operational sanitation system with that limited capacity has been and remains a serious environmental and health concern. Prior to the Gulf war the sanitation service sectors were operating at some cities with efficiently and using then-current technology with sewage systems and treatment facilities.

By 1995, access to potable water in urban areas had fallen from 95 percent in 1990 to 92 percent, and in rural areas from 75 percent to 44 percent. By 1997, water treatment plants were working at only 40 percent of their nominal capacities. The existing sewage treatment plants were not fully operational and untreated raw sewage was being disposed of into rivers - the direct source of drinking water for many - with consequent increases in the incidence of water-borne diseases.

The operation of water and sanitation plants, many of which were destroyed during the Gulf War, continues to be affected by the lack of spare parts and maintenance. The result is that drinking water is often unsafe. Unhygienic environments and poor sewage systems continue to pose risks to people's health. One consequence is frequent outbreaks of diarrhoeal diseases especially during the summer months. Cholera became endemic in all governorates of Iraq after the Gulf War. Cholera outbreaks have been reported, the most recent in June-August 2002.

According to the Water Supply and Sanitation Assessment issued jointly by WHO and UNICEF, about 85% of the population in Iraq had access to water supply services (96% in urban areas and 48% in rural areas) in 2000. About 79% of the population had access to sanitation (a flushing toilet discharging into a public sewer system or a hygienic latrine). However, only 31% of the rural population had access to such sanitation facilities. Before the war, Iraq pumped 3 million cu. m. of water per day from 140 water treatment facilities. Today, facilities operate at about 65 percent of that capacity, mainly because of electricity shortages and the looting of water plant generators used to pump water and sewage.

UNICEF is currently trucking approximately 6,000 cu. m. a day to the Iraqi capital. Baghdad's three sewage treatment plants are inoperable, allowing domestic and human waste from an estimated 3.8 million people to flow into the Tigris River. The plants represent three-quarters of the country's sewage treatment capacity. Baghdad's Shark Dijlah water plant is being repaired to pump 45 percent more water in the future. The plant is expected to add 225,000 cu. m. per day to the water supply by July 2004. Reports from the environmental laboratories indicate severe cases of pollution. Almost 30 – 50% of the analyzed samples showed deviation from the acceptable value for drinking water (5 NTU). On the other hand, the drinking water samples taken from hospitals, schools, randomly chosen homes and water projects, often showed high degree of pollution with pathological bacteria as well as high total counts of bacteria. The sewage systems were not existed in all the Iraqi Governorates ,but some sewage projects were constructed in eight Governorate only, these are, Babil, Basra, Karbala, Maysan, Najaf, Qadisaya, Salah Al-Deen, & Thi-Qar .The other Governorates had a Rainfall Drainage Networks in certain places (i.e. Storm Sewer System).

The Impact of Downpours on the Water Supply Systems and Sewerage System of Eforie South - Costinesti, Romanian Black Sea Coast, on September 22, 2005

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Keywords: Romanian Black Sea coast, Downpour, Water supply system, Sewerage system, Pollution indicators

The water supply systems and sewerage system from Eforie South – Costinesti at the Romanian Black Sea coast provide public services in this sector of the littoral, which during the summer season faces a considerable increase of the local population from about 30,000 inhabitants to about 200,000 inhabitants.

Water supply occurs through the Sarmatian aquiferous (water catchments Costinesti and Biruinta) by means of an interconnected system consisting of storage reservoirs, disinfection stations, supply and distribution networks.

The Sarmatian aquiferous supply occurs through rainfall and from the lose water of existing irrigation systems. The water is infiltered through loessoid superficial layers, up to the Sarmatian limestone chipboard. The groundwater proves a good quality in accordance with the EC Water Framework Directive 2000/60 and national legislation. To ensureing a good quality of marine coastal waters and of bathing waters, waste waters are collected by pumping stations and a related sewerage system, in a waste water treatment plant (mechanical and biological treatment) in Constantza South, having a total capacity of 507 l/s.

On September 22, 2005 both these water supply systems and sewerage system have been seriously affected by downpours (222 l/m2).

The Costinesti hydrographical basin extends to an area of 21.5 km2; the surface water flow reached a maximum input of 200 m3/s !

Due to this high value, the water wells from Eforie South and Costinesti, the drinking water tank and the disinfection plant of drinking water from Costinesti, some of the wastewater pumping stations and the Waste Water Treatment Plant (WWTP) Eforie South have been overflowed !!

Due to the lack of vegetation and of correlation between the ground morphology and the civil constructions (the railroad earthwork and other civil constructions disrupt the natural drainage of the Costinesti area), therefore causing problems of overflowing of rainwater; the level of rainwater increased with about 3 m after 22 September !!!

In order to secure drinking water supply for the population, to minimize the environmental pollution due to the overflowing of the wastewater pumping stations and of the WWTP Eforie South and to reduce to minimum the danger of epidemic diseases, special measures have been taken during this period.

The quantity and quality of the water pumped from the overflowed WWTP Eforie South, in the emmissary, originating in the near flood plain meadow Tuzla and precipitations, have been monitored; the water flow discharged into the Black Sea had an amount of 1,179,300 m3.

The quantities (in tones) of some pollution indicators, such as solid suspensions (SS), chemical oxygen demand (COD) and biological oxygen demand (BOD), discharged in the emmissary during the flood in 2005 are much higher if compared with their quantities in the same period of the previous year.

In conclusion vulnerability to pollution of groundwater accumulations depend on the geological constitution of the area, fault systems wich affect the Sarmatian layers, the flow direction to underground aquiferous flux, civil constructions, urban and rural settlements, the manner of waste depositing, the way of water catchment emplacements; the Sarmatian limestones are affected by fissures, cracks and karst gaps, sometimes of considerable size, which permit a fast underground water circulation, and together, a high or low input of pollutants (effluent) especially during floods.

The pollution vulnerability issue in the mentioned area constitutes a very important problem, because the existing water catchment pollution can affect the drinking water sources of a lot of inhabitants and tourists during the summer season, and because this area has no other water sources.

In order to reduce the flood impacts concerning the water sources, the dwelling and the marine water quality, following recommendations emerge after the dramatic experience in 2005:

- necessity of adequate correlation between constructions and ground morphology,
- transportation of wastes only in ecological dumps,
- interdependent taking into consideration of surface water and underground water and compulsory rigorous supervision of water quality with a view to evince possible pollution sources,
- establishment of sanitary zones under severe conditions,
- careful management of surface and underground water, in all areas, strictly interdependently,
- soil treatment by fertilizers in accordance with environmental protection and water management provisions,
- optimization of underground water exploitation in order to assure the aquiferous system protection and implicitly of the water supply system,
- decrease of waste water impacts on the marine environment/ecosystem quality through appropriate processing by up-dated waste water treatment plants,
- use of data/information concerning waste water discharge into the marine environment for completion of regularly issued reports on its quality state.

Flood Management Approaches, a Case of Crisis Management versus Risk Management

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Keywords: Flood, Risk Management, Natural Hazard, Flood Damage, Resilience Strategies

According to the statistics presented by UN, floods and storms have imposed the most severe damages to human communities; even more than earthquakes as just in one decade the damages of floods and storms exceeded to more than $21 billion versus $18 billion damages imposed by earthquakes. In the period of 1993 to 2004, each year more than 255 million individuals have been prone to natural disasters.

Iran has been the 10th disaster-prone country in the world and in the recent century more than 150,000 individuals have died in natural disasters. Each year more than 70% of the budget for Natural Disaster Impacts Mitigation Program and Unexpected Disasters Counteracting Headquarters is spent to retrieve the flood damages. In the five past decades, the flood damages in Iran have increased to an extent of 250 percent.

Unfortunately, flood management and flood damage mitigation has been disregarded and only when a devastating flood occurs and turns to a disaster, it attracts the interests of authorities and experts. Authorities usually try to react to natural disasters through crisis management to mitigate and compensate the damages and rehabilitate the disaster-prone area.

Although a specific and definite solution does not exist for all flood-prone areas, flood is worth studying and investigating regardless of their complexity and it may be possible to find proper solutions to manage floods and mitigate their damages and even to profit economically from them.

In this paper, different types of floods occurred in the country are classified by their characteristics and some statistical interpretations from the flood damages are presented. The reasons for increases in flood damages are discussed and the current flood management strategies in the country are assessed. Finally, suggestions are presented for the move from crisis management to flood risk management.

The proposed strategies are resilience flood risk management strategies. In 1973 Holling defined resilience as “a measure of the persistence of systems and of their ability to absorb change and disturbance and still maintain the same relationships between populations and state variables”. Pimm used the following definition: “the speed with which a system disturbed from equilibrium recovers some proportion of its equilibrium’. More generally the term is used to describe a tendency to stability and resistance to perturbation. Its use is comparable to the use of the concept of sustainability, in the sense that everybody agrees that it is desirable, without agreeing on what is precisely meant by it.

Strategies for flood risk management in which resilience is used focus on reducing the impact of floods by “living with floods” instead of “fighting floods”, as in the traditional strategy. Therefore, resilient flood risk management is flood risk management that aims at giving room to the floods but with concurrent impact minimalization. This implies that also the consequences of floods have to be taken into account and that safety standards must be differentiated on the basis of land use and spatial planning. The area as a whole is more resilient if the less valuable parts are flooded prior to the more valuable parts, which are being safeguarded longest.

A resilient flood risk management strategy also considers measures to reduce the impacts of flooding, such as the design of warning systems and evacuation plans and the application of spatial planning and building regulations. Resilience strategies may also include measures to accelerate the recovery after a flood, e.g. damage compensation regulations and insurances.

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Alternative Energy Reverse Osmosis for Water Potabilization during Extreme Natural Events

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Keywords: Reverse Osmosis, Alternative energy, Solar energy, Eolic energy, Potabilization

Natural disasters like hurricanes and extreme rains end up producing floods, decomposed organic material, salt water intrusion and toxic dispersion in all kind of costal communities, affecting the potable water availability. These types of events contaminate potable water sources with direct impact on local population health. At the moment the way to provide potable water in natural disaster areas has been the transportation of bottle water to the particular location or the transportation of electrical portable potabilization units. Transportation of bottle water to affected areas represents a great cost in terms of time and money. On the other hand the transportation of portable electric potabilization units it's also time consuming and energy unreliable.

Reverse osmosis represents the must common technology used for the production of bottle water, mainly because of its water quality reliability, cost and simplicity to operate. Must units currently utilize during natural disasters affected areas are reverse osmosis units.

The great disadvantage for Reverse Osmosis at natural disasters location it's the energy required to perform the separation process involved in the water potabilization process. Like any other separation process reverse osmosis needs energy in order to separate contaminants from water. Conventional energy source for Reverse Osmosis units is electricity, either coming from the grid or from gasoline generators, both sources very unreliable in natural disaster areas.

The objective of the present technology development represents a way to assure potable water availability at natural disasters costal locations without the need of traditional energy sources (electricity and hydrocarbons), sources that are very unreliable at those conditions. An analysis on the conditions after natural disasters in costal areas shows the existence of potable water sources contaminated with ocean water, decomposed organic material and toxics, also lack of energy from the grid and unavailable gasoline for the same reason. With this general scenario the development of a portable alternative energy Reverse Osmosis unit was designed to provide potable water at costal locations after natural disasters in costal areas. The unit was designed to utilized wind power (eolic energy) and solar radiation as alternative sources of energy as well as conventional gasoline and electricity. With this unit the production and availability of potable water at costal disasters sites can be immediately provided after the outcome, especially when the units could be on stand by at costal sites. This situation results in a risk reduction of adverse health effect by reducing the gap of unavailable potable water and by assuring the quality of the drinking water after natural disasters.

