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Drainage Basin Management – Hard and Soft Solutions in Regional Development

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Drainage Basin Management
– Hard and Soft Solutions in Regional Development

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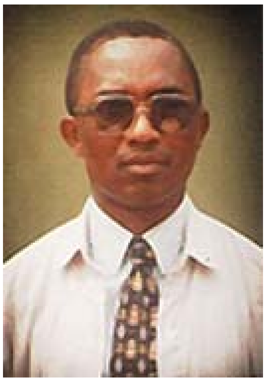
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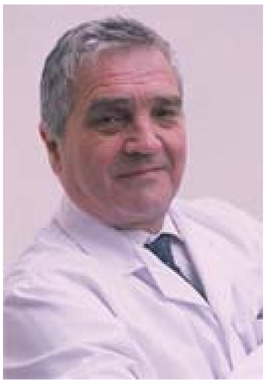
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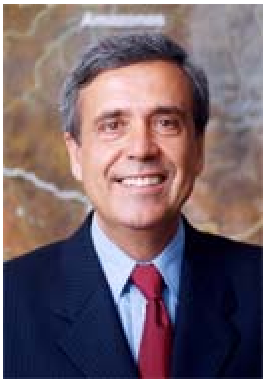

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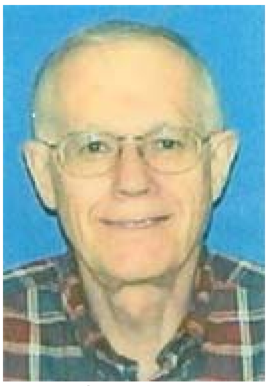

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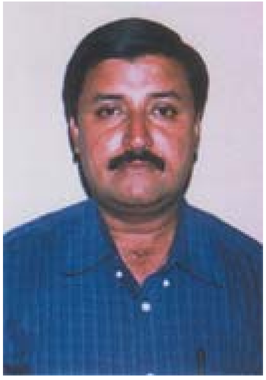
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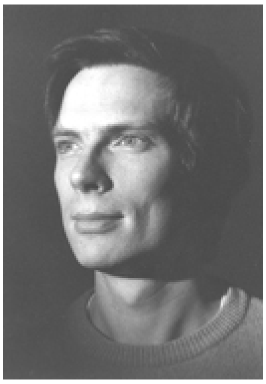
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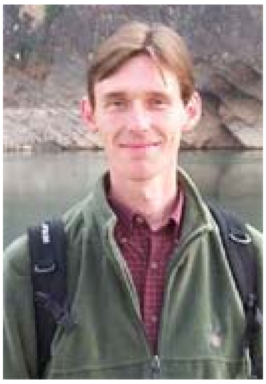
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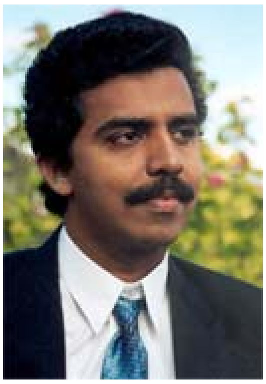
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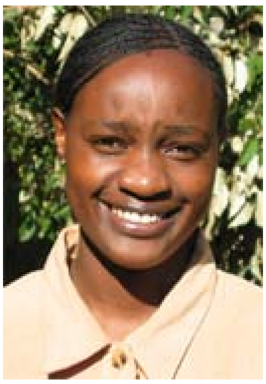
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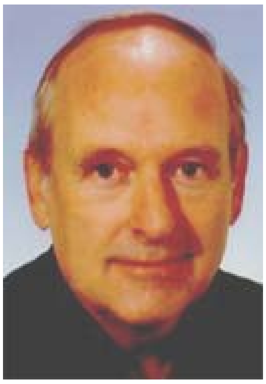
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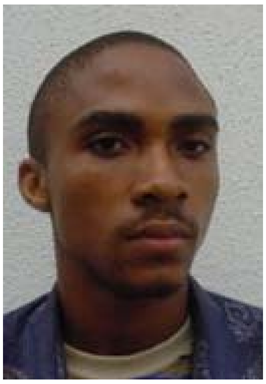
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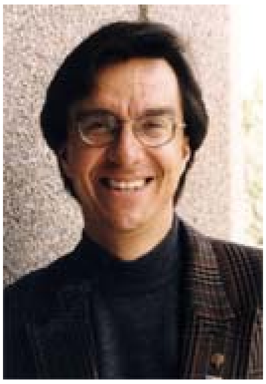
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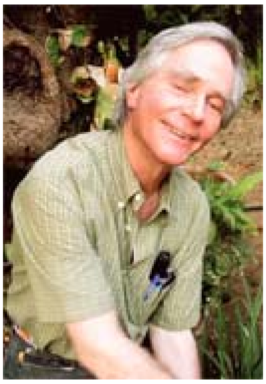
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Workshop 1:

Design and Operation of Infrastructure for Multiple Development Objectives

Social, environmental and economic impacts of the High Aswan Dam

Dr. Cecilia Tortajada, Mexico
Third World Centre For Water Management

The current knowledge-base on the actual benefits and costs of large dams, some 15-20 years after their operations have commenced, is very limited. At present, thousands of environmental impact analyses (EIA) are available for large dams, but these are all hypotheses since they forecast what are likely to be the situations after they start operating.

The impact evaluation of three large dams, the High Aswan Dam being one of them, was initiated by the Third World Centre for Water Management to answer these and other associated questions, and to enhance our knowledge-base so that the future dams can be more scientifically planned, and the existing dams can be managed more efficiently so that their benefits can be maximized and their adverse impacts can be minimized in order that the society obtains optimum advantages through their construction and operation.

The impacts of the High Aswan Dam can be classified broadly into four categories: physical, economic, social and environmental. This classification is somewhat arbitrary since many of the impacts are often interrelated, and one impact may spawn other impacts.

The economic benefits of the Dam have never been in doubt. At the time of its construction, total cost, including subsidiary projects and the extension of electric power lines, amounted to Egyptian £450 million. This is estimated to have been recovered within only two years, since its annual return to the national income was estimated at E£255 million: E£140 million from agricultural production, E£100 million from hydropower generation, E£10 million from flood protection, and E£5 million from improved navigation. Viewed from any angle, these are remarkable economic returns from any development project.

Prior to the construction of the Dam, silt used to be spread over land or carried to the Mediterranean delta. It is estimated that each year floods used to deposit 12 million tonnes of slit on land along the Nile. The reduction in soil fertility due to the loss of the nitrogenous component of the silt now has to be compensated for by the annual addition of some 13,000 tonnes of lime-nitrate fertilizer. The Egyptians had been taming the River Nile long before the construction of the Aswan High Dam, and coastal erosion in the Nile Delta was observed as early as 1898, when the first man-made structures started to control the river's flow. This erosion accelerated after the construction of the Dam. Appropriate measures have now been taken, or are being implemented, to mitigate the effect of the coastal erosion.

Following the construction of the Dam, the fish catch in the Mediterranean declined from 22,618 ton in 1968 to 10,300 tons in 1972. By 1980, it had recovered to 13,450 ton. However, what is not generally recognized is that the High Dam Lake created a completely new source of fish, and, by 1982, was producing 32,000 tons annually, more than compensating for the loss in the Mediterranean catch.

The health issue that has received the greatest attention as a serious adverse impact of the Aswan Dam is schistosomiasis. The incidence of schistosomiasis increased very significantly in the newly irrigated areas immediately after the construction of the Dam. There is no doubt that the establishment of a new irrigation system in a country like Egypt, with extended shorelines of the Lake Nasser, and newly constructed canals, provided a good habitat for B. truneatus, a snail that acts as an intermediate host for S. haematobium. Some of the people that migrated to these newly reclaimed areas were already infected by this debilitating disease. However, there has been an steady declined is schistosomiasis transmission rates for the period 1935 to 2002 and the complete elimination of Schistosoma haematobium is imminent in the Delta region and in large parts of Upper and Middle Egypt. The World Bank (2000) considers that if an "all-out war" is declared against schistosomiasis, it can be completely eradicated from Egypt by 2025. In terms of malaria, there have been no reported cases in Egypt since 1998, including in Aswan and the Lake Nasser, except for a few imported cases from Sudan. The Dam thus has had no impacts on the incidence of malaria. Filariasis has not been found in Aswan and the Lake Nasser areas. In fact, the Ministry of

Health and Population expects to eliminate Lymphatic filariasis from Egypt by the end on 2005 from Lower Egypt.

A comprehensive assessment of the social, economic and environmental impacts of the High Aswan Dam indicates that it has contributed very significantly to the development of Egypt as a nation after the Revolution of 1952. If the dam had not been constructed, Egypt would have suffered very serious economic and social stresses due to the prolonged droughts of the 1970s.

Detailed analysis of the Aswan High Dam indicates that it has been a remarkable successful dam, certainly much more than its ardent supporters had expected when it was planned and constructed. The question then arises, if this has been such a successful dam, why does it have such a bad name outside Egypt? This question can now be definitively answered through reasons embedded in the Cold War, superpower rivalries, and personal animosities between personalities involved. For the first time, an objective analysis of the events behind the construction and financing of the Dam will be discussed, based on historical documents from Egypt, USA, UK, Russia, France and Germany, which will shed new light as to why the reputation of the Dam was deliberately trashed by certain parties.

Investment in 'Watergy' Efficiency as a Strategy for Avoiding Costs of New Infrastructure: Cases in Mexico

Ms Margaret McMorrow, USA
Alliance to Save Energy

Maximizing the capacity of existing infrastructure through efficiency instead of encouraging new construction is the most cost-effective and sustainable way to meet the world's water needs.

The production and supplying of water to municipalities is an energy-intensive activity. Most water utility operations require energy and these operations are performed without interruption year round. The relative impact of energy consumption for this activity requires greater attention due especially to the pressure it puts on investment needs in the available energy infrastructure.

In the case of Mexico, water utilities have a great effect on overall energy consumption. According to the CNA (National Water Commission), and based on operating costs reported by the water utilities themselves, overall utility energy consumption costs between US$ 446 and US$ 553 million per year. At the same time, the national invoicing of energy in Mexico in 2003, according to data from the Mexican Federal Energy Commission, was US$ 12 billion. These figures can be confirmed using water production figures and experimentally calculated energy intensity of Mexican water systems. The impact on the energy consumption of the water and sanitation sector is between 3.6 and 4.4 %. There are several factors that make the energy situation of the water utilities more critical.

High Impact of Energy Cost on Income

Due to operating and political problems, there is a disparity in the unit cost charged by water utilities to users, whose average rate is US$ 0.50 /m3. Therefore, their total revenue is US$ 1,354 million, which has not changed substantially since 1994.

Energy costs represent between 32 and 40 % of the gross income of Mexican water utilities. This situation makes energy a vital factor in the efforts being made by utilities to improve their financial situation. The magnitude of potential energy savings, between 10 and 40%, documented in case studies, becomes much more meaningful to a water utility struggling to provide service under these conditions.