A Prototype is currently in construction and will be in operation by may of 2006, the prototype will be install at the Gulf of Mexico in a rural area were no electricity is available and extreme events in the past have produce lack of water services during hurricane periods. Water quality and quantity will be determined at different solar and eolic energy availability in order to generate a preliminary cost benefit evaluation. The cost of the prototype will be optimized in order to increase the possibility for the communities to have the units in stand by all the time. Actual prototype limitations are the maximum concentration of dissolved solids in the contaminated water (20,000 ppm) and the maximum flow rate per unit (1600 l/hr). Both limitations are directly related to the maximum level of water pressure obtained from wind power and solar sources. Up to now, current solar and wind power (eolic pump) technologies could not give enough energy (pressure) to produce potable water from sea water. Current research is concentrated in developing an eolic pump strong enough to desalinate sea water.

Potabilization of brackish water with an alternative energy reverse osmosis is ready to step up to a commercial level. The next objective at this point with the current prototype is to add an automatic water bottling / bagging system in order to reduce the potential contamination of the water in the filling container process.

Improving Water Management and Sanitation in Rural Area in Ukraine: Role of Extension Service

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Keywords: rural community, sanitation, extension program

The quality of water and state of water management and sanitation is rural area in Ukraine are generally poor [1-2]. Surface and groundwater are often contaminated by agricultural and household activities, additionally only 25 percent of villages are connected to a centralized water supply system, all another residents use water from shallow wells which are significantly contaminated by nitrates, pesticide residues, bacteria, sometimes by heavy metals and phenol[3-4]. Agricultural runoff is the second leading cause of surface water pollution, the situation is aggravated by inappropriate manure storage, leaks from livestock farms and cattle breeding areas together with direct discharges of wastewater from the households. According to the latest data each seventh sample from a centralized water supply system and each fourth sample from a wells violated standards, each thirteenth sample from water supply systems and each fourth sample from wells failed to meet the health requirements for bacteriological indicators. As a result the health problems significantly increase in rural area in Ukraine and leads to the fixed cases of dysentery and cholera in 2000-2004 [1].

To resolve the situation attempts have been done to educate local rural communities regarding proper water management, use and sanitation [5-6]. Faculty at the National Agricultural University has developed an Extension Program which is focused on water management and sanitation. Program includes such important topics: (a) water management,(b) prevention measures for safety water use ,(c) deterioration of water quality and impact to health ,(d) proper sanitation as a key point to improve health conditions in rural area .

Using the extension program two training have been accomplished at rural communities located in the South and South Eastern part of Ukraine. Both regions are shortage of drinking water resources and have a significant problems with water supply and sanitation.

Surface water samples from closely located small river and lake were collected at both communities and analyzed. The obtained results were presented for local communities and discussed. The fact of interconnection between deterioration of surface water, quality of drinking water in wells and health problems has been fixed.

As a result of activities accomplished the level of people awareness about proper water use and necessity of sanitation substantially increased in both rural communities. This fact was confirmed by results of sociological surveys.

The developed Extension program and it's practical implementation can be considered as example how to create links between water - society and environmental issues at the local level.

References

1. National Report about State of the Environment in Ukraine, 2004
2. Dnipro Basin Environment Program, Final Report, UNDP-GEF, 2004
3. Pidlisnyuk V. Water Quality degradation caused by agricultural practice: case study from Ukraine, in Proceeding of 15th Stockholm Water Symposium, Stockholm, Sweden, 2005
4. Pidlisnyuk V.V., Aliev K.A., Stefanovska T.R. Ukraine and Water Framework Directive, Kyiv-Mogula Academy, 2002
5. Pidlisnyuk V., Borisyuk M., Pidlisnyuk I. Sustainable Use of Water resources : Perspective for Ukraine // Proceeding of the International conference "Integrated Management of Natural Resources in the transboundary Dnister River Basin", Kyshyney, Moldova, 2004
6. Pidlisnyuk V., Slobodenyuk M. Implementation of Sustainable Water Use in Ukraine, Proceeding of seminar „Safety Environment and Human being: education, science and practice", Kyiv, Ukraine, 2005

Sustainability in the Guanabara Water Basin (Rio de Janeiro Metropolitan Area): Case Study of The Guanabara Bay Cleaning Programme Implementation and Impacts

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Keywords: Sanitation, planning, metropolis, management, sustainability, inequality

The socio-economical and environmental intra-metropolitan inequalities in Brazil are well publicized facts and one can state that spatial segregation has been a defining factor in its urbanization. Brazilian metropolitan areas, such as Rio de Janeiro, are increasingly characterized by the presence of very wealthy neighbourhoods provided with the best services next to poor neighbourhoods with extremely limited infrastructure.

During the last two decades the Brazilian Government has launched several policies and urban interventions as attempts to minimize inequalities between different urban areas.
In this context, the Guanabara Bay Cleaning Programme is the biggest urban infrastructure project developed in Brazil in the last 30 years. That programme has mainly aimed to contribute to the improvement of living conditions of urban dwellers in low income neighbourhoods through the provision of basic infrastructure. The programme implementation has been very slow and despite the important amount of financial support provided by international agencies it has not achieved many of its goals.

This paper focuses on the role of the Guanabara Bay Cleaning Programme on the current urban development process in the Rio de Janeiro Metropolitan Area. The question we are interested in is: what are the current environmental conditions of a metropolis with 12 million inhabitants, with accelerated demographic growth of the poor areas, heavily polluting industries, continuous generation of urban substance, notably through the growth of informal settlements, and the absence of good governance?

The Guanabara Bay Cleaning Programme (GBCP) experience was chosen because (a) it makes available knowledge about the state and extent of environmental degradation in significant area of the metropolis and (b) it highlights specific barriers and conflicts related to the monumental task of dealing with the problem of environmental degradation in the Rio de Janeiro Metropolitan Area – at political, administrative, social, economic levels and of notable interest to this paper, in terms of its urban development.

In that sense, even though this paper relates critically to knowledge generated by the implementation of GBCP, it is not a critique of GBCP project itself. Despite its merits, the GBCP contains a number of shortcomings, already at the stage of project design, which would make it an easy target for criticism. Although, such shortcomings will be touched upon in this paper, our focus is rather on issues highlighted through the consequences of the GBCP implementation in the metropolitan development.

Therefore, this paper investigates the impacts of the Guanabara Cleaning Programme on the Rio de Janeiro urban development process. Based on the magnitude of the budget of the programme and its relevance to the improvement of the life quality of the Rio de Janeiro dwellers, the main discussion of this paper is the role of GBCP in the context of the Rio de Janeiro intra-metropolitan inequalities.

In studying the impact of the GBCP, we present: (a) a description of the GBCP intervention process and its goals, (b) a spatial analysis of the Rio de Janeiro Metropolitan Area defining patterns according to social, infrastructural and landscape/geographical data and its development from 1990 and from 2000, (c) a correlation between the historic evolution of these patterns from 1990 and from 2000 and the Guanabara Bay Cleaning Programme where the main goal is to understand the role of the GBCP implementation in the spatial distribution of these patterns through these 10 years.

The conclusion describes a critical analysis of the GBCP role in the current urban development process of the Rio de Janeiro Metropolitan Area, identifying its influences on the intra-metropolitan inequalities dynamics of the Rio de Janeiro Metropolitan Area. It is possible to affirm that the GBCP has an important role in the intra-metropolitan inequalities of the Rio de Janeiro expanding the infrastructure to municipalities traditionally characterized by their low life quality, but on the other hand several management and implementation problems are leading the program to minimize its positive impact and to reaffirm the current spatial segregated pattern.

Lessons from Using PUR-Purifier of Water for Providing Safe Household Water in Emergency Situations

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Keywords: point-of-use purification, PUR- purifier of water, safe water, emergency relief, tsunami

This paper presents lessons from the emergency use of PUR-Purifier of Water to provide safe drinking water following natural and humanitarian disasters, including the South East Asia tsunami and the Pakistan earthquake. .

PUR is a combined coagulation, flocculation, and disinfection treatment system, developed through a collaboration between the P&G Health Sciences Institute and the US Centers for Disease Control and Prevention (CDC). It has been shown to reduce diarrheal illness in four randomized-controlled health intervention studies conducted by the CDC.

Several characteristics of this technology make it particularly useful for providing safe drinking water during emergency situations. These include its ability to be shipped as "non-hazardous", its long-term stability, and its effectiveness in removal of pathogens even in turbid waters. To provide detailed monitoring of the use of PUR technology in emergency use situations, four independent evaluations have now been completed. AmeriCares provided PUR to Sudanese refugees in Chad and found that PUR was practical to deploy with limited education and without provision of additional hardware. A rigorous evaluation of PUR was conducted by CDC after tropical Storm Jeanne struck Haiti in September 2004, causing widespread flooding that contaminated water sources and killed and displaced thousands of people. CDC interviewed 100 households in three rural communities where local leaders had distributed PUR. Seventy-eight percent of respondents correctly answered five questions regarding PUR use, and 81% reported PUR easy to use. CARE provided PUR in a nutrition feeding program in Ethiopia as part of a USAID sponsored Safe Drinking Water Alliance, and results will be presented. Johns Hopkins conducted a health intervention trial and assessment in a Liberian refugee camp and found diarrhea reduction of 93% in PUR households compared to groups provided with safe water storage alone.

Since these assessments some 15 million PUR sachets have been distributed to the survivors of the Southeast Asia tsunami, and a further 8 million sachets following the Pakistan earthquake. The lessons from these large scale deployments of point-of-use technology have been incorporated into a Standard Operating Procedure (SOP) for disaster relief to optimise future operations.

The use of PUR in these situations will be reviewed, and the lessons learned will be shared.

Supply of Water for Human Consumption in Extreme Situations and Barren Zones By Means of Generators by Condensation of Potable Water

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Keywords: Condensation, human consumption, potable water, new technologies, water generators

The objective of this project is to make self-sufficient, for the supply of potable water, towns that so far are dependent on outer help. Supplying high quality water and reducing thereby illnesses derived from consumption of unsuitable water.

We shall guarantee the supply independently of pluviometer levels, weather conditions and water reserves levels.

Our project is based on water generators networks which work in extreme situations where there is no possibility of finding water for human consumption.

It can be arranged in a fixed or mobile way, through the supply of water to isolated centers of population, installing a plant of generators in a fixed place.

The water generators particularity is that they do not need other sources, as the water is obtained from the air, through condensation, and it is designed for extreme climates and barren areas.

In areas with small population we can adapt a generator to the rear of a van and follow a route of distribution of water for human consumption, about 500 liters per day of practically distilled water. Complying with the guidelines of the report WATER FOR LIFE on the minimum quantity required for healthy life that is 15 liters per day, we are able to supply water for towns with more than 30 inhabitants per generator unit. Thus we will increase their number according to the place to be attended to. We have the advantage that there is no need to obtain water from any remote source and in case the drought is over they could be moved to other place. This solution could be adopted temporarily.

On the other hand, we could also install a generating plant with capacity depending on the requirements and having a definitive solution for the supply of potable water we could install as basic unit generators of capacity for 1500 liters/day, easily transportable in case of finalization of the period of water scarcity or the temporary breaking of a camp.

Next we will briefly explain the technology we will use in our project:
It is the production of potable water by means of the AQUAER generator, condensing the absolute air humidity by means of a refrigerating installation. The peculiarity of the invention is that it does not need water from other sources as this is obtained from the air humidity, being possible to work in desert climates.

The water content in the air, as steam, is considerable though apparently looks dry. As an example, we can say that the air at 30ºC and 60% relative humidity contains more than 16 grams of water per kilogram of air. If the temperature is lowered under the dew point, that is the temperature which starts condensation, we will obtain water similar to rain water.

In this case temperature will be cool down to 0ºC, approximately, with a supporting refrigerating installation specially designed to operate in desert climates. The water obtained should be practically distilled and free from bacteria and viruses.

In Namibia, in the district of Walvis Bay it has a cost of (28 Amperes) 30.28 cents per KW/h. The cost amounts to 0.1 cents per liter of water.

The Aquaer Generator can operate with solar energy, whereby the cost per liter would be practically reduced to zero.

Our advice is to install plants with several generators in order to secure definitively the supply of potable water, improving the hygiene and consequently reducing infant mortality.
It is especially useful in places without water resources or with them being contaminated, in refugee camps and catastrophes where drinking water is indispensable.

Water Disasters in Sri Lanka in the Recent Past

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Keywords: Tsunamis, Floods, Droughts, National Planning and Security

Introduction

Sri Lanka is situated in the Indian Ocean (Latitude N 6-10, Longitude E 80-82.5) just South of India and the population is about 20 million. North East Monsoons reach Sri Lanka in December January period in the middle of the Maha cropping season. South West Monsoons reach Sri Lanka in May June in the middle of Yala cropping season. Inter monsoons are definite sources of storms reaching Sri Lanka in between monsoons due to crossing of the Sun over the Island. They reach in October and March. Land preparation for cultivation begins with these inter-monsoons. Some times these inter monsoons are accommodated with heavy disastrous storms and are causing damage to property and loss of life. Cultivation in wet zone is depending on rain fall, base flow of streams and shallow ground-water. Cultivation in other areas is supported with storages of tanks. Long lasting drought destroys the cultivation in many parts of the country. It also affects the drinking water supply of cities as the river system slowly dries. The tanks dry after one cropping season of the upstream areas. Sanitation facilities are not specially made but residents use available water bodies for bathing. Fresh water tanks as well as sea water is used for bathing. Inland fresh water sources are fully used for drinking in case of droughts. Wells are dug in the tank bed and make it deeper and deeper as the drought increases. The droughts are recurring at 9.25 years interval. Intermediate serious droughts are recurring in dry zone, which will affect few districts. Some droughts are directly affecting Hambanthota District as it lies at South East edge of the island. Shallow wells supply drinking water in villages. In case of droughts the most critical problem is the bathing, washing of clothes and drinking. The banana plantation begins to fall and perennial crops start drying.

There are severe floods occurring due to frontal type storm formation in the beginning of monsoons. Wet zone, mountains are subjected to rain fall of 330mm per day as in May 17, 2003. When it happened nearly seven districts were affected and land slides were frequent with 2000 deaths. The affected area becomes inaccessible due to road blocks. Water transport becomes difficult due to grades in the river courses. Telephone signals are affected to cut off all communication links. Electrical distribution system is affected as the lines are damaged and power is cut off for safety. Survivors are confined to hill tops and trees and in some cases on roof tops. High winds disturb the roof structure of all weak houses. People suffer with coldness and starvation. The lost persons caused sudden shocks in the livelihood and the survivors also face with the same fate. The darkness in the night fully endangers all the victims of possible earth slips, venomous attacks and wounds to the body.

The storm water drains to the lower basin and creates severe damage as the population density is very high in lowlands. Dam failures associated with floods in the wet zone and dry zone directly wash down the drainage passage and break all the tanks in cascade. Kantale Tank disaster in 1985 caused 200 deaths.

Tsunami

A new disaster came on 26 December 2004 due to an underground volcanic activity between Asia and Indo Australian plates. This is a new experience and the damage was confined to coastal areas. Eastern coast was affected at 8.30am and southern coast was affected at 9.20 am onwards. Western coast was affected at 10.30 am onwards. Nearly 38000 lives were lost and 10 000 were missing. About 80 000 houses were damaged. Many buses, cars, trucks, boats, dredgers, railway compartments, cycles were damaged with occupants. Sea water caused salinity in all fresh water wells and wiped out all drinking facilities. Salinity ran up along all the streams and made difficult to run water supply projects. Beruwala, Galle, Matara, Tangalle, Tissamaharama scored heavy losses and made inaccessible and water stored for six hours. The tsunami reflected from Maldives came at 1.15pm. It had little effect but survivors suspected another attack and left for distant areas abandoning houses. This paved way for looters. Damaged bridges cut off transport. Heavy wounded persons left unattended and some died in the night due to shock and starvation. Drinking water and food was not available.

Occurrence of hydrological disasters is increased due to global warming and Sri Lanka has increased mean temperature by one degree Celcius in the last sixty years. This is recorded in all stations in the island and common to South East Asia as well. Intensity of droughts and storm floods that follow the drought is increased over the last forty years. The population doubled in these forty years. Drinking water and sanitation problems were increased under normal conditions but were severe under extreme situations.

Unusual Diseases
Tsunami affected areas later developed epidemic conditions of unusual fever. This was stopped by taking suitable control measures. A form of meningitis was identified as propagated by mosquitoes. Hospitals were alerted and doctors took suitable methods to separate the patients. The tsunami brought up materials lying on the bottom of the sea to the land. Dark colors were adhered to that water. Wells were cleaned by pumping and the new ground water was not contaminated.

Supply of Drinking water
Bottled water was distributed to the concentration camps. Large barrels were collected and provided to all clusters of refugees. These camps were erected with foreign aid at many places. The tents provided coverage from rain and heat. Excessive rain reached later and created chaos for tent occupants. Temporary houses were constructed on available lands. Permanent houses are allocated outside the 100m set back limit. No construction is allowed with in this limit and repairs are allowed in between 100m and 300m from the sea low water level. Sanitation facilities are provided to all camps with suitable water storage tanks and water sealed toilets at a higher elevation. Separate taps are given near the bathing spots and drainage canals were provided. Mosquitoes grew in number due to water blocks. Land for permanent houses is scarce in this thickly populated coastal belt. The debris of houses was piled up at suitable places. Pollution of ground water was reduced by using same material for construction. It was sad to say that damage less University was closed for three months. Drug addicts are among the refugees and create troubles. Free water facility was given to partly affected houses.

Drought affected areas were supplied with transported water from bowsers. Aid schemes provided employment for those affected to remain in home areas without leaving. Repairs to tanks were attended in dry period.

Dry zone tanks are for rice irrigation but drinking reservation before the drought is necessary specially, when the drought is predicted as in 2001. Next drought is predicted in 2010.

Floods needed necessary search from boats and helicopters. Distribution of food parcels and clothes are initiated by state and NGOs. Financial aid is given to those lost parents and houses. Control of diseases is a duty of Health services. Refugees are slowly transferred to their original status. Frequent occurrences create an experience to villagers.

Conclusion

Swimming is a definite method to reduce drowning under water accidents. Classes are necessary to train people. Constructed tanks at a suitable high spot provide water storage facility in every village in case of disaster. Sufficient water storage for drinking is to be reserved in every village under the new project.

Intake from rivers for town supply projects from Kelani, Kalu, Gin, Nilwala needs salinity barriers and special intake ready for emergency in the upstream so that salinity effect is reduced. Flood protection project in Nilwala needs bund protection from offenders. It created devastation due to bund cutting by offenders to save some houses in the middle unprotected area. Suitable storage and diversion projects are to be planned for Nilwala, Kalu and Kelani river basins. Awareness programs to behave during floods and tsunamis are planned. When sea water receded by one km people went to catch fish but finally lost lives. This is a good experience for future generations. People need to develop means to control theft under disasters.

Application and Development of Emergency Water Purification Plants in Tsunami-affected Areas in Sri Lanka

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Keywords: Tsunami, Water treatment in emergencies, international water aid, drinking water mobile, mobile water supply

The president of the European Well & Fountain society [EWFS] - founded in April 2004 in the city of Karlsruhe Germany, which today has 70 members from Austria, France, Germany, Switzerland and The Netherlands - Professor Dr. Dietrich Maier decided after the terrible tsunami catastrophe on the 29th December 2004, to supply a refugee camp in Weligama, Sri Lanka with permanent fresh drinking water.

After the rehabilitation of more than 100 high salt concentration groundwater wells, the members of the EWFS together with a team of 14 co-workers of the fire and water department - Ludwigshafen and the Stadtwerke Karlsruhe waterworks – installed a prefiltration-reverse osmosis water purification plant, combined with a fully equipped laboratory for monitoring chemical and biological parameters. Located beside a riverbank filtration well with a diameter of 2m and a depth of15m, this plant releases up to 10,000 L of safe drinking water a day and has done eversince installation. The drinking water is transported to the camp by a so-called bowser.

From January to March 2005, this team succeeded in training five students from the University of Ruhuna, Matara in order for them to take over the daily task of producing drinking water. On his last visit to Sri Lanka from the 13th January 2006 – 20th January 2006, Professor Maier observed that the co-workers of the Sri Lankan university were doing an excellent job on a daily basis, providing water for 300 adults and 400 children, who lost so much due to the tsunami.

During this time the German and Sri Lankan water-aid-team decided the development of a currentless water treatment system for emergencies as one of the most important and most needed works in the field of emergency water purification.

Unfortunately it is well known that after tsunami and flood catastrophes, earthquakes, hurricanes and volcanic eruptions, especially in the first 3 days, when the power supply network is destroyed and drinking water pipes are broken, people have to supply themselves with drinking water from the nearest possible source. After the tsunami catastrophe in Sri Lanka the first drinking water aid came from Australian and American soldiers after a period of 72-96 hours. After the terrible Hurricane Katrina in New Orleans, many people had no safe drinking water even after 7 days. In all cases, surrounding water sources were contaminated with salt, oil, heavy metals, solvents and germs. In many cases people – especially children – drank the contaminated water in order to survive and often contracted cholera and dysentery as a result. Notably in the Eastern part of Sri Lanka, near Ampara many children died in the first 5 days. Therefore it is highly necessary to develop a nonelectrical and simple water purification system for use in the first days after a catastrophe, which should be no more expensive than tents or blankets and are just as necessary In most cases after five days international drinking water aid is established by Red Cross,

OXFAM, Medicines without borders and other similar aid organisations.
In Sri Lanka we tested the idea to produce bacteriologically safe drinking water from river and waste water in a 10m long plastic film hose with a capacity of 1200 L – enough for 400 people per day.

After the treatment of the contaminated water in the slope lying hose with 100g/m3 free chlorine during a time of one hour, the next step was to dose the water with 800g/m3 of powdered activated carbon. Within a time of one hour this amount of activated carbon destroyed the chlorine to a small residue and adsorbed all the organic contaminants such as oil, solvents and ptomaine. In the next step 100g/m3 of FeCl3 was dosed, in order to flocculate the activated carbon and also to remove heavy metals such as lead, copper, mercury, arsenic and so on. The last step is the filtration of the water. This procedure has been proven by German troops as a safe method to produce drinking water from all types of contaminated water. Soldiers carry out the procedure in large tanks on large trucks with electric pumps and stirrers, which are supplied from heavy emergency generating sets. The procedure in known as „Einheitsdosierprozess" (EDP).

During our initial investigation in Sri Lanka there was no electricity supply and the empty system could not weigh more than 20kg. Therefore as reactors we chose plastic film hoses and to use as stirrers, air bubbles were produced by one person operating a pneumatic pump. The trick is the „sloping position" of the plastic film hose coupled with the fact the air is passed through the 0.5µm-filter at the lower end of the hose, so that the bubbles – when large enough – are released and rise to the top of the hose. Within this system the bubbles produce enough turbulence in order to mix the chemicals and distribute them around the whole hose. Another advantage of the hand made air pressure is the fact that the 0.5µm-filter is simultaneously backwashed during filtering, so the filtration rate is kept constant. During our initial investigation we had to solve a lot of problems, but the basic principle of the system was correct.