Energy Required to Meet Development Objectives

Taking the year 2010 as the planning base, it is estimated that Mexico will have a population of around 112 million and water demand for public use will grow by 1.03 million inhabitants each year. Therefore, 94 million m3 a year will be required (mean provision of 250 L/capita/day). By reducing the shortfall in current coverage from 83.3% to 90% in that same period, a further 112 million m3 a year will be required, which makes a total increase in water demand of 206 million m3 a year, or 10,663 million m3 over the next six years. If the current physical efficiency of 65% is maintained, approximately 3,732.38 million m3 will be lost in leaks. At a production cost of US$ 0.3/m3 (diversion alone), US$ 1.12 million would be wasted with an energy consumption of 2239.43 GWh at a cost of US$ 210.5 million.
If by the year 2010, efficiency is increased to 85% (a technically desirable level), then US$ 120.29 million or 1.28 GWh would be saved from the averted energy that is embodied in water lost to leaks.

Redefining Investment in the Water Sector

There are two potential development paths. One course includes building the required new infrastructure to meet the expected demand for water resources. Another track involves building fewer new water facilities and finding ways through efficiency to get more out of existing water systems. This second method avoids many of the tangential costs such as increased energy demand, pollution, increased O&M, etc.

The key financial decision-makers need to clearly understand these two development paths and the costs and benefits of both. This paper will make the case for adopting a strategy of aggressive efficiency. It will also describe the steps that major development banks and their government partners need to take to make it happen. Without clearly embracing this vision, lending institutions and tax payers will over pay for unneeded water infrastructure and underserved populations will continue to go wanting.

Enhanced Reservoir operation for securing water quality and quantity in water stressed areas

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Water Quality Protection and Management Section,

Co-Author: Prof. Lehmann, Department of Civil Engineering and Survey, University of Hannover

Key Words: Reservoir operation, Water stress, Water quality and quantity management, Water resources management, sustainable use of water infrastructure

Water quality problems, such as salinisation or eutrophication, affect the usability of freshwater resources stored by dams and impoundments. The increasing demand for safe fresh water resources, as highlighted in the Millennium Development Goals and strengthened by the EU Water Initiative, calls for an increased consideration of water quality aspects within the management of multi-reservoir complexes. The expected tightening of the global water and food crises also implicates the conflict aggravation between the provision of irrigation and potable water resources. Specializing reservoir operation rules, considering water quality issues and adapted to this dispute, helps satisfying environmental and human needs by a demand-oriented management. Reservoirs play a vital role in the water resources management and the securing of the water supply. Current estimates suggest for instance that some 30-40% irrigated land worldwide relies on dams (WCD, 2000). In particular, the past operation of uncontrolled mixing of high and low quality water contributes to a total reduction of water use efficiency. Enhanced reservoir operation strategies offer a way to strengthen the sustainable and demand oriented distribution of water resources with different quality and quantity. The evaluation of the current water supply and security situation necessitates a tool, which is able to support the decision finding in daily operation, future adaptation of system operation, and drought management. A methodology for the assessment of the trade-off between stored water quality and water volume is presented. The developed Water Quality and Quantity Index (WQQI) enables an improved distribution and use of water resources with spatial and temporal varying water quality. The methodology also improves largely the integration of simulation models in planning of operation strategies. Past water quality models mostly support solely a comparison of water quality parameters against given standards, and could not allow the more comprehensive assessment of obtained scenarios concerning the supply security in quantity and quality. Project results from multi reservoir system case studies in Tunisia (Sidi Salem reservoir, Medjerda catchment) and the Aral Sea region (Tuyamuyn Hydroengineering Complex, lower Amu Darya) highlight the potential for improving the water quality by adapted reservoir operation strategies, and the better integration of existing infrastructure in new approaches for combating water stress.

Practical, interdisciplinary, and multi-objective measures as erosion control, bypassing, and individually storing of water in different reservoirs, are possible means to obtain an increasing availability of high quality water. They form main parts in the field of enhanced reservoir operation. The presented study results will help to assess feasible options and assist the planning of option combinations. Enhanced reservoir operation is considered as a main building block within the development of specific IWRM strategies under water scarcity, and is also included as a technical option in the recently started FP6 Integrated Project AQUASTRESS. Moreover, it will support current studies for developing European drought management strategies.

Hierarchy of Criteria for Integrated Water Resources Projects Prioritization

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Co-Author: Mr. Reza Ardakanian,
Assistant Professor and Deputy minister of water affairs in Iran

Abstract: The choice among alternative water projects is generally based on the fundamental objective of cost minimization. There is, however, a need to consider sustainability, the technical, environment and social implications in integrated water resources planning, in addition to economics. In order to achieve this, multi-criteria decision making (MCDM) techniques can be used. Constructing a multi-criteria decision making model needs a hierarchy of criteria and the relative importance of the weights.

Government of Islamic republic of Iran has approved some important rules for water resources management. But these acts are in Vision, Strategy and Policy levels. Ranking projects needs constructing Hierarchy of Criteria from approved acts. This study first investigates criteria of other countries for screening projects in watershed area and national acts of Iran introduced preliminary hierarchy. For "Public Participation" three session of "Value Management" have been celebrated. In those sessions some experts from NGO's and some Stakeholders from Government attended. The experts after negotiation and revision constructed the Hierarchy of Criteria.

Application of the Integrated Hydrologic-Economic Decision Support System: the case of Bui Dam, Volta Basin

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Center for Development Research, University of Bonn

Co-Authors: Dr.Charles Rodgers & Dr. Luna Bharati
Center for Development Research, University of Bonn

This study is part of the ongoing research within the GLOWA Volta project, an integrated sustainable water management project funded by the German government.

The main objectives of the GLOWA Volta project are the analysis of the physical and socio-economic determinants of the hydrological cycle in the Volta basin, West Africa, and subsequent development of a Decision Support System that will assist planners and stakeholders in improving the quality of water allocation and water use decisions. The core of the decision support system is an integrated economic-hydrologic simulation model that is currently being developed by an interdisciplinary team of scientists. Its main elements are a network flow hydrologic model linked with a physical hydrology simulation model (WASIM-ETH) and integrated with an economic optimization model incorporating water demand for irrigated agricultural production, hydropower generation, municipal and rural household water demand. The hydrologic and socio-economic data used in the analysis is the product of several years of consistent data collection effort of the GLOWA Volta project scientists.

The integrated framework allows for the evaluation of alternative policy and development scenarios at various spatial scales. One important scenario under consideration is an examination of the impacts of the proposed Bui dam in the Ghanaian Volta Basin. The Ghanaian government has been considering the construction of Bui dam, intended to increase the country's power supply, over the last 40 years, and has commissioned a number of feasibility studies. The projected annual energy generation of the proposed dam is 1150 GWh. The Bui development site is located on the Black Volta river upstream of Volta lake at the border of the Northern and Brong-Ahafo regions of Ghana. The estimated capacity of the Bui reservoir is 12,600 million cubic meters and active storage capacity of 6000 million cubic meters. It has been a controversial issue because the proposed reservoir lies in part within the boundaries of the Bui National Park, an important nature reserve. In addition, the construction of the dam would entail relocation of about thirty villages currently located within the proposed reservoir area. The potentially high social cost of the proposed construction underscores the need for ex ante simulation modeling of the various consequences of the Bui dam. The objective of this research is to provide an integrated assessment of the proposed project, inclusive of its impact on the water and power sectors, natural flow regimes, and social and ecosystems health.

The strength of the integrated approach lies in the observation that project-related impacts are not strictly local, but rather have reverberations throughout the basin economy and ecosystem. Potential local impacts include the resettlement of 30 villages, alteration of riparian ecosystems subject to inundation (in this case including a regionally important hippo population placed at risk), increase in waterborne illnesses and disruption of the seasonal cycle of discharge downstream of the dam. Offsetting these negatives are the potential for a shift from high-risk rainfed agriculture to irrigated agriculture, and more dependable domestic water supplies. Potential basin-wide impacts include a possible reduction in deliveries to downstream Volta Lake, which stores water for hydropower generation at Akosombo and Kpong dams and supports fisheries of regional importance.

These implications are being explored using a basin –scale integrated economic-hydrologic simulation model. The availability of clean, relatively inexpensive power is arguably as important to the Volta region's development as is expansion of irrigated agriculture. Alternatives to hydro generation exist, primarily in the form of thermal power generation powered by natural gas delivered via the proposed West African Gas Pipeline, but carry with them environmental costs in the form of carbon emissions. These and other factors must be weighed and evaluated within a wholistic framework of analysis, extending the current development of the integrated modeling framework of the GLOWA Volta decision support system.

An Assessment of FCD Projects in Bangladesh

Mr Giasuddin Ahmed Choudhury, Bangladesh
Bangladesh Water Development Board

Presentation of topic and analysis of issue: Water resources management is central to the life of Bangladesh. In the past, the rain-fed rice production was the mainstay in agriculture and dry season rice was cultivated only where enough irrigation water was available. However, this scenario changed quickly in the middle of the last century, when the necessity of feeding the ever-increasing population triggered the implementation of large-scale water sector projects.

During this period, about 461 water resources projects, ranging in size from small single structure schemes to large multipurpose ones, were completed. The types of water sector interventions also varied from rural FCD (inland and coastal embankments and polders; small-scale FCDs; compartmentalization; river training and bank protection and river dredging), urban FCD, minor/small-scale irrigation, major/large-scale irrigation to structural and non-structural flood-proofing. Infrastructures provided in these schemes include, among others, about 8,515 km of embankments, 4,900 km of irrigation canals, 6,500 km of drainage channels, 60 km of revetments, 6,000 sluices, 140 cross dams, 80 groynes, 850 bridges, 225 km of roads and 1,350 buildings and sheds. It is estimated that since the independence of the country, around US$ 3 billion investments have been made in the water sector.

Many criticisms are leveled against FCD projects: these have reduced the extent of wetlands, thereby reducing fish production and also impacted navigation. Social impact assessments of some projects done recently show that many farmers benefited from being able to grow three crops a year and landowners benefited proportionately more than other groups. Tenet farmers also benefited, but as they are often responsible for the entire costs of inputs and irrigation, their share of increased return is less.

Some people expect that FCD projects should play a greater role in poverty alleviation. Is it not too much to expect? As if increased food production is not enough for FCD projects. A recent study conducted by BWDB shows that 5 million tons of additional rice productions may be directly attributed to FCD projects and another 2 millions tons to public irrigation projects. This is approximately about one-third of the total cereal production of the country. Moreover, FCD projects create an environment, where HYV rice could be grown with added inputs.