On the other hand we have the idea, to develop a pull-pump-and power unit (ppp), using a common chinese one-axle traktor..

The advantage of this development is the fact, that this ppp-unit can be used for rehabilitation of salted wells and as well as producing electric power for mobile water purification plants, which are installed in a special swimming and driving trailer. With this drinking water mobile, which also contains a field laboratory for chemical and bacteriological examinations, nearly all contaminated waters – even salt water – can be purified to a save drinking water.

Vulnerability of Sanitation Systems and Sustainable Alternatives Available

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Keywords: vulnerability, sanitation, flooding, Tsunami, groundwater

It has become clear from extreme events causing flooding that sanitation systems are highly vulnerable and the first to create health and environmental problems. High water tables flood pit latrines, septic tanks and sewerage systems disabling these systems and contaminating drinking water sources. Costly relief activities are made necessary including temporary toilet facilities, water treatment systems and inoculation and against water-borne diseases. For areas that flood on a regular basis due to monsoons and coastal storm surges, alternative more resilient sanitation systems can be suggested. The Red Cross has introduced dry sanitation systems in the Li River in Guangxi Province of China to combat the effects annual flooding caused by the annual monsoon rains. Although the installed toilets are often flooded along with other adjacent buildings, they are built above the ground level and designed to retain their contents minimizing pathogen contamination of the ground and surface water. As soon as the floodwaters have abated the toilets can be used by adding lime. So although the water table remains high for several weeks following the flood, the communities have access to safe sanitation and ground water for drinking and hygiene purposes. Similarly in the recent Tsunami-affected areas in Sri Lanka, the EcoSanRes Programme in collaboration with the Red Cross is introducing alternative sanitation systems in the coastal communities that have seasonally high water tables.

Even during drought periods, water-borne sanitation systems can become disabled and the lack of water for hygiene can become a health risk. Here again dry sanitation systems can provide safety and the limited water supplies often trucked into communities can be used for drinking and hygiene purposes instead of flushing excreta into pit latrines. Such alternative sanitation systems are presently being used in advanced multi-story buildings in urban areas (e.g. in Erdos, Northern China) and in installations in rural villages in several regions of Africa, Latin America and Asia. They cost less than pit latrines, septic tank and sewer systems and provide odour-free conditions, hygienic and environmental safety. These systems also provide the added advantages of source separation, containment, sanitisation and recycling back to soil systems. This means that black water from toilets can be separated into urine and faeces fractions (dry or wet), that greywater can be kept separate and treated locally or in decentralised systems and that storm water be kept separate from the sanitation system. This decreases the vulnerability of the sanitation system and ensures minimum impact and quick recovery following flood events. Urine contains about 70-80% of the nutrients excreted by humans so urine diversion means removing most of the nutrients at source thereby reducing the potential pollution if sewers become overloaded with floodwaters. The faecal fraction which contains the pathogens that can contaminate drinking water and threat human health can be contained and composted on site or in decentralised systems and returned to the soil.

For sustainable sanitation approaches to take root will require capacity building, innovation, social marketing and participatory decision-making within communities. It also calls for integration between sectors such as water and sanitation services, town planning, housing, roads and drainage, solid waste management and agriculture.

Impact of Tsunami in Coastal Tamilnadu (India) and Sustainable Water and Sanitation Services

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Keywords: Natural Disaster, Tsunami, Geomorphology, Water supply and Sanitation, Sustainability

Introduction: The Tsunami of 26th December 2004 which struck Tamil Nadu coast, had caused colossal damage with human death toll crossing 8,000, more than 17,000 animals perished, over 4,000 ha of standing crops destroyed, thousands of family lost their houses and tens of thousands of people lost their livelihood.

The national and international agencies have primarily focused on emergency humanitarian responses, eg. disaster relief needs of communities and logistical support actions such as infrastructure repair and providing temporary and permanent shelters. One aspect of rehabilitation and reconstruction of tsunami affected villages which has not been given due weightage during reconstruction is the geomorphologic changes and its impact on the drinking water supply and sanitation services. Realizing this gap, the Wetland International (South Asia) has initiated an assessment exercise under the title "Green Coast Recovery Project; securing the future of nature and people after the tsunami". As a part of this exercise, a field visit was undertaken to eleven tsunami affected villages along the coast to study the geomorphologic changes and the impact of tsunami on drinking water supply and sanitation services. This paper describes the field research results and conclusion arrived there from.

The main conclusion of the field observations from the Tsunami impact in coastal areas of Tamilnadu (India) is that the force of the tsunamis is enhanced by a combination of factors like onshore topography and near shore bathymetry. The geology, lithology of the coast and the tectonic and geomorphic features also has direct bearing over the tsunami vulnerability. The tsunami caused much devastation to the drinking water supply and sanitation services of the affected villages.

Relief and Rehabilitation works done for Water supply and Sanitation: The coastal villages normally do not have a reliable drinking water source within their village and water supplied by tapping sources from outside the villages. In water supply affected villages water is supplied through tanker lorries by private operators for a cost. Street taps have been provided in temporary as well as in permanent shelters. The permanent shelters are being constructed as per the approved plan given by the government. Though each house has been provided with separate toilet and bathroom, they have to depend only on the street taps for water. The sewage disposals have not been planned.

Normally in the coastal villages, the people used to defecate in the open sea shore. The use of toilets is very rare. The women use the waste lands where trees provided the screen. In temporary shelters, toilets have been built. But as water supply is not provided to these toilets the usages is minimum and maintenance is also poor. In some villages, the women have been forced to use a part of the house as toilet, as there was no alternative. In some villages, the women have either to go out or used a part of the house as a toilet and clean everyday. They cannot use the beach, as it is a market area.

Conclusion and Recommendations: We need to understand the existing geomorphic set up of the village and the constraint in implementing a rational rehabilitation plan. The violation of CRZ act is rampant and most of the lands are owned by private people. The lands under the Government control are the low lands which are vulnerable to natural hazards. The existing institutional set up and how can that be strengthened to take up the rehabilitation work need to be understood. In short, an integrated master plan has to be prepared with the help of local community which must be implemented through them with technical and financial support from service providers such as Governments and NGO's.

The capacity building of the Village Community and SHGs and creation of awareness on Health and Hygiene especially in the use of toilets among all the coastal villagers is to be carried out as a part of rehabilitation works. If awareness on sanitation is created through school children in Tsunami affected areas, the rehabilitation on Sanitation will be sustainable.

SIWI Seminar for Young Water Professionals:

Co-management of Water for Livelihoods and Ecosystems

Is Co-Management of the Okavango Delta Resources Possible and Can it Guarantee both Sustainable Livelihoods and Ecosystem Protection?

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Keywords: Ecosystem, livelihoods, sustainability, co-management, access

Inhabitants of the Okavango Delta depend directly on the natural resources of the Delta for their mere survival. The sustainability of their livelihoods is dependent on the waters of the Okavango River, which originate from outside Botswana borders. The human population is however not the only one dependent on the Delta resources for survival, a vast variety of biodiversity equally exists in this ecosystem. It goes without saying that there is increasing competition and conflict over the resources from all the sectors of the economy. This poses increasing danger on the ecosystem, risking degradation and collapse, which would have adverse impacts on biodiversity and people's livelihoods, especially the livelihoods of the poorest inhabitants.

Current management of the Delta ecosystem is sectoral and hierarchical at best and as a result not representative of all resource users. Modern and traditional practices clash as talk of conservation and sustainable use arises. Communities feel that government policy for managing the resource is mostly geared towards profit and conservation and therefore benefits "big business" such as tourism and industry and excludes subsistence users. Efforts have been made in the past to practice co-management by the government and communities but these efforts have mostly failed, resulting in resource capture by mostly the commercial tourism and fishing industries.

A year-long research project for a master's degree found that the management of an ecosystem like the Okavango Delta can better be managed by implementation of an integrated approach such as IWRM, in order to guarantee both sustainable livelihoods and protection of the ecosystem itself. This study shows the impacts of the current management approach on both the quality of the ecosystem and the livelihoods of the people dependent on it. It reveals a decline in the quality of livelihoods as well as loss of biodiversity. Importantly, one of the key impacts of water resources (mis)management is the increasing marginalisation of local people from their resource base: centralised planning based on a narrow understanding of 'water' obscures from government view the livelihood needs of people in Ngamiland and their complex relationship to the water resources of the Lower Okavango River Basin.

Research reveals a pattern in natural resources use that is mostly unsustainable, posing threats of ecosystem degradation by both human and wildlife. Wildlife conservation efforts have resulted in an unsustainable increase in the wildlife numbers, resulting in high interaction between humans and dangerous wildlife, domestic animals and predators, as well as conflict between wildlife and crop farmers. Vegetation resources have also been significantly degraded by overpopulation of wildlife, directly affecting the livelihoods of people who depend directly on these vegetation resources. Access to the Delta water for fishing, farming and transport has also significantly lost to commercialised fishing, fenced off fishing grounds and tourism. Current system of delivery are inefficient; legal frameworks tend to favour those already empowered in society-commercial ranchers, tourism operators; wealthy individuals who are free to pursue 'self-help' through borehole development; government policy and practice regarding access to water supply leaves rural people particularly vulnerable; and access to water related resources is diminishing for people most dependent for survival on the resource base. Importantly, decisions are taken without adequate data. As a result, water appears to be treated as an open access resources, where the powerful are free to capture as much of the resource base as the law (however weakly implemented) will allow.

Government policy continues to fail to encourage co-management between commercial fishing and tourism industry and communities. As a result, resource capture has ensued, resulting in both increasing poverty and ecosystem degradation.

The study relied on primary, secondary and tertiary data collected over two years. Here I present data obtained from 43 village meetings, interviews with key informants, and a close reading of various unpublished studies and government documents regarding water resources management policy particularly as it relates to Ngamiland/Okavango Delta. Other sources were consulted to give perspective to the study and offer comparative examples. These included published data in the form of journal articles and books on IWRM and water resources management in general. Tertiary sources such as the media-print, television, radio, internet-were consulted on an ad hoc and/or opportunistic basis.

How can management of the Okavango Delta be beneficial to both the people and ecosystem? Perhaps a practical step in the right direction would be implementation of co-management of the Delta resources based on IWRM principles. The need for resource-based institutional structures (River Basin Planning based on an ecosystem approach) is clear. Only determined political will on the part of decision-makers in key policy position can bring the necessary influence to facilitate positive change. In Botswana, there is little incentive to change current management practices. Prospects for overcoming current negative practices and instituting IWRM are therefore limited.

Negotiated River Basin Management for Co Managing Ecosystems and Livelihoods

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India

Keywords: Negotiated Approach, Ecosystems, participation, Integrated River Basin Management, livelihoods, platforms

Ecosystem protection and nurturing the livelihoods of poor are of utmost importance in attaining Millennium Development Goals. Though seemingly at cross-purposes, both can be implemented synergistically as they depend on each other. The paper explores implications of negotiated approach to river basin management that empowers local communities, for sustainable water management.

The pattern of "winners" and "'losers" associated with ecosystem changes, and in particular the impact of ecosystem changes on marginalized communities, has not been adequately taken into account in management decisions. (Millennium Ecosystem Assessment) Policy has seldom integrated the needs of local population and needs of ecosystems. Unrealistic policies, in absence of stringent enforcement mechanisms have limited effect on field. This can be amended if communities are actively involved in planning and decision making process. Ecologically viable management strategies for tropical Asian rivers will succeed only if the socioeconomic context of development plans is taken into account (Dudgeon, 1992)

New and evolved fields of water management like IRBM are welcome change in conventional water management scenario, in that they are expected to function in a framework of ecosystem approach. IWRM aims to strike a balance between use of resources for livelihood and conservation of resources to sustain their functions for future generations. (Falkenmark, GWP TEC Paper 9)

IRBM holds a promise, but the way it is envisioned in developing countries, with centralized river basin organizations and experts recommending top down measures, it will revert to centralized rigid system. At the same time, a complete biophysically founded ecosystem approach where humans are not seen as part of the ecosystem will not be applicable on field. Need of the hour is a balanced approach that empowers communities in making informed choices about managing their ecosystems.

The negotiated approach is a variant of conventional IRBM, based on a collective vision that: 'Sustainable and equitable water resources will be enhanced through a negotiated approach that recognises the river as a unit and embraces local level initiatives, while simultaneously adopting an integrated and ecosystem approach to basin management' (Hirsch, Paranjpye, 2005)

Negotiated approach functions through creation of platforms for negotiations from the lowest possible level, applying subsidiarity principle. Through discussions, sharing of data, information and knowledge, communities reach mutually acceptable decisions and being convinced about decisions taken, adhere to it. Decision-making through platforms also creates spaces for problems to emerge. Through open discussions, sustainable solutions evolve.
Applying Negotiated approach in seven basins of the world

Through a project funded by DGIS, civil society organisations Both ENDS and Gomukh documented the results of implementing a negotiated approach to river basin management in Bhima basin: India, Khulna-Jessore : Bangladesh, Se San : Cambodia, Nan: Thailand, Sand : South Africa, Ocona: Peru and Tiquipaya- Cochabamba : Bolivia. Project partners represented unique bio-climatic, socio- political and institutional background of their native lands. Following are selected outcomes of negotiated river basin management to livelihoods and ecosystems:

Bhima Basin India

In this drought prone basin, negotiated approach was applied initially to a watershed of 8000 hectares through formation of watershed committees and water users groups that met periodically to discuss water allocation issues for catchment. Gradually, government officials, engineers, experts were involved in the process. It has to be noted that additional efforts had to be made to involve below poverty line families and women. Their participation ensured equitable water allocation.

Outcomes of negotiations

Conservation of sacred groves:

Sacred groves are small patches of virgin forests, protected through religious sentiments.They have become sanctum sanctorum of biodiversity and important source of fresh water springs. With education and urbanisation, ancient belief systems are lost and sacred groves are dwindling. Through awareness generation and negotiations, locals of Kolwan valley decided to refrain from collecting/cutting firewood and construction woods from the groves. Through analogue forestry, area of groves was expanded and water source was strengthened. Water tank built at the base of the grove collects fresh water from the spring and now supplies water to a population of almost 2500 people.

Se San Basin:Vietnam Cambodia:

Se San is a transboundary tributary of Mekong straddling Vietnam and Cambodia. The construction of Yali dam in Vietnam has had pronounced economic, social and ecological impact on several provinces of Cambodia, including the remote Ratnakiri province.

Water releases from the massive hydropower dam completely altered Se Sans flow regime. Ecosystem impacts were scourging of river bed, decline of fisheries and fish species, dry wet seasons, dry season floods etc. This resulted in severe long term impacts on resident indigenous communities

Outcomes of negotiations:

Se San Protection Network was organically created in 2000. Active involvement of local communities ensured that problems and impacts were identified. Through various studies conducted by SSPN, it was concluded that annual livelihood losses of households in Ratnakiri amounted to USD 2.5 Million in 1999. Over time, the effort was upscaled from local to international level. A small initiative in a remote area led to negotiations between Vietnam and Cambodia and an active involvement of MRC, Oxfam, and the international governments. Successful negotiations will have a positive impact on livelihoods as well as the aquatic ecosystem.

Co managing Ecosystems and livelihoods

Ecosystems dependent communities are best placed to assess the impacts of unsustainable practises on ecosystems as well as the communities and seek integration in an organic and holistic way. Also, Negotiated approach and participatory decision making is important while dealing with natural resources as balancing the needs of ecosystems and societies entails significant trade offs. For the solutions to become acceptable, trade-offs have to be handled with equity and sensitivity.

River Basin Perspective:

It has to be noted that in absence of a river basin perspective, isolated success stories have a limited impact on the aquatic ecosystems. For an approach to be universal and acceptable, it needs to be replicable spatially and temporally to an entire river basin.

Conclusions and Recommendations:

Ensuring livelihood security and ecosystemic well being entail complicated trade offs. In such cases, sustainable decisions have to be taken with equity and sensitivity. Involving stakeholders, especially weaker sections of the society like women and Below Poverty Line families in planing and decision-making guides us towards equitable decisions. A negotiated approach to river basin management that empowers lowest level discussion platforms and empowers rural population with knowledge and information about their natural resources is an effective way forward in achieving synergy between livelihoods and ecosystems.

Building Resilience in Semi-Arid Agro-Ecosystems: the Importance of Managing Water and Soils for Food Production and Ecosystem Insurance Capacity

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Keywords: resilience, agro-ecosystem, semi-arid Africa, ecosystem services, dry-spells

Semi-arid agro-ecosystems provide the resource base for some of the fastest growing human populations today, and are inhabited primarily by poor people who are dependent on the productivity of these systems for their livelihood security. Small-scale farming is the main income source in these regions, but harvests are low and unreliable. Water scarcity, primarily in the form of droughts and dryspells is one of the main challenges for the farmers in this region. People here also depend directly on other ecosystem services generated in these systems, such as fuel-wood, fodder for livestock, pollination and erosion control. A major challenge is to sustain, or enhance the resilience of the agro-ecosystem in order to ensure the long-term capacity of the system to generate both food and other ecosystem services in the face of large-scale water variability.

This paper propose a theoretical framework for studying the resilience of semi-arid smallholder farming systems, which is used to analyze changes in resilience over time in such as system in northeastern Tanzania. The paper is based on findings from a case study of agro-ecological and social changes, and driving forces behind them, in the Makanya catchment the last 50 years. The methods included interviews with local stakeholders, aerial photo and satellite image interpretations of land cover change; and rainfall and population data analyses.

Resilience of agro-ecosystems

Social-ecological systems, such as agro-ecosystems, are often robust to change over a range of conditions but respond strongly to change when key variables within them approach certain thresholds. In such systems, the passing of a threshold can result in dramatic changes. This happens since the system moves into a different regime, characterized by different functions and feedbacks. The paper identifies two such regimes for semi-arid smallholder farming systems. The first is 'sustainable' or desired, where the provision of enough biophysical resources to support the people living in the system is ensured over time. In this regime the system develops along a trajectory where management of the land results in feedback processes that maintains, or even improves, the capacity of the natural resource base to sustain the population in the area. In the other regime the resource base is becoming degraded, increasing the vulnerability of the local communities. Agricultural products and other ecosystem services are not produced in sufficient amounts to sustain the population over time, and management practices trigger a negative spiral of feedbacks that result in lower harvests, clearing of new land, loss of soil organic matter, even lower harvest, etc. Two variables are suggested, possibly exhibiting threshold properties, to be especially important for determining the trajectory of the system. The first deals with the capacity of the arable land to sustain adequate crop yields over time and is related to water availability for crop growth, and the quality of the soil. The second variable relates to the capacity of the surrounding landscape to provide livelihood options other than farming for people in the system.

A changing resource base
The case study revealed that people who live in the study area were of the opinion that the local resource base had become more degraded over the last 40-50 years. According to them, the area of bushland and forest was significantly reduced during this period, and increasing land areas were put under agricultural production. Soil fertility declined, wildlife disappeared, and natural resources used in their daily lives became increasingly difficult to find. They ascribed this development to the growing population's needs for resources, to declining rainfall and to non-working regulations for natural resource protection.

The informants' narratives on landscape changes and the aerial photo and satellite image interpretation support each other. The change detection showed that cultivated land had increased dramatically in the catchment, covering about 38% in 1954 and 66% in 2002, whereas bush land had been reduced by nearly half. Over the same time period the population in Same District is estimated to have increased with more than 200%. The rainfall analysis did not show any significant changes in rainfall amounts for the time period studied. However, an increased frequency of longer dry-spells was found, indicating a change in the distribution of the rain, which results in an increased water vulnerability for the farmers. It is concluded that the landscape has undergone considerable changes over the last 50 years, primarily in terms of a reduction in bushland and an expansion in farm land, but also in terms of loss of ecosystem services. This seems to have been driven by institutional changes resulting in altered strategies for natural resource management, in combination with population growth. The increased dry-spell frequency has likely contributed. Applying the conceptual framework on this case it is suggested that the system has moved from a desirable towards a degraded state over this time period.

However, there seems to be a current window of opportunity for change due to a number of converging factors that potentially can turn this degradation trend around. These include far-reaching policy changes in Tanzania making alternative forms of natural resources management possible; a decreased gap between farmers, researchers and authorities, making local participation more likely; the establishment of new local institutions that could constitute platforms for natural resource management. It should be noted that the further the degradation trend is allowed to continue, the more challenging and costly it will be to turn the trend around. Building resilience of a more desirable state will depend on how successfully land and water can be managed in an integrated way to sustain food production as well as other ecosystem services.

Rehabilitation of Tanks in Tamil Nadu for Livelihood Security and Ecosystem Development

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Keywords: Tanks, Tank Rehabilitation Department (TRD), phased development, livelihood opportunities, ecosystem approaches

Sustainability of any ecosystem depends on ensured livelihood security of the communities' habitating in the delineated land mass. Co-management is not about allocating small portion of water for nature to fulfill the concerns of biodiversity and environment. Instead, co-management of water is about actions through mulidisplinary integrated instutionalised environment for improving the quality of the environment, enriching livelihood of weaker sections, who struggle below subsistence level, in synergic combination with ecologically sound approaches.

In spite of certain common functional and structural attributes in all ecosystems, great diversity exists even among the spatially adjacent ones. So, while formulating the strategies for development of ecosystem in conjunction with livelihood opportunities, the factors such as socio-economic aspects, cultural issues, knowledge of the existing environment and ecosystem, climate, topography, etc have to be given due consideration since, successful strategies in one ecosystem may be futile in another.

In Tamil Nadu, southernmost state of Indian subcontinent contains 39,502 tanks, large to small, which plays a vital role in agriculture and shaping up the rural economy. These tanks housed small freshwater ecosystem and surrounded by small terrestrial ecosystem. But such systems are gradually eroded leaving the rural people in the state of fray. So there is a need to restore such small, nevertheless important systems for improving the quality of environment, ecosystem and rural people.

Analyzing these issues perspectively, emphasis the need for establishment of an separate institutional arrangement called "Tank Rehabilitation Department (TRD)", Comprising central and state governments, NGOs, local authorities and communities. For the revival of tanks, TRD will address the issues such as construction and maintenance of tanks, raising resources, management of water, protection of interests of weaker sections, general welfare and people participation etc.

This paper addresses the strategies or ways in which the TRD needs to proceeds to achieve the designated objectives in phased manner. Initial, interim and final are the three main phases, in which each phase will have several sub-phases. For example, providing employment at an average of 10 people per tank will generate employment for 4 lakh people, who are below the subsistence level. Some of the sub phases are water for irrigation, fish culture, and forestry in tank area, fuel and fodder, minor forest products, silt for farmers, people participation.