With regards to environmental impact assessment of FCD projects, it is generally observed that the eco-systems with greatest bio-diversity are perennial water bodies, homesteads gardens and forest reserves; seasonal floodplains have poor biodiversity. Most FCD projects are located in the floodplains and thus do not have as serious biodiversity impacts as might be expected. However, some FCD projects have caused adverse impact outside.

Capture fisheries on the floodplain are still an enormously valuable nutritional and economic resource. The reduction of captures fisheries due to FCD projects has partially been redressed through intensified investment in culture fisheries.

Discussions of results/findings: The activities in the water sector have generated a knowledge base that is rich and diverse. Some approaches have failed outright to deliver the intended benefits while others have achieved reasonable amount of success. Some interventions have helped the alleviation of rural poverty while others have aggravated the situation. In some cases, water sector infrastructures have triggered more social cohesion while a few others have intensified social conflicts

Can we afford now to abandon FCD projects? During 1998 and 2004 floods, except for a few cases, all FCD projects provided primary flood protection. An example is Dhaka Flood Protection Project, which provided full flood protection to the western part of Dhaka city during these floods. Bangladesh is one of the densest countries of the world. Almost 1000 people live per square kilometer of land. FCD projects are necessary human interventions and these are serving their intended purpose of flood protection.

What is needed now is to rationalize the existing FCD projects and put them on more successful and sustainable basis. This can be built on two foundations. The first is making use of the rich legacy of experience of Bangladesh in water management spanning over half a century. The other is the imperative of dealing with the problems in a systemic perspective that leads to an overall improvement of management of water resources. The concepts and approaches to be used in the context should be as far as possible based on past experiences. There are many good practices that have worked and been beneficial. The specific contribution of the effort should be to collect, consolidate, harmonize and operationalize these different approaches into a single mode of operation in their respective fields for their institutionalization and use throughout the system. This effort constitutes building on the first foundation.

Secondly, it should work within and through the permanent organizational structure of BWDB and it should aim explicitly at systemic improvement. This latter strategy is based on the assumption that chances of success of reform efforts are greater in approaching the problems holistically rather than attacking the problem in one geographical area or unit of an organization. This effort explicitly should intend to achieve systemic change, be it in the field of institutional development, participatory scheme cycle management and improved operation and maintenance. Internalization of these approaches in the organizations concerned should be a key strategic objective.

Hydrologic Criteria for Development and Flood Mitigation in Drainage Basins of Semi-Arid Regions. Case Study: Wadi Watair Basin – South Sinai, Egypt

Dr. Mohamed Ali Sonbol, Egypt
Water Resources Research Institute

Due to the limited water resources and the rapid increase of population in Egypt and their high concentration in the Nile valley and the Delta, the Egyptian Government has implements great efforts to develop new settlements and communities. The development of these new communities is a must to strengthen their role in national economy and strategic development. This can be achieved through a comprehensive research works and studies of the different resources.

The natural hydrological aspect in such arid and semi-arid regions like South Sinai Governorate, where Wadi Watier basin is located, is formed from different components. These include, among others, seasonal flash floods; groundwater recharge; sediment transport; and flow of the natural springs. Previous studies showed that a relatively large amount of flash flood water is lost every year to the Gulf of Aqaba while damaging roads and infrastructures. Therefore, the major goals of this research are: (a) establish analytical connection between the hydrologic response of the drainage basin to rainfall; (b) flood mitigation and development purposes by some planned and proposed detention and storage dams; (c) recharge to the groundwater. The estimation of the runoff hydrographs was carried out using the software of the Watershed Modeling System which uses the hydrologic model HEC-1 with the digital elevation map of the basin to determine flood flows of different rainfall storms associated with various return periods at the proposed dam sites. Due to the short records of rainfall at Watier basin, rainfall recorder of 50 years of rainfall records at a neighboring basin was used. Rainfall frequency analysis is one of the applied techniques to estimate the probabilities associated with the design flood events, thus answering questions as to how rainfall of various magnitudes are likely to occur and what is their probable frequency of occurrence (or return period). This will eventually lead to an efficient design, which averts disasters as well as assessing the risk.

The results from this research have given the geomorphologic and hydrologic characteristics resulted from Watier basin and its different sub-basins. The detention and storage dams were proposed according to risk to floods and priority to development. The types and the dimensions of these dams and the storage reservoirs have been also defined. It was concluded to use the detention dams and artificial storage lakes at this specific area due to: high evaporation rates and high costs; and artificial storage lakes are better for artificial groundwater recharge.

Operating the Sacramento River for Multiple Objectives in the Face of Climate Change: Developing Strategies through Stakeholders Processes

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Presentation of topic and analysis of issue: The two central challenges in California water management are: (1) to overcome the spatial and temporal mismatch between where and when the precipitation occurs and where and when needs arise to use water, and (2) to balance the competing needs for water for off-stream uses in agriculture and urban areas, and for in-stream use for aquatic ecosystems. In California, the mismatch of demand with supply reaches dramatic proportions: two thirds of the state's precipitation occurs north of Sacramento, while over two thirds of the state's water use occurs south of Sacramento; in addition, over 80% of the total precipitation occurs between October and March, while about 75% of all water use in California occurs between April and September. The challenge is, thus, to ensure that water is available in the right place and at the right time for both humans and ecosystems.

Climate change has the potential to cause some major disruptions to the California water system, starting within the next two or three decades and continuing over the rest of the century, by which time projections show a doubling of population. Climate change is likely to exacerbate the mismatch in the timing and location of precipitation and to sharpen the competition between off-stream and in-stream water uses. The predicted reduction in the snowpack and the earlier timing of snowmelt will greatly complicate the task of managing California's reservoirs, and make for a more difficult tradeoff between filling reservoirs to capture runoff for warm-season uses versus leaving empty space for flood control in the event of a possible late winter storm. Any future adjustment of the current reservoir operations regime in response to this tradeoff also has implications for meeting ecosystem objectives in the system.

Discussion of Results/Findings: An integrated hydrology/water allocation framework (Yates et al. 2005a, b) has been constructed on the Water Evaluation and Planning (WEAP) platform (Raskin 1992), which recognizes that water supply is defined by the amount of precipitation that falls on a watershed. Further, this basic supply is progressively depleted through natural watershed processes, where the watershed itself is the first significant point of depletion through evapotranspiration (Mahmood and Hubbard, 2002). The residual supply, after the satisfaction of evaporative demands throughout the watershed, including terrestrial ecosystems, is the water available to the water management system. Thus, as in the physical realm there is a seamless link in the WEAP framework between climate, land use/land cover conditions, and the management of the water system. This approach also allows for joint management of blue and green water, as described by Falkenmark and Rockström (2004).

An application of this integrated framework was developed for the Sacramento Valley, which includes three of the primary surface water storage facilities in the California water system, Lake Shasta, Lake Oroville and Folsom Lake. The operation of these facilities is based on the assumption that a large portion of the available water supply in the spring months is stored in the higher elevation snow pack. This framework has been applied under future climate change scenarios to investigate how the hydrology could impact associated ecosystem services and is being introduced into several stakeholder processes in the State of California, including: the Statewide Water Planning, Integrated Storage Investigations, and Ecosystem Restoration Investments. The introduction of climate change into these processes profoundly changes the dialogues – opening a realization of the critical need to balance the water allocations between and within humans and ecosystems, which are inherently interdependent.

Conclusions and Recommendations: Future climate change has the potential to substantially alter the hydrologic regime within which water management and operation of infrastucture in California takes place. This nesting of water management within a hydrologic regime motivated the development of the integrated hydrology/water allocation climate change assessment framework embedded in WEAP. This tool has been unbound from past hydrology and is driven solely by the climate signal that will evolve over the course of the coming century. It is uniquely suited to introducing climate change assessment into water management decision making processes and an understanding of tradeoffs by stakeholders.

Integrated management of inter-basin water transfers: The case of the Lesotho Highlands Water Project

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Water is scarce in many regions of the world. But even in countries with an overall water abundance, demand exceeds supply in many areas. To overcome water deficits, water is often imported through inter-basin water transfers (IBWT) at international, national, regional and local levels. While such transfers are important for social and economic development, they can have enormous impacts on the riverine ecology in the exporting area, the importing area and the path linking the two areas. The exporting area can experience reduced flows, changed seasonal hydrology, or reduced dilution, all of which can negatively impact on the riverine ecological resources that provide direct and indirect benefits to populations residing in the area. The importing area can experience flooding of rivers; changed water temperature, chemistry and quality; and water logging, which may impact negatively on aquatic ecosystems. Imported water can also exacerbate scouring and erosion in the receiving rivers. The erosion may alter the flows necessary to inundate floodplains/wetlands and impact negatively on agricultural productivity and floodplain/wetlands ecosystems. Environmental Impact Assessments (EIAs) of IBWT often leave out ecological consequences of such transfers. When included, the assessments are often done after important project's elements have been designed.

Inter-basin water transfer schemes have evident benefits in water deficient areas, but if not carefully assessed, instream ecological effects of such transfers can have serious unintended socio-economic and environmental impacts on downstream riparians in both the exporting and importing areas. For instance, too much water than optimal, could be transferred to the importing area at a high opportunity cost for lost ecological resource/biodiversity values and hence reduced social welfare. It is therefore important to integrate instream ecological considerations into sectoral management of water resources before IBWT projects are implemented to ensure both socio-economic and environmental sustainability.

This paper uses the Lesotho Highlands Water Project (LHWP), that transfers water from the Orange River Basin in Lesotho to the Vaal River Basin in South Africa, as a case study to show how environmental sustainability aspects can be integrated into economic development planning to ensure integrated management of IBWT. Using the multi-country ecological social accounting matrix (MC-ESAM) for Lesotho and South Africa (SA), that integrates ecological implications of the LHWP with the economic benefits of the project, the paper analyses the impact of lost ecological services downstream the LHWP dams in Lesotho on the well-being of households directly affected by the project in Lesotho and the general economies of Lesotho and SA. The social accounting matrix is an important tool for analyzing distributional impacts.

The results reveal that while the LHWP has significant direct and indirect benefits in terms of social and economic development in Lesotho and SA, the project has serious unintended impacts on ecological resources and services, with resultant deleterious well-being implications for populations residing within the reaches of the LHWP rivers and downstream the LHWP dams in Lesotho. The results from the MC-ESAM analysis indicate that not only the welfare of populations directly affected by the project in Lesotho is likely to fall, but also that of other households and social groups, as well as the income of the general economy of Lesotho. Also, because of economic dependence of Lesotho on SA in terms of imports, SA will also incur some losses in terms of reduced trade from Lesotho.
The paper demonstrates the significance of integrating ecological consequences into impact assessment of IBWT before such transfers can be implemented to ensure Pareto optimality, and of considering economy-wide impacts of multi-sector, multi-country linkages associated with IBWT for a holistic and integrated management of IBWTs.

Yacyreta Dam: The social and enviromental impacts of the Mega Dams.