Conclusion: Although the present institutional arrangement undertakes the rehabilitation work, most of them are one dimensional and in fragile manner. So there is a need to create an institution (called TRD in this paper), which can work in multidimensional and integrated manner to ensure the livelihood security of the needed by ecologically sustainable practices.

Industry, Community and Research Collaboration for Sustainable Water Management – Some Australian Experience

Author: **Ms. Anwen Lovett,**
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Keywords: catchment, stakeholder participation, partnerships, sustainable agriculture, ecosystems

Australia is a large, diverse continent - geographically, climatically and ecologically. We have vast floodplain systems, ephemeral arid rivers and bountiful northern rivers. Our climate is boom and bust, with the country enduring years of recurrent drought, only to be overwhelmed by flooding rains. Australians have a strong cultural connection with the wide open landscape of the inland, the rural way of life and iconic river systems such as the Murray-Darling and Cooper Creek. Our major river systems (especially in southern Australia) are highly regulated through weirs, levees and dams, as in their natural state they would spend much of the year dry. These river systems have been the lifeblood and driver of rural and regional development, without which the inland would have been uninhabitable. However, agricultural prosperity has come at a price, and many regulated river systems are now demonstrating signs of severe ecological stress such as declining water quality, increasing salt levels and loss of native species.

The presentation will report on Australian approaches to sustainable water resources management. The key characteristics of the Australian approaches analysed here are:

- Active participation of affected stakeholders in research, development and extension;
- Partnerships, co-investment and shared ownership between government and rural industries in those research, development and extension activities; and
- The establishment of catchment (watershed) management organisations across the whole continent with a mandate to take an integrated approach to natural resource management at a catchment or landscape scale.

Australian rural industries and farming communities, as managers of substantial tracts of the landscape, are at the cutting edge of finding innovative approaches to sustaining agriculture, ecology and regional communities. Through case study examples from Land & Water Australia's collaborative research, development and extension initiatives, this presentation will show how co-investment between government and agricultural industries can lead to more sustainable outcomes at farm, community and landscape scale.

Case Study 1:
The irrigation sector in Australia underpins many rural communities and is a significant contributor to the economy. It consumes about 70% of all diverted freshwater resources and contributes about one-third of the value of agricultural production from 0.5 per cent of the land area. However, irrigation impacts on the ecology of streams, floodplains, wetlands and estuaries. The National Program for Sustainable Irrigation is focussing research on critical environmental issues while also aiming to improve the productivity of irrigated agriculture and maximise community benefits. An example is the Goulburn-Broken Irrigation Futures project, where a community-led futures scenario process is being undertaken to help that

community determine its long-term priorities for social, ecological and economic development.

Case Study 2:
The Land & Water Australia National Riparian Lands Research & Development Program has collaborated with the wool, cotton, sugar and dairy industries to develop on-farm guidelines to assist farmers to better manage their rivers and streams for production, ecological and social outcomes. Farmers are trained in the use of guidelines through local facilitators and extension staff. Workshops are held to train these people in delivering what is often quite technically difficult material to landholders. This is achieved by bringing scientist and end-user together so that products can be developed that are underpinned by rigorous science but presented in ways that are tailored for a particular industry.

Case Study 3:
Grain and Graze is an integrated farming systems program which is seeking to connect on-farm production and natural resource management sustainability outcomes with catchment sustainability priorities. It is doing this through funding collaborations between catchment groups, farming systems groups, industry and government research and development.

The Wise Use Principle: When Words of Wisdom are Confronted with Reality

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Keywords: water, wise use principle, ecosystem services, poverty reduction, conservation

The Ramsar Convention is the oldest of the international environment agreements, signed in 1971 in Ramsar (Iran), on the shores of the Caspian Sea. Well before the Rio Summit, the Ramsar Convention was pioneering key concepts that govern environmental management today. Sustainable development or management of natural resources, integrated approach to ecosystem management, integrated river basin management, payment for ecosystem services; all these concepts are grouped, for the Ramsar Convention, under the umbrella of 3 words of wisdom: the "wise use principle". Established as the key philosophy of the Convention since 1971, the wise use principle has been the backbone of Ramsar's action for more than 35 years. But is it really efficient? How do nice theories translate into real actions when confronted with reality? Can the wise use principle really assist management of ecosystems for their natural resources, for poverty alleviation or for economic growth and development while conserving the planet's biodiversity? Can international agreements and conventions really make a difference or are they just paper and money consumers?

Throughout history, aquatic ecosystems have been vital for humans. It is no accident that river valleys and their floodplains have been the focus of human civilizations for over 6000 years. Wetlands, in the sense used by the Ramsar Convention (i.e. any water body, from the mountains to the sea, permanent or ephemeral, including human made ecosystems such as irrigated agricultural fields, rice paddies or shrimp ponds) are among the most productive ecosystems on the planet and provide a wide spectrum of vital services: water supply, food resources - including fishing and hunting - irrigation, recreation, religion and beliefs, transportation and communications, energy production, filtration and sanitation, storm prevention and flood mitigation, shoreline stabilization and erosion control, groundwater recharge and discharge or stabilization of local climate conditions, particularly rainfall and temperature, etc. What can explain, then, the fact that today, wetlands are disappearing and degrading faster than any other ecosystem on the planet, less evident, according to the Millennium Ecosystem Assessment?

Although we are the same species, the perception of a wetland by an inhabitant of the 35th floor of an apartment building in New York and by a villager in the Sundarbarns of Bangladesh is probably very different. And so the world's political perception of wetlands is also shaped by these individual perceptions. In fact, being mainly an urban species, people now have views of wetlands which vary from seeing them as possibilities for tourism when they are far away, to objects for use (and usually drainage!) if they are close by. And that is when the vision is not simply limited to seeing them as a source of mosquitoes, worms and other disease-bearing organisms…

The Catskill area catchments, north to New York, and their US$8 billion worth services in drinking water filtration and provision for the city of New York, the Chilika Lagoon, in India, and its extraordinary recovery process, helped by the Ramsar Convention and the wider International Community, through the Montreux Record mechanism; the western highlands wetlands in Ethiopia and their vital contribution to people's survival through a wide spectrum of ecosystem services, including the provision of safe drinking water; or the Várzea project in Brazil where the wise use of the Amazon River's floodplain by empowering local communities significantly improved their quality of life and raised household income, are just a few examples of how the wise use management of wetlands and water resources can result in poverty reduction and improved livelihoods, as well as ecosystem protection and biodiversity conservation. A simple equation seems to give part of the answer while adding some more words of wisdom: re-connecting people and nature.

Sebastià Semene Guitart was born in 1974. After his university studies in Evolutionary Biology he completed a PhD on Population Biology from the EPHE/Sorbonne University (Paris). During the last years of his studies, he started working in parallel in journalism, including collaborating with several radio stations and writing chronicles for one of Andorra's national newspapers, El Periòdic d'Andorra, on cinema and society issues. He is currently working as the Convention Development Officer of the Ramsar Convention since 2004.

Resource Recovery, Ecosystem Conservation and Livelihood Options in Bengal Deltic Region

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India

Keywords: Aqueous delta, Ecology, Recycling, Sedimentation, Wetland

Presentation of the topic: Bengal delta, formed by two great rivers, the Brahmaputra and the Ganges, many small rivers and tributaries, is the largest in the world, located in the eastern India and Bangladesh facing the Bay of Bengal. It is a complex area with estuaries, marshes and wetlands, canals and creeks and streams, forests, wild life, fertile agricultural fields, villages, towns and cities. It is a vulnerable area for cyclone, flooding during monsoon, pollution, erosion and sedimentation. In such situation, unsustainable pattern of development has disturbed ecology. People mostly poor live with this and their livelihood is based on water system, utilising wetlands, flood water and sedimentation for agriculture and resource for wastewater for fishery near urban area etc.

To the poor the sustainability is survival and the poor try to co-exist with the aqueous environment, the dictionary meaning of ecology is interrelationship of organism and traditional practice of fishermen and farmers keeps this low land water area in river basin and in coastal delta become the area of livelihood. It is estimated that traditional commercial practices is wetlands provide livelihoods support for about 2.4 million people in West Bengal State in India.

Case Studies: There are three case study presentations,
(1) The Rangabelia project in the Sunderbans delta (78 km southeast of Kolkata) is one of the best practices of rural water management utilising local resources and making it a generator of rural development to alleviate poverty. Water is a key to development and shallow ponds collect heavy rainfall (1700 – 1900 mm) in monsoon months. The project is based on overall water management with rainwater collection ponds and channels using biofilters, biomass cultivation with fuel generation and pyrolysis, proper and systematic wastewater reuse/treatment, lowcost and innovative sanitation. This is a multipurpose project with many innovative ideas and socioecenomic benefits. The rainwater reservoir covers a total area of 0.6 hec or 30% of the area. The whole pond system collects around 15000 cum i.e. 15 million litres of water per annum and the element of partial recycling contributes a further 5% percent to the storage system. The water filtration process is natural, open to sunlight. The host of water hyacinth, duckweed and lilies help in limiting turbidity, cleaning the water etc. Besides availability of better water and sanitation, the project is productive with increased crops yields in agriculture and fishery. It supports flora and fauna and local biodiversity and ecology.

Mr. Ranajit Gupta, Secretary General, Centre for Built Environment is the consultant for many years to initiator the Tagore Society for Rural Development. In other wetlands areas in the delta rural people are commercialising major wetland products obtained from plant resources. Several others minor wetland plants (including medicinal herbs) and vegetable are harvested.

(2) The Community Based Wetland Ecosystem (CBWE) in Titagarh Municipality, a northern subarban industrial town, 22 km north of Kolkata and in adjoining rural area Bandipur is also known as Integrated Resource Recovery Project based on waste water treatment and aquaculture.

The land is leased to 110 farmers, around 30-32 types of vegitables are produced. There are fishermen for fish production. The stabilisation tanks at Bandipur in the local project are rented out to local farmer who pays to the Government and the village council. Kolkata Metropolitan Development Authority (KMDA) has provided planning and funding for infrastructure and basic operational cost.

With urban agri-aquaculture model separated solid waste is composted for vegitable production and liquid waste is recycled to produce fish with 'Reduce, Recycle and Reuse'. Besides employment to the people, productin of food, better land management and environment providing buffer between urban and rural areas with more oxygen. There are long term benefits in planning.

Ms. Sumita Gupta Gangopadhyay, a Founder member of Centre for Built Environemnt and Assocoate Planner, KMDA has advocated this and waste water recycling is included in official urban development programme.

(3) Another example of wetland based livelihood option and conservation of ecosystem is in east Kolkata wetlands and also in ponds operated by Mudialy Fishermens Cooperative Society, in Southwest Kolkata. Kolkata has the largest recycling district in the world and east Kolkata wetland is included in the list of Ramsar convention sites. The indigenous system of reusing waste water for fish production based on phytoplankton is being adopted in other areas. The fish ponds are 148 in numbers and now with 15000 tonnes per year production in 2500 ha. The area has become a nature park. Centre for Built Environment has organised seminars, conferences, and training programmes and campaigned, along with others, for preservation of such wet land ecology.

Discussion of results: Hydrological cycle is an integral part of ecological cycle. Wetland is a productive system. It has direct, indirect and optional economic values. There are lessons from the case studies. Indigenous method of ecololgy based treatment of water for food, employment and enhancing environment improvement in river basin or deltic low lands is a participatory process with multiple benefits and livelihood options.