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The Yacyreta hydroelectric power project, along the Parana river on the border of Argentina and Paraguay, is currently seeking to expand its capacity from 2700MW to 3700MW by increasing the dam height from 76m to 83m. In November 2000, project operator EBY began soliciting preliminary proposals from banks and companies for a $600-700m debt package for the dam's expansion, in the hope of reaching financial close by March 2001. The dam, only now starting to come into operation, has been troubled by delays and controversy for over 25 years. Initially the dam was only built to 76m instead of 83m because of significant problems with, and opposition to, environmental and resettlement issues. EBY, a bi-national governmental agency, and the governments of Argentina and Paraguay seek to eventually privatize the final stages of the works.

Key Political and Downside Risks
Intense controversy regarding project design and social and environmental impacts has created a 10-year delay in original dam construction and reduced the dam height by 7 meters, equivalent to 1000 MW.

According to the World Commission on Dams, the project has sustained losses of $6 billion due to corruption. Project costs are now estimated at $12bn, six times the original cost of $1.6bn.

The World Bank has conditioned project expansion on World Bank-approved environmental and social mitigation measures that may threaten the project's financial feasibility.

Overview
The Yacyreta hydroelectric power plant provides an example of how a project's severe social and environmental impacts can create intense opposition and political will requiring costly mitigation measures that render a project financially infeasible. As a result of an outcry by international advocacy organizations, project sponsor EBY curbed the initial construction of the dam to a height of 76m, and the World Bank and Inter- American Development Bank made environmental and resettlement plans a condition of financing for both the initial and expansion phases of the project. The project was originally scheduled to be completed in 1996, but is still seeking financing for the final stage of construction.

Corruption, Mitigation Increase Project Costs, Threaten Viability
Yacyreta project costs have increased to $12 billion, over six times the original estimate of $1.6 billion. A sizable portion of this cost overrun increase is due to corruption, with a 1994 World Commission on Dams report maintaining that the Yacyreta project lost $6 billion to corruption. In addition, a World Bank Inspection Panel report found that the costs of effective resettlement and environmental mitigation have been seriously underestimated, and that up to $2 billion in additional financing (EBY's current RFP is for a $600-700m debt package) will be required if the reservoir is raised to its final design level of 83 meters above sea level. The World Bank questioned the financial viability of the dam if it were to be built to its full height and adequate mitigation measures were taken.

Project Expansion Hinges on World Bank Approval
As a result of activist pressure, the World Bank and Inter-American Development Bank (IDB), as key financiers of Yacyreta project construction, have conditioned project expansion on a set of environmental mitigation and resettlement plans that have yet to be proposed and approved. The government of Argentina, a major World Bank and IDB borrower, is under a contractual obligation to not expand dam capacity until both the World Bank and the IDB grant their approval, regardless of whether the two institutions provide financing for the expansion.

As of January 2000, the World Bank's opinion regarding dam expansion is "that there should be no change from the 76-meter level, unless and until further study is undertaken to assess the social and environmental impacts, as well as extensive participatory consultation with the affected communities."

In a related matter, the World Bank's Board of Directors has yet to rule on action to be taken in response to a grievance claim filed four years ago. The Bank's Inspection Panel, its own accountability mechanism, investigated the case in 1997 and found gross violations of Bank social and environmental policies. An unfavorable World Bank Board decision on the Inspection Panel claim could jeopardize the World Bank/ IDB expansion approval, stopping the project expansion completely.

Coalition Against Project Grows

The activists, including prominent international groups such as World Wildlife Fund, are likely to be even more opposed to project expansion because raising the dam height by 7m would result in twice the area to be flooded, and more than 30,000 (the total number has not been accurately estimated) additional people will have to be resettled. A recent report opposing the project was co-authored by ten international environmental organizations. Opponents have operated a sustained campaign against the dam, using lobbying and delaying tactics ranging from blocking roads to pressuring multilateral development banks to condition their financing. For example, in February 1998, 2000 protesters blocked the main highway into Encarnación, Paraguay, in the dam reservoir area. Several other mass demonstrations against the dam and the manner in which EBY has managed the compensation and relocation plans have been staged. Possible future setbacks include a petition by a public interest litigation organization for an injunction against the project on the basis of illegal expropriation.In december of 2004, Both Goverments (Argentina and Paraguay) anounce the plan of raise the level of the dam,until 83 meters. The proyect will be finish in 2008. The didn´t say anything about the enviromental and social problems of this "new" proyect.

Strategies for Flood plains – Space for Nature or Human Living Space?

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Streams and rivers all over the world have been altered by past human activities. Sections of rivers that were once meandering and lined with vegetation are today very often straight. The connection to their natural floodplains is either reduced or does no longer exists. Changes in agricultural and urban land use have resulted in erosion and sediment problems. The loss of retention volume has generally increased the flood risks.

The strategies how to deal with flood plains involves the river bed and the river meadow lat-erally as well as longitudinally since all influences on the river stretch from the source to the mouth. They consist of different types of measures that generally improve the ecological situation of a river. There are measurements like the construction of fish ways that are impor-tant and relatively easy to realize. But in most of the cases the areas that are affected are in agricultural utilization or in urban areas and therefore the central point of many conflicts.

Mainly the natural flood plains are not further available because of the human activities which have expanded into them. These areas are protected by flood control installations (e.g. dikes, flood walls) and have therefore no direct contact with the water level of the river.

In the case of flood protected agricultural areas there is at least a possibility to partially re-obtain the land and to improve the discharge characteristics of the rivers especially during flood events. Planning must take into consideration e.g. the impacts of changing water depths (including ground water levels), the sediment transport balance or the changing travel time of a flood wave when opening a dikes line to regain a natural flood plain. Obviously, as more area is at a rivers disposal, it can develop its natural profile so much the better. In urban areas riparian areas can be a first step for conservation and rehabilitation

The development of natural structures is also very much influenced by the maintenance work. Maintenance work must be done in accordance with biological time scales. This includes the brooding times of birds, the flourishing time of the vegetation, but also different spatial de-pendences.

In unused or only extensively used river meadows the burst of a stream causes normally no particular steps because no immediate damages or disturbances occur. Flooding is rather of a vital significance for the developmental processes in riparian areas and river meadows. Among other things, formation, organisation and development of the biosphere as well as morphological structures and linear networking of a water body are affected by regularly flooding. The organisms living in this surrounding always or at times are often rare specialists that are dependent on submerge and flooding as a basis for living.

The location of a settlement at a stream is both, chance and danger. Incentives for building at the river were the various possibilities for the use of the water body, e.g. fishing, waterpower utilization and as a means of transport. Therefore, flood plains have always been preferred locations for the development of urban areas. There, first the higher situated surface were set-tled which, if at all, were only flooded because of disastrous floods and which endangering was at first not immediately discernable.

The rising pressure for settlements and the increasing prosperity and first successes of techni-cal flood protection – which in turn led to a loss of awareness of flood risks – brought about that from 1950 onwards a large number of buildings were constructed in high risk areas, i.e. in the natural flood plains of the rivers. In the course of the years increasing intrinsic values were installed in these areas. The protection measures taken deceive public with a high degree of security. It had been ignored that the protection was only sufficient for designed floods events but not for every flood. In the following decades extreme floods repeatedly caused larger damage, although increasing sums of money have permanently been spent on flood protection over the years.

Concerning larger streams it is of advantage that people familiarised themselves early with the hydrological and hydraulic characteristics of that rivers. At smaller rivers it is often possible to improve the flood protection through the mitigation of local spots, as, for instance, the ex-pansion of too narrow bridge passages or the improvement of the runoff achievement of a piping that is not efficient enough. Such steps can often be realised for the short term.

Strategies for flood plains require a lot of different planning steps and patience during realiza-tion. Therefore the planning consists of short term, middle term and long term measures. The most important step is a continuous conservation of existing flood plains to avoid further irre-versible changes. The legal side (e.g. land ownership, land use, road allowances or existing water rights), social-economic aspects (mainly economic problems of agriculture), ecological risks require a constant weighing of each parameter against the others.

Beside the technical planning work the planning team has to think about the non-technical questions concerning the implementation of a strategy. There is often a general consent for ecological improvements but steps and goals are quite often non-identical. This is mainly due to the fact that the scientific approach of an expert is different from the view of laymen. Espe-cially if they are affected by a planning. A good information policy that incorporates all persons concerned improves the acceptance of a proposal and is sometimes decisive for the whole project.

The Water Infrastructure Challenge in Victoria

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Water resources, and the infrastructure to sustainability manage these resources, are a priority for the Victorian State Government. Nine consecutive years of drought, projected population growth, combined with the potential impact of climate change and the economic importance of agriculture, emphasise the importance of investment in innovative and efficient water infrastructure systems.

Victoria's water infrastructure assets have a replacement estimate of more than $30billion. Aging assets, losses from seepage and evaporation, and improvements in sewerage and treatment, are all issues given the pressure on Victoria's water resources. A societal wide consensus has emerged on the need to view water as a scare valuable resource, and invest and legislate accordingly. Building more dams is not considered the solution, as dams simply take water from an existing source.

Finding solutions that meet both economic and environmental needs was identified as a key area for policy by the current Victorian Government when elected in 1999 and 2002. Irrigation and river health needs are being jointly addressed through cost-effective innovation, such as using channel automation technology, and recycling to free scarce water resources for enhanced environmental flows into stressed river systems such as the famous Snowy and Murray Rivers. Water market development, water allocation systems, integrated infrastructure and environmental planning can further address water issues for Victoria.

Victoria has led the change in thinking across Australia - through keynote policy and project initiatives, and the Victorian Water Trust, the government is driving water sector change both within Victoria and at the inter-governmental level. The Victorian State Government has combined a substantial and ongoing financial commitment (close to $1billion), with consistent public advocacy for innovative water-use practices. Local communities and the private sector have both been involved in developing innovative solutions that address local issues.

The Government recently released a White Paper, entitled Our Water, Our Future, identifying six priority areas for water reform. These are: developing an improved water allocation framework; restoring rivers and aquifers; smarter use of irrigation water; smarter use of urban water; pricing for sustainability; and developing an innovative and accountable water sector. Water infrastructure has also been identified as a key component of regional development, supporting industry and rural communities.

Case studies around these priority areas illustrate how infrastructure solutions are being used to encourage cultural change, supporting long-term water resource management and sustainable development within Victoria. Specific examples are used to discuss environmental flows, irrigation efficiency, security of supply, regional development through recycling, water recycling for irrigation and waste management, and enhancement of country town water and sewerage systems.

Reform requires strong financial and political support, supporting a range of solutions tailored to the needs of all geographies. Technical and financial innovation are critical components, as is partnership between government and the private sector, in order to design and deliver infrastructure solutions meeting the developmental needs of stakeholders.