Adoption of Rainwater Harvesting to Mitigate the Impacts of Land Cover Changes on the Local Hydrology - Case study of Lare Division in Kenya

Author: Mr. Joseph Sang, Kenya

Keywords: Rainwater harvesting, Impacts, Land cover change, Hydrology, Lare division

1. Introduction

Extensive land cover changes are known to affect the spatial and temporal hydrologic regime of an area. These include their effects on the soil water storage, surface water yield and streamflow, where the seasonal characteristics are changed. Mostly changes in land cover include extensive encroachments into forestlands in favor of other uses such agriculture, settlement and industry, yet forests play a crucial role in the ecosystem. The degree of land use and associated degradation can be linked to the human activities, which in turn are linked to population growth. High population growth coupled with immigration into an area applies more pressure on the land and its resources. This sometimes results in irrational use of the resource and thus their degradation. To cope with these effects on hydrologic regime there is need of a measure to reverse the effect of deforestation. Since afforestation is not possible in settled areas, conservation measures need to be introduced. One of such measure which is not widely utilized, though has many advantages, is rainwater harvesting. Rainwater harvesting is the capture, diversion, and storage of rainwater for a number of different purposes including landscape irrigation, drinking and domestic use, aquifer recharge, and storm water abatement.

2. Background

This poster is based on a study carried in the 134 km2 Lare division of Nakuru district, Kenya. The division receives medium and unreliable amounts of rainfall, though the main agricultural practice is mixed farming. The area is also intersected by numerous streams, whose flow characteristics have been affected and become unreliable. Despite these numerous streams there is prevailing scarcity of water for both human and livestock use, which is intensifying with time. These changes have been linked to the extensive removal of forest cover in favor of agriculture and settlements in the area. To cope with these changes the local farming community has successful and extensively adopted rainwater harvesting. The farmers harvest the rainwater from roof catchment or storm runoff from roads. The water is stored in different types of tanks and ponds for use during the dry season.

The main objective of this study is to identify the impact of land use/land cover changes on the local hydrology and how it has contributed to the adoption of rainwater harvesting in Lare division. Different data sources were used for this purpose. These include LandSat data, a Quickbird image, historical streamflow data and GPS-supported field survey. Series of LandSat data were used to determine the trend of land cover change over 20 year period, whereas the Quickbird image showed the current rate of rainwater adoption and the location of the harvesting ponds. To determine the change in hydrologic characteristic of stream, historical streamflow data were analyzed for changes over the 20 year period. The socio-economic impact of rainwater harvesting was determined by carry out a GPS-supported field survey. In the survey a semi structured questionnaire was administered to the farmers. This survey also tapped the local logical knowledge of possible impacts of land cover change and use of rainwater harvesting as a mitigation measures.

3. Summary of the poster

This poster seeks to highlight three major components of rainwater harvesting in Lare division. First the posters seek to the link between changes in land cover and the hydrologic regime in the study area. This is based on the comparison of trend of land cover change over the twenty year period and the corresponding streamflow.

Secondly the poster shows the rate and method of adopting rainwater in the division. Why some farmers adopted harvesting runoff, whereas others are using roof catchments. The factors and any local knowledge that has contributed to these successful adoptions of rainwater will also be highlighted.

Finally, the poster will give the impact of rainwater harvesting on the livelihoods of the local populace. How rainwater harvesting has contribute to socio-economic development in the area. Gender issues and emerging socio-economics activities that can be directly linked to the rainwater harvesting, this include improved food security and availability of clean rainwater at the homestead.

4. Conclusion

To cope with impacts of the current human activities, new and efficient conservation measures need to be put in place. One of the measures is rainwater harvesting, which has been successful adopted in Lare division and its advantages have been harnessed by the local community. As a result they have improved their livelihoods through increased food and water security. Therefore, as a recommendation from the study the Lare success story on rainwater harvesting should be documented and promoted for more adoption elsewhere.

Revival of Lake Ecosystem for Enhancing Livelihood Options through Co-management of Kondakarla Ava Wetland, India

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Keywords: Wetland Ecosystem, Visakhapatnam, India, Conflict resolution , Co-management, Just & Sustainable Livelihood

This presentation deals with a 3-year old project aimed to initiate processes of co-management for the conservation of a degraded Wetland, Kondakarla Ava, near Visakhapatnam, India. The main objective is to ensure equitable, just & sustainable livelihood (s) for all stakeholders of the lake, upon whom the impacts of ecosystem degradation are severe, affecting their basic livelihoods. The first part of the presentation traces various unsustainable practices for the use of the wetland, leading to its degradation and created conflicts among different stakeholders, while the second part focuses on the ground realities and challenges faced in initiating co-management in the wetland. An attempt is made to discuss a replicable model of co-management of the lake that provides equal opportunities to gain sustainable livelihoods through ecological management. The model provides practicable recommendations relating to policy and strategy development, participatory governance, institution building and livelihood strategy related to wetlands in a developing economy. Lessons drawn from this can provide advice for professionals seeking to use co-management as an implementation strategy.

Kondakarla Ava Wetland, the second largest fresh water lake in Andhra Pradesh (AP), is situated in Visakhapatnam district. It is a typical example of a rural lake in a developing economy in South Asian region. Kondakarla Ava, a part of the Sarada riverine system, is rich in its fauna and floral diversity, and is one of the major stop over sites for many migratory birds flying through AP. It is perennial and supports water throughout the year and thus acts as a major source for recharging the soil moisture and ground water levels in the region.The wetland serves as an economic backbone of its 17 surrounding villages.The economies of these villages to a larger extent revolves around it, for activities ranging from irrigation, fishing, washing, cattle rearing and others. Communities engaged in farming, fishing, and washing cloths are completely dependent on it for their livelihoods. Thus, throughout its existence wetland has been influencing the lifestyle and development of its surrounding economies. It has also been recognized as one of the important sites for ecotourism development by the Tourism Development Corporation.But despite all the importance attached to Kondakarla Ava, it’s been subjected to severe environmental degradation in recent times. The surface area and level of water along with the local avian and fish populations have been decreasing and all this has affected the socioeconomic conditions of the lake dependent communities very badly. So, it needs urgent conservatory measures for sustainable socioeconomic development of its dependent communities.Conflicts and inequity in sharing Kondakarla Ava’s resources, is the major issue, which forms an obstacle to its sustainability. The region is prone to the “Tragedy of the Commons” theory. Many governmental departments and local bodies have authority (decision making powers) over the wetland. With a plethora of “stakeholders” it is almost difficult to define rights and responsibilities for each one. The villagers have lost interest in involving themselves in any activities towards conservation of the wetland even though their livelihoods are dependent on it.In Kondakarla Ava conflicts exist at both, inter and intra village levels among various user groups.The major conflicts are between upstream and down stream farmers; rich and poor farmers & between farmers and fishermen. The rich and the politically dominant groups influence communities by trying to thrust their "rights" on the marginalized sections of the society, who thus feel ignored. Conflicts and disputes arising from these factors are something that cannot be avoided, suppressed or ignored.The ongoing project was motivated by the need for a common forum for all stakeholders to understand and negotiate with each other to contribute constructively and collectively for Kondakarla Ava's development which can ensure equal rights and responsibilities. Ten out of the 17 wetland dependent villages have been covered under the project to produce replicable models. The project implementation has been carried out in four major phases.

The first phase commenced with the process of studying Kondakarla Ava's ecosystem, its socioeconomic environment & various ongoing practices, aimed to recognize and focus on issues related to environmental degradation.The second phase involved motivating stakeholders leading to cultivation of mutual understanding and equitable sharing of wetland resources leading to just livelihoods. This phase included conducting PRA exercises, meetings with communities & awareness campaigns. This phase focused on a stage of 'Conflict to Concord'.The third phase dealt with capacity building programs and exposure visits aimed to enable wetland users, especially the marginalized sections for active participation and providing them an opportunity to learn from other such successful collaborations. The phase focused on a stage of Concord to Collaboration.

The fourth phase aimed to facilitate institution building (Formation of "Wetland Users Committee") at village and wetland level involving all stakeholders that could monitor wetland development activities and ensuring distribution of rights and responsibilities with equity and justice. This institution was also assisted chalking out a micro plan for a period of five years. Multi-criteria decision analysis was used to identify priority areas and communities' preference.The project also finds out various livelihood potentials in each conservation activity to ensure its sustainability. Indicators have been set up to assess the functioning of this co-management model. The project recommends a holistic, balanced and coordinated approach for wetland management at both policy and grass root levels for equitable distribution of rights and responsibility.

Integrating Human and Ecological Dimensions: The Principle of Equitable and Reasonable Utilization and Participation in the UN Watercourse Convention

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Keywords: International water law, Equitable utilization, Integration (humans/ecology), UN Watercourse Convention, International customary law

The use of international watercourses is always multi-dimensional and entails both human and ecological facets. From a legal point of view, co-management of international water for livelihoods and ecosystems meets two challenges: to legally take into account economic, socio-cultural and ecological aspects of water use and to organize a legal scheme to balance these different features. A legal framework for administering international waters must provide for an institutionalized process for weighting the diverse interests by means of co-operation with emphasis on finding win-win solutions.

The principle of equitable and reasonable utilization and participation has become the cornerstone of international water law. But is it capable to legally integrate anthropocentric and ecological uses? Although the broad lines of the principle are widely excepted, its exact impact is regarded by many to be still evolving and its interplay with competing norms like the principle of sustainable development or the no harm-rule is widely disputed. A key to answer these questions might be the UN Watercourse Convention.

According to the UN Convention, the principle of equitable and reasonable utilization and participation constitutes the centrepiece of international water law integrating the essential rights and duties of the riparians of international waters. Specific rules of international water law are understood as mere facets of this unitary norm making any isolated application of particular rules of international water law without reference to the overall picture unlawful. In order to put this holistic approach into practice and to solve the problems of distribution, protection and development of international waters, the UN Convention claims that every legal assessment needs to be subject to the key element of the principle of equitable and reasonable utilization and participation: the ongoing weighting process of all significant aspects of a given situation by means of co-operation.

The concrete meaning of “equitable” and “reasonable” is to be determined on a case-by-case basis as part of the comprehensive balancing process. With the idea of abstract equality of riparian States, water uses and weighting factors in mind, this process is not granting any a priory primacies, but tries to find tailor-made solutions for each specific case. Pursuant to the UN Convention, this process is aimed at the optimal and sustainable utilization of the waters concerned. By taking into account the interests of other riparians, the search for an equitable solution includes the so called no harm-rule and refers not only to distribution matters but also to the protection of the waters as a due-diligence obligation. An adequate protection of a watercourse has to take its bearings from the ecological equilibrium of the entire ecosystem of the watercourse.

The UN Convention makes the principle of equitable and reasonable utilization and participation include not only the right to use an international watercourse but also the duty to co-operate in its development and protection. In general terms, this duty relates to the regular exchange of data, the regulation of the water flow and the maintenance of installations. But there is also a specific obligation to co-operate with view to the protection of the aquatic ecosystem, which is, however, subject to a large discretion of the riparian States. Importantly, the principle of equitable and reasonable utilization and participation entails no explicit obligation to institutionalise the co-operation, but encourages the establishment of joint management mechanisms.

Due to evidence of consistent State practice and a corresponding opinio iuris, it is expected that the principle of equitable and reasonable utilization and participation (in the form it gained in the UN Convention) is about to become international customary law. Since the adoption of the convention by an overwhelming majority in the UN General Assembly, States have been systematically inspired by the text, which, being a framework convention, provides for both substantial rules and guidance in the implementation of these rules. This practice includes more and more States originally opposing the convention.