Environmental Impact Assessment of Greater Dhaka Flood Protection Structures

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Floods have the greatest damage potential of all natural disasters worldwide and affect greater number of people. In the last decade, there has been catastrophic flooding experienced in Bangladesh, China, Germany, India, Mozambique, Poland, the USA and elsewhere. But the citizen of leased developed nations that suffer the highest toll from the occurrence of flooding.

Greater Dhaka, the capital of Bangladesh is situated in the central part of the country and is surrounded by the rivers and very big drainage channels on four sides. Bangladesh suffered major serious floods during the monsoons of the years 1987, 1988 and 1998. During 1998 flood, vast areas of the country including the capital city of Dhaka were flooded to an unprecedented degree with flood levels about 1.5m higher than normal level for a period of up to four weeks. Then in Dhaka city alone, it was estimated that around 77% of the total metropolitan area of 260 km2 were submerged to a depths ranging from 0.3 to over 4.5 metres, and that about 60% of the total city population of around 2.5 million were directly affected. Damages caused by this flood were also estimated to be in excess of Taka 700 (US$ 11.7) million.

In an effort to protect Dhaka from devastating floods the Government of Bangladesh in collaboration with other international support agencies has undertaken construction of flood protection structures along greater Dhaka boundary. The first phase of the project, to provide flood protection facilities to the westerly half of Dhaka City, has already been completed. The constructions of flood protection structures were so hurriedly done that there was serious deficiency in planning, design and construction processes. Due to construction of two types of protection structures, namely reinforced concrete wall and earthen embankment, the facility can not be used as roadway. The construction of conventional earthen embankment without proper soil investigation and economic analysis has already caused several embankment failures. The embankment breach followed by flooding is likely to cause greater damage to lives and properties. In this study, these aspects are clearly identified with recommendations for proper remedial measures. A comprehensive guideline to improve waste management system in grater Dhaka city, proper environmental analysis of the project with the solution of major environmental issues and a cost-effective solution of flood protection structure with better serviceability is reported in study.

Combined Use of Simulation and Optimization for the Operation of the Three Gorges Reservoir on the Yangtze River in China

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The Three Gorges Project (TGP), one of the largest hydraulic projects in the world, is located on the Yangtze River in China. Its construction commenced in 1994 and will be fully completed in 2009. In 2003, the main structures of the project have been built and a small reservoir (comparing with the reservoir finally formed) has formed. In June 2003, the reservoir was put into operation. Before 2009, the TGP will partially play an important role in the harnessing of the Yangtze River, such as the flood control, power generation, navigation improvement etc. The operation of TGP reservoir was a typical multipurpose problem. According to the Chinese Flood Control Law, in flood seasons the TGP reservoir level should be kept at the top of conservation zone to empty the flood control zone. As the water level moves into flood control and conservation zones, the operation goals will change. Obviously, the conservation zone is a key parameter in the operation of the reservoir. For a reservoir with fixed storage capacity, less conservation storage zone means more flood control zone, which is undoubtedly safer for the flood control. However, less conservation storage zone also means lower water head and less power generation. That is to say, there exists a conflict between the flood control and power generation in the determination of conservation zone. In this paper, attempts were made to find an optimal conservation zone to trade-off the flood control and power generation in flood seasons during the period of 2004~2006 for TGP. In order to solve such a multipurpose problem, a combined model of simulation and optimisation was proposed and developed. Two main incompatible objectives, the power generation and flood risk, were taken into consideration. The power generation was set as the total objective function, and the flood risk was transformed to one of the constraints. The combined model contains three components. Firstly, an operation model corresponding to the predetermined rules of the TGP reservoir was developed. The goal of this model was to make daily release decision according to the state of the reservoir at each time interval. Secondly, by using the operation model and 120-year long (1882-2001) records of daily flow discharge, simulation was introduced to operate the reservoir under different boundary conditions. The main outputs of simulation include the 120-year mean power generation, flood risk etc. These outputs will become the inputs for the optimisation model. It should be noted that the conservation zone was regarded as one of boundary conditions in this simulation model. Finally, the dynamic programming was applied to optimise the conservation zone according to the simulation outputs. In this optimisation model, conservation zone was set as a decision variable. The simulation model was embedded in each step of the optimisation, and every decision will trigger the simulation. The combined model yielded three optimal conservation zone values for 2004, 2005 and 2006 respectively. And the results show that without increasing the flood risk the optimal conservation zone will increase the power generation 1.24% (1.53×109 Kw·h) for 2004, 2.45% (4.5×109 Kw·h) for 2005 and 2.32 % (4.98×109 Kw·h) for 2006 respectively, comparing with the predetermined conservation zone. This study also indicates that the combined use of simulation and optimisation is an efficient method to solve such kind of multipurpose problems. Due to its large effect on Yangtze River management, the determination of TGP's conservation zone has attracted considerable attention from different communities.

Through using the long record of historical hydrological data, this study obtained the optimal conservation zone in a historical perspective. So the results can only provide the statistical, not the real-time information. In March of 2004, the results have been submitted to the China Yangtze Three Gorges Project Development Corporation to help decision-making.

Multipurpose Development through Rubber Dam Projects in Bangladesh: A Cost effective and improved technology for water management

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The economy of Bangladesh is largely rural based and high unemployment leads to high incidence of poverty especially in rural areas. Agriculture is the single largest contributing sector in the national economy (about 35%) and increased productivity in agriculture is a major target of the country's development plan to achieve higher living standards. Being the drainage outlet of the three major river systems of the world – the Ganges, the Brahmaputra and the Surma-Kushiyara-Meghna system, Bangladesh drains large parts of India and Nepal and some part of China. About 90% of combined flow of these rivers come from the upper riparian countries and only 10% is generated from within Bangladesh. Thus the traditional rain-dependent monsoon agriculture in Bangladesh is subjected to flood hazards. On the other hand the dry season agriculture is heavily dependent on ground water irrigation as there is no rainfall in dry season. Conservation of surface water is therefore of utmost importance to sustain agricultural growth through better water and irrigation management in the face of nature's uneven distribution of water throughout the year. A cost effective and improved water management technology is very essential to exploit possible ways and means of surface water retention and conservation in a low and flat country like Bangladesh. Rubber Dam is one of such promising technology to retain and conserve water in reservoirs, lakes and channel storages of small and medium rivers in Bangladesh for irrigation and other multipurpose development as introduced and implemented by Local Government Engineering Department (LGED) and Ministry of Agriculture. Compared to the traditional earthen cross dams, irrigation through Rubber Dams is very reliable and timely. The technology is reliable as it can withstand the flash flood, high tides and surges without being washed out. The easy inflation-deflation characteristic results in timely farming activities and also increases the reservoir storage. Such dams if constructed in hilly areas are effective for water supply and other works. These types of dams can also be used for pisciculture, hydropower generation, environmental improvement and recreation purposes. The low height (up to 5 m), low capital and O&M costs, low generation period and quick inflammation and deflation properties of the rubber dam make the technology very attractive over rigid dams and gated water regulating structures. LGED constructed two pilot rubber dams in Cox's Bazar district in 1995 to conserve dry season flow of meandering Bakkhali river and Idgaon khal for winter irrigation. The Bakkhali Rubber Dam was constructed in a tidal environment to separate downstream saline water and retain upstream sweet water in the Bakkhali river and its tributary channels. Water is lifted from the reservoirs by LLPs under private management to irrigate 6000 ha land for winter rice in the area. It has increased about 21,000 metric tons of crop production per year. The project has also brought positive impacts on activities in non-farm sector, increased employment opportunities for landless laborers and distressed women through increased farm and non-farm activities. Development of related infrastructures and facilities like roads, bridges, markets, electric power etc have brought positive impact on socioeconomic activities of local people. In Idgaon Rubber Dam, water is distributed by gravity to irrigate 2000 ha land for winter rice cultivation. It has increased crop production by 11,000 metric tons per year. After successful implementation of two pilot projects another pilot project was taken in Bhogai river in Sherpur district and implemented in 1998-1999. This rubber dam project can irrigate 2800 ha land and increase crop production by about 6,000 tons per year.

To develop an appropriate operation, maintenance and management plan for the Rubber Dam schemes, a very intensive interaction is taken up through holding series of motivational meetings with the beneficiaries, pump owners and local government leadership by socio-economists from LGED and a 3 tier committee system is formed. The people in Rubber Dam Projects actively participate in O&M of the projects and regular pay their irrigation fees. It was interesting and gratifying to observe that, unlike the other public sector irrigation projects where the O&M is the responsibility of the irrigation agency, these projects are operated and maintained by the farmers' organisations. Thus LGED has neither any manpower involvement nor any financial obligation, regarding the O&M of these rubber dam projects except the case which is beyond the management of the local people. The beneficiary participation in O & M in the Rubber Dam Projects in Bangladesh in fact has been a model and is being replicated in other water projects in Bangladesh. An assessment study was carried out for two pilot rubber dams by

Bangladesh University of Engineering and Technology. The study shows that this technology can be replicated in other suitable areas of Bangladesh. Based on the success of three pilot projects, LGED took 10 Rubber Dam Project in 1999 to be implemented in five years time. 8 Rubber Dam Projects out of 10 were found as feasible and those are nearly on completion. LGED has also done a preliminary study of another 40 such Rubber dam projects to be carried out all over the country. The technology is being replicated in other countries also. For example Bangladesh has extended its technical support to India to construct Rubber Dam in Kerala and SriLanka.

This paper would discuss multipurpose development through Rubber Dam projects in Bangladesh, cost effectiveness of the technology and socioeconomic and environmental impacts of the projects in Bangladesh.

Southeastern Anatolia Project: A sustainable integrated regional development project

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Southeastern Anatolia Project is an integrated project that aims developing land and water resources in the region. The program consists of two parts each of them covering projects related to the basins of either the Euphrates or the Tigris. The program envisages the construction of 22 dams, 19 hydraulic power plants and an irrigation system that will bring 1.7 million hectares of land under irrigation. Upon the completion of the project, 29 % of the total water potential of Turkey will be managed through the facilities on the Euphrates and the Tigris, which together flow more than 52.9 billion cubic meters of water a year. The planned irrigation area corresponds to 20 % of total irrigable land in Turkey and annual energy production to 22 % of total electric energy potential in Turkey.

The GAP region extends over an area of 75,000 km2 and a wide range of crops each requiring different climatic conditions are raised in this area including olive, pistachio, hazelnut and persimmon. The region has 3.2 million hectares of land fit for crop culture. Forested areas make up 1.3 million hectares while 2.3 million hectares of land consists of pastures and ranges. The GAP focuses on efficient utilization of these natural resources. For the first time in Turkey the management, operation and maintenance of new irrigation systems have been directly transferred to Irrigation Districts, which are organizations formed by local farmers. In 1998, the region accounted for 41.6 % of the total cotton output of Turkey. Favorable climatic conditions in the region make it possible to reap two crops a year. The region is also quite fit for animal husbandry. The agricultural development objectives of the GAP include the following: Raising levels of income in the rural sector; providing inputs for industrial enterprises in the region; creating employment opportunities so as to minimize out-migration and encouraging export oriented production in the region.