The principle of equitable and reasonable utilization and participation in the form of the UN Convention is a result of last century's dynamic development of the law of natural resources in general and international water law in particular. Even after its codification in the UN Convention, the evolution of international water law will continue. The UN Convention leaves space for a progressive interpretation with the emphasis on taking comprehensive account of ecological interconnections and strengthening international co-operation.

The principle of equitable and reasonable utilization and participation has become the fundamental legal rule of international water law and integrates both the aspect of human use and the ecological dimension of international waters. Being more flexible than the competing no harm-rule and more precise and "water specific" than the concept of sustainable development, the principle of equitable and reasonable utilization and participation constitutes the best legal basis for a co-management of international waters for livelihood and ecosystems.

The significant contribution of the UN Convention to the elaboration of the principle of equitable and reasonable utilization and participation, however, do not set an end to the development of international water law. The accessibility of the UN Convention to a progressive interpretation allows to gradually replace any distributive methodology by a consequently co-operative and ecological approach. However, the convention mainly concentrates on fighting the water crisis on a global level, but pays little tribute to the individual and local level, which gains progressively importance in the international water debate.

Managing Sydney's River Systems – Its Not Technology, It's the Ideology that Needs Changing!

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Keywords: Integrated Management, State Owned Corporation, Institutional Barriers, River Dependent Industries, Ideology

A Google search on the world wide web of the topic 'Co-management of water for livelihoods and ecosystems', presents over 50,000 links. Essentially all of these links relate to water resource management challenges in the developing world. Indeed mere mention of the topic itself almost unconsciously brings forward an image of communities somewhere in Asia or Africa to our minds. However, what may come as a surprise to many, the topic is just as relevant to Sydney, a renowned capital city of the developed world.

Whilst long-term economic survival of the industries dependent on Sydney's Hawkesbury-Nepean River is on one side, on the other is the metropolis of Sydney, with its 4 million people, who depend on the same river for the security of their water supply. The Hawkesbury-Nepean catchment has Sydney's largest water supply storage the Warragamba Dam. In addition to Warragamba, six other large storages are also located on the Hawkesbury-Nepean. These storages have resulted in the reduction of flow in river due to water impoundment and the increasing demands of urban water supplies.

A recent report by the Hawkesbury Nepean River Management Forum, entitled Water and Sydney's Future confirms that the health of Sydney's lifeblood, the Hawkesbury-Nepean River, is under serious threat. The river is showing signs of environmental stress, with significant weed infestation, recurring algal blooms as well as deteriorating fish production. Poor river health has negative impacts on tourism, agriculture, fishing & recreational industries, which are dependent on the river. It is estimated that collectively the river dependent industries have current economic value of over AUS$2000 million every year. Thousands of Sydneysiders, often belonging to poorer socio-economic group make their living from industries dependent on the healthy flowing Hawkesbury-Nepean River. The paper will elaborate further on each of these dependent industries, providing a snapshot of the riparian communities that face uncertain future.

In many ways Sydney's water resource management challenges are not uncommon, at the dawn of the 21st century four major challenges are facing water supply planning world over. These include the continued growth in population putting pressure on water demand, the increase in pollution making many natural water sources unsuitable for supply, the growth of environmental controls such as environmental-flow requirements, with many water supply alternatives having been rendered unfeasible and finally, most rivers are now used for a variety of purposes, so another dam site or a given river flow usable solely for water supply may no longer be possible (Whipple 1994, cited in Chanan & Simmons, 2002).

The report by the Hawkesbury Nepean River Management Forum also recommends solutions to Sydney's water problem. Aim of these recommendations is to provide sufficient water for Sydney's consumption, while simultaneously protecting the rivers on which the community depends. Interestingly the report suggests that Sydney would have to become more self-sufficient in water rather than continuing to rely on drawing water from distant catchments. The recommendation clearly calls for a more holistic approach to water cycle management, with increased stormwater and wastewater reuse. Evidence collected by the Forum clearly demonstrates that if these alternative supply options are incorporated to their full potential, Sydney's water future will be safe for generations.

While the Hawkesbury Nepean Forum's mandate was to analyse the issue and recommend appropriate solutions, its in their execution is where the major challenge lies. It's not simply the lack of funds or even technology that acts as a limiting factor in managing Sydney's water resources sustainably. As has been claimed by various commentators in recent times in the media, it is the 'ideology' of those responsible that needs an overhaul.

It is argued that a fundamental cause behind the outdated ideology might be the fact that Sydney's water supply & sewage systems have been managed for over hundred years by an institutionalised monopoly, called Sydney Water Corporation. While there might be a degree of truth in these claims, but the issue of organisational culture and ideology is much deeper then a few bureaucrats. Gill (2005) puts the responsibility squarely on the State Owned Corporation (SOC) Model, under which Sydney Water also operates.

Being a SOC, the organisation has clear commercial objectives to make money for the Government. Under the auspices of Australia's National Competition Policy the key aims of corporatisation include increase productivity of staff and infrastructure, reduce costs, closely aligned costs of provision to pricing policy, improved service to customers as measured by efficiency indicators and above all a guaranteed dividend to consolidated revenue. While integrated water resource management and sustainability are terms defined in the operating licences, they aren't essentially the drivers behind the decision making process.

The paper will discuss the challenges involved in managing Sydney's river systems to ensure water supply security for the metropolis, while guaranteeing livelihood for those who depend directly on the river. It will discuss a range of integrated options that have been selected by the Hawkesbury-Nepean River Management Forum as long-term solution for this challenge, while commenting on ideological challenges that stand in the way of achieving truly integrated water cycle management in Sydney.

Knowledge Management in Water(shed) Management

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Keywords: knowledge management, water, watershed, capitalization experiences, India

Water is a basic and essential element for economic, ecological and social well being of the society. Proper management of this scarce resource is critical to the policy makers as well as water users. The concept of Integrated Water Resource Management (IWRM) includes planning and management of drinking water supplies, access to sanitation services, provision of sufficient water for production and availability of water for conservation of ecosystems. There are many projects that make an effort to adhere to the IWRM concept but most of them are limited to pilot cases in specific areas.

A number of such successful pilot projects were analyzed and evaluated. But the projects remain as successful pilots with not much success in upscaling or replicating them elsewhere. Best practices approach is considered as another way of carrying forward the success stories. It is the process of documenting field-based activities, operational procedures or capacity building approaches that are successful and sustainable in social and environmental terms and can be readily adopted by other individuals or organizations. But this approach is too strait jacketed to fit all situations and hence, the scope becomes limited.

This paper proposes Capitalization of Experiences (CE) as an alternative or complementary approach to analyze experiences through a process of distilling key lessons from individual experiences. CE is a form of institutional learning. It is a process of learning together through knowledge and experience sharing among various practitioners for better water management. The overall objective of this process is to collectively analyze experiences in water management and draw out common insights. It may comprise a variety of methods such as documentation and exchange of experiences, evaluations, case studies, cross-section analyses and other methods used to evaluate, present and apply experiences. One important difference is the fact that in the process of experience capitalization, available experience is collected from the primary stakeholders (persons and organizations directly involved), and then assimilated and used to plan and implement changes.

CE like initiatives were undertaken by organizations such as Centre for Interdisciplinary Studies in Environment and Development (CISED), Danish International Development Assistance (DANIDA), World Bank etc. The common methods and approaches in these past activities included literature reviews, workshops, case studies based on baseline data collection, questionnaires, selected field visits etc. There is a need to build from these other CE initiatives and develop innovative methods for better experience sharing.

The objectives of the paper are to analyze the process of CE, the institutional linkages and networks created, how focus areas in watershed management evolved (for review)through a process of sharing information/knowledge and how institutions are collaborating to create an environment of sharing and learning based on their experiences. The paper draws lessons from the CE process initiated by the Swiss Agency for Development and Cooperation/

Intercooperation in India where a group of practitioners with experience in implementing and designing water sector projects come together as a 'Learning Group' and participate in a year long exercise with clear outputs at each stage.

As part of this experience, various methods and instruments are experimented with, to collate experiences and derive key learnings. Some of the instruments include story telling, brainstorming sessions, surveys, interviews and consultations, previously realized self or internal evaluations, cross-sectional evaluations, partner analyses, case studies, review existing documents, cognitive mapping, portfolio analyses, scenario techniques, etc.

The paper describes the context of watershed development projects in India and the need for capitalization of experiences. It describes one such process in detail and from this experience of collective learning, develops generic tools and methods that may be applicable in other situations. The relevance of this process is to propose an alternative approach to knowledge management, which has emerged as a key to promote innovations.

Groundwater Management in Iraq, Using Remote Sensing Technology: a Means for Combating the Desertification

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Keywords: Remote sensing, Image processing, Groundwater extraction, Desertification, Image classification

Iraq like many other countries in the arid and semi-arid region is exposed to desertification problems, especially in the Middle and Southern parts of the country estimated to be about one million hectares. This problem started because of the negligibility of the problem until it is expected now to have more than 90% of the cultivable lands. Some of the main causes of desertification in Iraq are the overgrazing, misuse of the plant coverage and sand dune formation. Recent estimates showed that 4% of irrigated areas were severely saline, 50% moderately saline and 20% slightly saline (i.e. a total of 74% of irrigated land suffered from some degree of elevated salinity).

Iraq is confronted with a range of environmental problems that are both immediate and severe. Critical long-term environmental vulnerabilities and risks are particularly associated with, ecosystem degradation, including desertification, land salinization and loss of biodiversity. The urgency to address the problem of desertification by coordinated international action is emphasized by the facts that the time for action is running short as desertification expands threatening new areas and new societies, while anti-desertification measures tend to be long-term, time demanding and the cost of anti-desertification measures escalates from year to year. Off-site (and social) costs of desertification will continue to increase as degradation adversely affects land, water and air resources. To study such a vast areas, the most suitable technology is remote sensing methods; the multi-data study will be used such as:

1. Satellite images with different wavelength.
2. Different topographic and thematic maps.
3. Field investigation.

The use of remote sensing documents for detection and delineating the classified units of rangelands and desertification activities is vital, due to the vast desert area, to apply the capabilities of satellite images such as synoptic view multispectral layers, and multi-date for the same area, to have classification maps in scale 1/100,000 that include:

a) Rangeland classes.
b) Distribution of rangeland classes in the desert area.
c) Distribution of vegetated areas (field, crops, forests, etc).
d) Extent and distribution of available water resources.
e) General distribution of the drainage pattern.

Remote sensing techniques have been selected for this study, which is the most suitable because of, and then inherent characteristics mentioned to delineate the different classes of the rangeland and the desertified areas.

Moreover, the arbitrary and dense groundwater extraction can cause large and fast diffusion of the desertification phenomenon.

To prevent and manage the consequences of drought and land degradation, it is vital to have timely, accurate and continuous information. Groundwater extraction monitoring can be used for regularly mapping the evolution of the general subsidence trend. However, there is a need to render these approaches effective to improve the strategies to combat desertification. Remote sensing technology is a mean to collect systematic qualitative and quantitative information at frequent rates on large areas. The remote sensing image processing renders possible to develop more advanced and efficient tools.

In this research , the use of the remote sensing image processing as an essential step in combating desertification process caused by groundwater extraction were indicated . The methods for groundwater extraction monitoring and desertification phenomenon mapping, such as vegetation index, sand index, image classification…etc., are presented with the experimental results performed on remote sensing images that cover case study areas in the arid and semi-arid areas in Iraq.

The obtained results show the ability to identify areas of subsidence. The produced land maps show a general subsidence trend in which most of the wells are distributed. These maps would allow local authorities to obtain information both for the location of the water exploitation zones and quantitatively correlate the ground water extraction with the land subsidence effect.