According to studies made, upon the completion of irrigation projects in GAP, the area brought under irrigation will be equal in size to the total area so far brought under irrigation by the State. This will naturally bring along significant changes in agricultural output and crop design. Such irrigation-led crops like soybean, groundnut, corn, sunflower and fodder crops will be the basis of flourishing agro-industries.

Compared to similar projects worldwide, the Southeastern Anatolia Project (GAP) in Turkey is rather ambitious in terms of its geographical area, physical magnitudes and targets. It is a multi-sector, integrated regional development project launched in the region of Southeastern Anatolia, one of the relatively less developed regions of the country. As an integrated project, it goes beyond physical investments in such facilities as dams, power plants and irrigation schemes and encompasses activities and investments, in a coordinated manner, in many diverse fields including agricultural development, industry, rural and urban infrastructure, communication, education, health, culture, tourism and other social services. The GAP has set its specific targets in the framework of the overall state policy to eliminate inter-regional development disparities.

Initiated first as a project for the development of water and land resources, the Southeastern Anatolia Project (GAP) was then transformed into a multi-sector and integrated regional development effort. The ultimate objective of the GAP is not only economic growth but also improving the life quality of people. All activities including those for infrastructure building, agricultural and industrial development, environmental protection, development of natural resources, social services etc. as well as other that directly contribute to economic growth are assessed in terms of their sustainability and contribution to improvements in quality of life.

Hence the ultimate objective of the GAP is to ensure sustainable human development in the GAP Region. Consequently, human being is placed in the focus of all development efforts. Physical structures that are already in the process of formation will lay the basis for human development. Sustainable development in the region will be achieved with the elimination of disparities within the region and with other regions, spread of equality and welfare, securing popular participation to the project and development of human resources.

To sum up, the sustainable economic growth perspective of the GAP envisages the following: Decent level of income for all; accessibility to social services including those in the fields of education, health and culture, sustainable utilization of natural resources; health environment; decent sheltering for all; mechanisms for ensuring the participation of people to decision-making and to create a sustainable society that can further develop on its internal dynamism.

Water Level Change in Wells along the Dead Sea Jordan Rift Valley, A Predictor for Earthquake?

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Two medium earthquakes that occurred along the Jordan-Dead Sea Rift recently shocked Israel and its neighboring countries. Two water wells, located quite apart, "announced" the earthquakes about one hour prior to the shock and about one hour earlier to the first seismographic record!

On February 11th, 2004, at 10:15 am the area of Israel and its surroundings was shaken by an earthquake felt all over the country. According to the Israeli Geophysical Institute, the seismographs recorded the earthquake at a magnitude 5.1 (ML) and calculated the epicenter to be the NE corner of the Dead Sea. Forty five minutes prior to the event a water well (Rewaya-6) located about 75 km north of the epicenter, at the southwestern margins of the Beit-Shean Valley, clearly predicted the earthquake. The well that is part of the water supply system in this area was inactive since midnight. The depth to the static water level is usually 162 meter. The static level was found to be stable over a period of about 10 hours until 45 minutes before the earthquake. At 9:30 am the static water level started to rise quickly, by the time of the shock it had risen by 4.5 m above the static water level. It continued to rise to a maximum level of 5.7 m at 10:25 and remained at this elevation for approximately half an hour. Following this it proceeded to drop back to the static water level.

Five months later, on July 7th, 2004 at 5:35 pm, the area of Israel and its surroundings was shaken by a magnitude 4.7 (ML) earthquake whose epicenter was some 25 km north of the Dead Sea along the Jordan Valley. Unfortunately, Rewaya-6 was active at the time of this quake. However about 1:15 hours prior to the earthquake another water well (Kokhav Hashachar) located about 15 km SW of the epicenter also clearly forecasted the earthquake. The well was not active at the time of the event. It was shut down in the morning several hours before the shock. The static water level stabilized at 343 m. Precisely 1:15 hours prior to the earthquake (at 4:15 pm) the water level at the well began to fluctuate, dropped by 4 m, rose to the original level, dropped again by 3.6 m at the time of the event, rose to the original level, dropped to a maximum of 6.6 m right after the earthquake, fluctuated once again and then stabilized at the original aquifer water level.

What conditions qualified these two wells appropriate as sensors or tools for earthquake prediction? The answer is most likely more complicated then our current knowledge. It is probably a mixture of coincidence combined with many factors. According to our data the following conditions are of prime importance for future prediction success: (1) The monitoring wells should not be connected to a pumping system. (2) The wells should be located at an appropriate distant from any other pumping wells in order to avoid artificial influence. (3) The aquifer should be confined. The Rewaya-6 and Kokhav-Hashchar wells were drilled into the Cenomanian-Turonian confined aquifer at total depths of 366 m and 758 m, respectively. (4) The well should be equipped with a monitoring device for automatic measurement of water level and/or pressure head. (5) The location of the wells is probably crucial for its response. Close proximity to active tectonic features is necessary. In this case the location of both wells is closely associated with major rift faults.

Numerous attempts have been made to achieve advanced warning for earthquakes. Studies have been carried out in an attempt to identify precursory signs that involve pre-shocks, geodetic changes, oil and water level changes in wells, geochemical changes, changes in the ratio of P/S waves, radon emission and unusual animal behavior. To the best of our knowledge all these methods have failed to predict earthquakes. Generally the anomalies attributed to the earthquake were found to appear following the event. In our cases the water level rise and fall in the regional aquifer were found to manifest themselves clearly prior to the earthquake, potentially giving a sufficient amount of time to warn the population of the coming quake.

Wuxi Urban Renewal-Social Impact Assessment

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1) Social Impact Assessment (SIA)
"Social impacts mean the consequences to human populations of any public or private actions that alter the ways in which people live, work, play, relate to one another, organize to meet their needs and generally cope as members of society. The term also includes cultural impacts involving changes to the norms, values, and beliefs that guide and rationalize their cognition of themselves and their society. Social impact assessment is defined as the processes of analyzing, monitoring and managing the intended and unintended social consequences, both positive and negative, of planned interventions (policies, programs, plans, projects) and any social change processes invoked by those interventions. Its primary purpose is to bring about a more sustainable and equitable biophysical and human environment."

2) Project Description
Wuxi Urban Environment Project (WXUEP) is an urban renewal project which is designed to increase the capture and treatment of wastewater in Wuxi,which is one of the important economic central cities in China and a famous tourist spot. Wuxi city's rapidly industrializing suburban districts through physical investments and institutional reforms that will enhance the viability and sustainability of wastewater systems, particularly in the rapidly developing districts of the city. In addition, it will support lakeshore rehabilitation around Wuli Lake as a new development and amenity area for Wuxi City. The objective of WXUEP is to enhance the quality of life of the rapidly increasing urban population and to enhance economic competitiveness to sustain economic growth in Wuxi by alleviating degradation of water resources and improving the quality of the urban environment.

In order to fulfill the objectives of the project, three main important works are to be carried out, namely; Wuli Lake Restoration Project, Huishan WWTP and network, Xishan District WWTP and network.

a) Wuli Lake Restoration Project
Wuli Lake is very seriously polluted area in Wuxi, and its water quality is quite inferior as per the standards required. In order to improve the water and ecological quality of the Wuli Lake to restore natural view of clear water and green bank, pollution control facilities composing the Wuli lake restoration project are planned to implement that include eleven wastewater control gates ; lake-bank restoration; ecological restoration that further include micro-organism purification, delay and curb algae, biology floating-bed purification and multi-function water quality purification bed etc .

b) Huishan WWTP and networks
Huishan WWTP is proposed to be located in Huishan economic development zone with total long-term installed capacity of 100,000cu.m./d. Related network is designed and is to be implemented according to the long-term scale, with 18 main pipelines of about 90km length, and 25km branch pipelines. Three sewage lifting pumping stations are to be constructed in pipeline network.

c) Xishan district WWTP and networks
Xishan district WWTP and network includes expansion of Dongting WWTP and network, and Anzheng WWTP and network. Dongting WWTP is a mixed industrial and domestic sewage treatment plant. Currently, daily treatment scale of Dongting WWTP is 30 million kilograms, with pipelines 39.8km in length and one road lift pumping station. Urban sewerage and drainage network supporting WWTP is under construction. WWTP in Anzheng and network has, currently, a total capacity of 20,000cu.m/d and is planned to expand the capacity to 40,000cu.m/d; pipelines are 145.4km in length, and three sewage lift pumping stations are constructed in the pipeline system.

3) Scope of SIA of WXUEP

WXUEP will have certain effects on social, economic and environmental aspects of the affected regions and communities. This paper focuses on the social and community changes that are caused, or likely to be caused by this project. A SIA method is adopted in this paper to analyze, monitor and manage the intended and unintended social consequences in order to ensure that better and transparent decisions and policies can be made concerning the participation of all potentially affected people and to identify means to minimize the costs especially those costs borne by people and maximize the benefits.

The set scope of SIA for WXUEP comprises of the main activities of concern, such as; identification of the project impacts on land, enterprises and institutions; identification of affected people; to facilitate and coordinate the participation of affected people; documentation and analysis of the public opinion, through public participation, of the planned intervention so as to be able to interpret responses to the intervention, and to assess cumulative impacts; collection of the baseline data (social profiling) to allow evaluation of the impact assessment process; to assists in resettlement action plan; to assists in the valuation process and provides suggestions about compensation (non-financial as well as financial); recommendation of mitigation measures; to assists in devising and implementation, monitoring and management programs.

Possibility of improvement of management the Dnepr reservoirs in conditions of emissions of radioactive pollution

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Keywords: management of reservoir; hydroelectric power plant; contamination transport

The Dnieper River is the third largest river in Europe with à catchment area of 504000 km2. The Dnieper Basin includes nearly 50 % of the total area of Ukraine and contributes about 80% of the total volume of Ukrainian water resources. The floodplain areas near the Chernobyl Nuclear Power Plant (ChNPP) and surrounding catchments are heavily contaminated by radionuclides, especially Sr-90. Dnieper water is consumed through the municipal tap water supply more than 8.1 million people, the reservoirs are also used for commercial fishing, and more than 1.8 million hectares in Ukraine is being irrigated by Dnieper water.

Although during the last years (1996-2004) the concentrations of radionuclides were 100 times lower in comparison to 1986 in the Dnieper reservoirs, the concentration of some of them is still 20-30 times higher the pre-Chernobyl background concentrations. After the Chernobyl accident the extra input of radionuclides into the Dnieper water increased the radiation doses to the population of various regions have increased by from 3 to 10% of a total collective dose for the population living in the basin of the Dnieper in the affected zone of the Chernobyl NPP. This increase is caused by direct water use as well as through consumption of irrigated agricultural products and fish products.

The urgency to decrease the collective dose to the population living downstream in post-Chernobyl situation requires water protective activity. The operation a hydro power plant (HPP) makes influence on a water level, volume of the reservoir, flow velocity, time of water transportation and, as a result on changes of concentrations of pollution (in particular Sr-90) in the outlet. So it may be used as one of countermeasure for water protection especially in emergency situation not requiring additional capital investments.

The main users and consumers of water from the Dnieper Basin are:

- the hydropower sector with six Dnieper power stations of total installed power capacity including the capacity of the Kiev pumped storage plant of 3 500 MW maximum capacity;
- the industrial sector with more than 6000 industrial enterprises;
- the agricultural sector with more than 50 large irrigation schemes;
- the municipal sector supplying 50 large cities and more than 1000 smaller towns with water;
- the fishery sector;
- the ship transport sector, allowing ships of up to 4 000 DWT from the river mouth to Kiev;
- recreation.

This situation results to extensive reservoir utilization, which has resulted in increased conflicts with other user interests. These conflicts become particularly pronounced during years with low runoff.
It is possible to evaluate the influence of a mode of operation HPP on Sr-90 concentration by the methods of modeling of radionuclide transport in view of interests of all users.

A box model with lagging argument (UNDBE) describing the transport Sr-90 in the reservoir has been developed. The model takes into account the time of transportation of water (and, consequently, of the pollutant) through a reservoir and mixing the pollutant in a certain part of compartment volume to the moment of completion of transportation. It is possible to considerably increase the accuracy of the on-line prediction of pollutant concentration at the outlet of the reservoir with minor complication of mathematical and programming tools and without increasing requirements to the quality of full-scale measurements.

There are representative hydrological and radiological data sets for the years 1991, 1994, 1999. Results of calculation of the model on data set of field measurements 1991, 1994 and 1999 are resulted.
With help of model the possible influence of modes of operation the Kiev hydroelectric station on change of concentration Sr-90 is appreciated. For evaluation of the influence of the modes operation of the Kiev HPP where made two scenarios – “the best” and “the worst” for 1991 and 1994. The best means that HPP operates for filling the reservoir with floodwaters from lowest reservoir levels to maximum volume during the peak of concentration of Sr-90 flowing through reservoir. The worst – working the Kiev HPP while lowest reservoir levels takes place whole time of the peak transportation.

The results of modeling show the possibility to change (by means of use of a mode of operation) the concentration nearly upon 20% and time retention of peak of concentration nearly for 18 days (from 30 to 48 days).

So we can use the opportunity for decreasing peak meanings of concentration with modes operation of the HPP. It gives us chance to make the concentration less than the Maximum Allowable Concentration (in Ukraine for Sr-90 2000 - Bq/m3) in extremal situations. The Kiev municipal tap water supply may work continuous in this case. Another situation – the short peak of maximum concentration quick flow by water supply system with minimum time of shut off water supply point and pass to alternative water supply. It makes minimum collective dose from water for population with minimum economy damage.

The Desna River (big left tributary of the Dniper) surrounded at once after the Kiev reservoir. Water in the Desna is clean as her watersheds are clean from radionuclides and spring-flood takes place a bit later than in the Dniper and in the Pripjat. A change of the time of the peak transportation makes the possible coincidence with the peak of the Desna spring-flood water for maximum discharge of the radionuclide pollution. It may additionally decrease peak concentrations in next reservoirs of the Dniper Cascade.

The time of transportation of peak changes from 10 till 40 days, therefore variations of the HPP modes of operation carry decade, instead of daily character and therefore not conflict with the hydropower sector (HPP more important because of its central function in daily peak following). We have no conflict with the industrial sector too. The extreme situations take place in spring, so we have no conflict with the ship transport sector as the navigation starts in the Dniper after spring-flood. The results of the changes of the modes operation of the HPP may improve the situation for the municipal sector and for the agricultural sector. But we have conflict with the fishery sector only.

Design And Operation of the Water Infrastuctures for Multiple Development Objctives: Uzbekistan's Initiativies in Syrdarya River Basin

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Introduction

The country's gaining of independence has adversely affected the irrigation sector: two thirds of the nation's water resources flow from Kyrgyzstan and Tajikistan. The irrigation sector has inherited huge network of reservoirs, dams, pumping stations, canals and other structures, but also great number of problems connected with all of them. Last years water management conditions has become aggravated which was caused by change-over of Toktogul hydropower unit to power generation regime providing for increase of winter release from Toktogul reservoir from 120 to 340 m3/sec. Due to absence of sufficient reservoirs to regulate winter draw downs downstream of Toktogul hydro unit the emergency water discharges from Chardara reservoir into Arnasay depression have risen sharply, and in Fergana valley and midstream deficiency of irrigation water, especially in drought years, such as 2000 and 2001. It is resulted in crop capacity decrease, slow development, low export income, and adverse impact on general living standard of the population.

Arnasay lakes system was formed in catastrophically high flood year of 1969, because over than 21 km3 was discharged from Chardara reservoir. Flooded area has reached 2000 km2 and currently water salinity is from 2 to 4 g/l in the lake system. At present Arnasay is a new largest lake system of the Republic of Uzbekistan. In 2000 water level reached 245 m in Arnasay lakes system, and total surface area increased to 3258 km2 and capacity to 35.5 km3. All of this caused destruction of dam and outflow between Aydar and Tuzkan lakes, agricultural infrastructure, fishing etc.

Results and Achievements

The Ministry of Agriculture and Water Resources of Uzbekistan initiated the two technical projects in order to improve management of water infrastructures in Syrdarya River Basin for multiple development objectives:

1. Rezaksay and Kenkul Water Reservoir Construction Project in Ferghana valley

2. Project of Construction of Arnasay Water Reservoir and Conservation of Arnasay lake ecosystem

The first project considers construction of two off-channel reservoirs, Rezaksay and Kenkul, in the Ferghana valley on the territory of Namanghan region for the accumulation winter energetic discharges from the Toktagul water reservoir. General capacity of two off-channel reservoirs is 850 Mln.m3 (Rezaksay – 660 Mln.m3 and Kenkulsay – 190 Mln.m3). Rezaksay has 100 m high dam and the original design of technical solution for the preventing of washout in the upstream of the barrage was used. Construction of Rezaksay reservoir financed by the Government of Uzbekistan is going on. Designing of the Kenkulsay water reservoir will be completed in current year.

Both water infrastructure projects have direct socio-economic and agricultural benefits for all groups of stakeholders. The design provides stabilization of guaranteed water supply for 200 thousand lands of the Ferghana valley in vegetation period and increasing of rural income till 25-30%, and improvement of living standards for more than 9 Million populations.

Second project on construction of off-channel Arnasay reservoir, with capacity of 500 Mln.m3 is aimed for accumulation of energetic discharges in winter period, and providing of irrigation of 40 thousand ha of croplands in Djizak region of Uzbekistan. It also guarantees reliable water supply of above located districts during the vegetation. The project promotes load reduction on Arnasay lake systems and conservation and ecosystem safety. At present the construction of Arnasay off-channel reservoir is practically completed.

In order to prevent the environmental catastrophe in Chardara reservoir command area the Uzbekistan water institutions is working out technical decision and interventions to mitigate of further flooding of Arnasay lake systems and adjacent Kazakhstan territory.

National initiatives of Uzbekistan to be realized on the problems of improvement the management and regulation river flow by construction and improvement of water infrastructures operation have found the support and comprehension of Kazakhstan responsible authority and institutions. They are revealing interest in joint cooperation and partnership. Similar interests for technical feasible interventions and initiatives in design and operation of water infrastructures for multiple developments of Central Asia countries, as it seems, has great future.

Conclusions

This paper illustrates the two technical projects to improve management of water infrastructures in Syrdarya River Basin for multiple development objectives. The first project considers construction of two off-channel reservoirs, Rezaksay and Kenkul, in the Ferghana valley of Uzbekistan for the accumulation winter energetic discharges from the Toktagul water reservoir. Second project is aimed construction of off-channel Arnasay reservoir and conservation of Arnasay lake ecosystems. It also provides the irrigation of 40 thousand ha of croplands in Djizak region of Uzbekistan. Proposed national initiatives and water management interventions in the middle stream of the Syrdarya River provide positive benefits for all groups of stakeholders, and will ensure safety of socio-economic and environmental interests of national and regional community.

Japans Expansion of Rural Water Supply and Innovative Water Purification Membrane Technology: New Possibilities for Assisting Developing Countries

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1. Summary

In Japan, water supply coverage (population served by water supply as percent of total population) is very extensive (97%) and water purification technology is generally at a high level. However, major challenges remain: boosting the water supply coverage in sparsely populated rural areas and ensuring the safety of rural drinking water through proper maintenance and management. Two strategies that have shown effectiveness in addressing these challenges are the government-implemented program for increasing rural water supply coverage through □gspecified small-scale waterworks□h (SSWs), and the deployment of membrane filtration technology in water purification systems. Japan□fs experience in these areas may be of service to developing nations where they urgently need to provide clean water access to many communities.

2. The Significance and Challenges of SSWs in Expanding Water Supply in Rural Areas

Water supply service operates on the principle of financial self-sufficiency. However, it is difficult to thoroughly apply this principle in sparsely populated rural areas. The scarcity of human resources in these areas makes it a daunting challenge to provide proper maintenance and management of supply facilities. Japan has a program for extending water supply coverage in rural areas through governmental financial support of SSWs, which are small-scale waterworks that serve water supply populations ranging from 101 to 5,000 people. In the past 50 years, the program has expanded water supply service to cover approximately 10 million people in rural areas, which make up more than 80% of Japan□fs area. The number of SSWs in operation has declined due to integration with other SSWS and large-scale waterworks, but they still account for nearly 90% of the roughly 10,000 waterworks in service nationwide. SSWs present their own challenges. For example, the lack of human resources makes it difficult to adequately run water purification operations, and thus there is concern over whether safe drinking water can be constantly supplied.

3. Advantages of Applying Membrane Filtration to SSWs

Depending on the source water quality, one effective means of resolving this impediment in SSWs operation is the employment of membrane filters in the purification process. Membrane filtration systems offer a labor-reducing advantage, as they do not require specialists to operate them. They are also a very effective solution against Cryptosporidium and other pathogenic microbes, as they completely filter out all particles above a certain size. Water purification membrane technology started spreading in Japan around 1993, and is currently deployed at 374 water purification plants, mostly small-scale facilities. Their total processing capacity is approximately 240,000 m3 per day. The cost of membrane filtration facilities has generally declined since their initial deployment (circa 1993), partly due to the falling costs of membranes. Today, the per-processing-volume cost of facility construction, including the filtration system, the building, and incidental equipment, is usually in the range of \300,000 (approximately US$3,000)/m3-daily water consumption to \400,000(approximately US$4,000)/m3-daily water consumption. Compared with rapid sand filtration systems, the membrane filtration technology entails higher equipment costs, but offers a slightly lower startup outlay when civil engineering and construction costs are added. In terms of operating costs, the membrane filtration technology requires additional electric power, chemicals, and membrane replacement, compared to the traditional sand filtration technology. However, the membrane technology requires less operational expertise that makes it a new alternative for developing countries where they are incapable of quickly training a large number of trained operators. The Japanese experiences could be transferred to any developing countries where they need urgent supply of clean water to people in large population. The variety of newly developed membranes makes it possible to select the proper degree of filtration to handle different quality levels of raw water and processed water. For example, large-pore membranes with nominal pore diameters of 2.0 ƒÊm are attracting attention as solutions for removing Cryptosporidium from surface water with low turbidity. Moreover, all sorts of membranes are now commercially available to handle specific functional requirements.

4. Conclusion

SSWs are a proven tool for expanding water supply coverage in rural areas in Japan. Although they pose certain operational challenges, one effective new solution is the use of membrane filtration. This technology offers safe, completely purified water without the need for highly trained operational expertise, and membrane filtration facility construction costs are declining overall, so it is expected that diffusion of this technology will accelerate in the coming years. The SSWs program and the use of membrane filtration technology could be considered a viable strategy for expanding water supply coverage in developing countries.

Features of Complex Use of Water Resources in Natural-Technical Systems

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At present there are continuous intensive technogenic influences of a society upon the natural environment, accompanying with changes of regularity of the processes proceeding in biosphere. With a view of satisfaction of requirements of a modern society are created the difficult technical systems, which are carrying out different technological cycles and implementing certain social and economic function.

These systems as a rule cooperate with homogeneous and diverse natural systems of an environment. The uniform complex of functioning of technical and natural objects forms natural-technical system. One of such characteristic systems is the water-economic system representing set of sources of water resources and various means of their regulation in a view environmental protection. Proceeding from this the natural-technical water-economic system carries out continuous interaction of natural and social and economic systems.

In Georgia water resources are one of the basic and unique natural riches. Despite of small occupied territory of Georgia (69,7 thousand km2), various natural and climatic conditions are observed: from area of an eternal snow and glaciers on the Main Caucasian ridge up to low plentifully humidified subtropics of Kolkhida and dry steppes of east and southeast of its parts.

In a hydrology of a landscape of Georgia the essential role is played by the reservoirs - artificial ponds adequate to essential social and economic requirements of a society in regulation of a river run-off, its territorial redistribution with a view of optimum multi-purpose use of water resources for water-power engineering, irrigation, water supply, fish industry, struggle against flooding, etc. In total in Georgia 43 reservoirs operates at different hypsometric levels with capacity 3175 million in m3. Various climatic conditions of the Western and East Georgia cause multiple purposes of reservoirs usage, in particular: reservoirs of the Western Georgia have basically energetic (power) purpose while in reservoirs of East Georgia an irrigation is prioritized.

One of the major natural-technical water-economic system in an arid zone of Georgia is Samgori Irrigation System (SIS). A source of water resources of SIS is the drain of the river Iori regulated by the river-bed Sioni and bulk Tbilisi reservoirs, with its total capacity 5 million m3.

Uniqueness of SIS consists that the accumulated volumes of water in reservoirs are used in complex for power, municipal and industrial water supply, fish industry, recreation, etc., not influencing a necessary limit of the charge at the pressure head site, are intended with a view of an irrigation.

Climate of SIS area is continental, droughty. Average long-term annual quantity of precipitation reaches 500-550 mm, maximum - 800 mm, minimum - 300 mm. Mid-annual temperature is 11-13 Co. The sum of temperatures during the year reaches 4572 Co. The massive is characterized by sharply expressed ash value, difficult microrelief, hilliness of the district, alternating plains and a plateau; slope changing within the 0,001-0,1. The soil-cover includes all variety of types of a soil characteristics for East Georgia.

Irrigated area of SIS is 60 000 ha and is used basically under vineyards and orchards, and also for cultivation of grain and vegetable crops. For irrigation basically various technological ways of a superficial irrigation are applied, that actually does not promote rational use of water resources and prevention of occurrence of negative ecological consequences.

Fifty years' functioning of SIS has revealed the operational specific features caused by variability of deficiency of humidity and water consumption of agricultural crops, fluctuation of a level of subsoil waters in a wide range, complexity of relief - topographical conditions, a variety of a complex of hydraulic engineering constructions and hydrounits (regulating reservoirs, overflow dams, water intakes, tunnels, passageways, inlet and outlet channels, ganged constructions, pump stations and installations, etc.).

The analysis of the long-term data of operation of SIS presents that the quantity of the water used for irrigation is determined not by deficiency of humidity, but by actual presence of available volumes of water. Direct consequence of such practice is that in non-extreme but in average according humidity years at the SIS deficiency of water resources is observed, which arises basically for the lack of hydro-geological, hydrometeorological, hydrological and soil - meliorative factors, reliable technique for a quantitative estimation of evapotranspiration from agricultural fields, and also influence of the impact of an irrigation on an environment.

Wrong quantitative estimation of one and full ignoring of other factors, absence of an opportunity of the forecast of dynamics of their variability should lead to the negative consequences which have expressed in formation of occurrence of the sites of soil erosion, landslips, landslides, raising of a subsoil waters level, bogging of district, etc.

A variety of factors of components determine complexity of functioning of SIS and specifies necessity of development of scientific and technical bases of management of its water resources on the basis of reliable information security which is meant as the differentiated account of all natural both ecological factors and return influence upon them non-realized - an irrigation.

To this problem till now it was not given sufficient attention, however without the quantitative analysis of the importance of each factor and their interrelation it is not probable rational use of water resources in SIS that in turn defines a level of social and economic development of a society.

Realization of the Program of Reconstruction And Modernization of the Water-Sewer Economy of City of Cherepovets

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In 90th years in Cherepovets as a result of rough growth of the industry and housing construction there was rather adverse conditions in a water-sewer economy of city.

The structure of a complex of water clearing constructions included two water-purifying stations (WPS): water-purifying station N1 1954 years of construction which was reconstructed and extended up to productivity of 25 m3 of water in day. M day, and the WPS N2 constructed in 1965 and 1972 with the one-stage technological circuilation of water treating on contact ligts. Design productivity WPS N2 of 145 m3 in day. Both stations have been projected and constructed according to working on those periods of time specifications «Water drinking». Further requirements to quality of potable water repeatedly became together, and that them to achieve on WPS N2 it was necessary to lower considerably speed of a filtration, productivity of station thus should decrease by calculations up to 115-120 m3 in day.

At the same time on a complex of clearing constructions of the water drain the situation also became aggravated. Clearing constructions the common productivity of 195 m3. The m. in the day entered into operation stage by stage in 1965, 1973 and 1986, worked also on a limit of the productivity. During the fresh period loading on them grows by 20 %. Constructions have no reserve and cannot be stopped for full major overhaul without dump of the crude sewage to Sheksna river that is completely inadmissible. During hydraulic overloads of a construction work astably, there is a danger of carrying out of active silt and deterioration of the cleared sewage. The probability of flooding by household sewage through sewer well territories of city is high.

Due to efforts of administration of city and experts of municipality of action on development of a water-sewer economy. Improvement of an environment and the population of city of Cherepovets on 1997-2010 г.г have been included in the federal target program. The program provided on means from federal, city and regional budgets to lead expansion and reconstruction of water clearing constructions and clearing constructions of the water drain. 50 % of necessary means the federal budget should allocate, 50 % - local budgets.

In October, 1999 construction of tanks of pure water, volume 44000 m3, have been completed also tanks are started up in operation. It has allowed to increase a stock of potable water for needs of city, to stabilize work of water-purifying station and to increase water delivery in a water supply system at o'clock of the maximal water consumption. The project of expansion of water clearing constructions disinfecting of water on WPS N3 was provided by a method of chlorination. However, taking into account, that reliable and safe disinfecting of potable water from a virus infection is rather actual for city, the center of sanepedemiological control it was offered to "Water canal" to work this question, having considered all alternative methods of disinfecting of potable water, in particular a method of ultra-violet processing and to provide industrial inspection behind circulation of rotaviruses and a virus of a hepatitus A and in water of a water source and in potable water.

In parallel with introduction of ultra-violet desinfecting water work on the organization of virologic laboratory was conducted. In August, 2002 the laboratory has acquired the license of Ministry of Health of Russia for the right of carrying out of research works with viruses. Experts of virologic laboratory have the maximum(supreme) medical formation(education). Quality of the equipment of laboratory is so high, that scientists - ecologists of Moscow and Saint Petersburg carry out(spend) at us the tests and are engaged in research work. The presentation has taken place in December 2002 «The Center of research of water» which structure included also virologic laboratory. In September 2003г. The center of research of water is accredited with reception of the certificate till September, 20, 2008.

In 2003 have started construction of a new water-fence by productivity of 290 m3 in day. Now it is mounted and established on a design mark lower well, it is concreted load, are made for a fence of water, excavations on a river bed for stacking of selflowing pipelines and оголовков are executed, works on a lining selfflowing pipelines are started by a method of "puncture".

Thus, introduction of the newest technologies of water-preparation, and disinfecting and quality assurance of water have allowed health officers of city to take off a question on «the water factor of transfer of activators of intestinal infections» from the agenda.

Workshop 2:

Coping with Climate Variability, Climate Change and Water-Related Hazards

Mitigating the Greenhouse Effect by Sequestering Carbon by Woods Planted in Dry-Zones, Utilizing Wasted Water Resources

Prof. Arie S. Issar, Israel

A series of investigations carried out during the last two and a half decades in the framework of the J. Blaustein Institute of Desert Research of the Ben Gurion University of the Negev, Israel, have shown that about 10 to 20% of the runoff water is wasted as flash floods, causing erosion and other damage before they reach the sea or salt lake.

This source of water was utilized efficiently by the ancient inhabitants who used methods of water harvesting. In addition water is wasted due to capillary movement and evaporation from bare sand-dunes, and uncontrolled flow of ground water into the sea and saline lakes and marshes.

The investigations of the present author have shown that vast areas were desertified during recent historical climate changes. These regions can and should be reclaimed.

Investigations carried out by climatologists of the Tel Aviv University, Israel, have shown that while the quantity of rains in the northern part of Israel diminishes, which they attribute to the global warming, at the same time the central and southern part of Israel enjoy an increase in the quantity of precipitation. They attribute this augmentation to the increase in vegetation cover since irrigated agriculture expanded in this region. In other words the decrease of the albedo (back radiation from the soil) and increase in humidity due to evapo-transpiration increased the precipitation over a semi-arid region.

A team of Weizmann Institute and of the Hebrew University at Rehovot investigated the carbon sequestering of the forest of Yatir planted north east of Beer Sheva in an area, which gets only about 300 mm/year. They found out that each hectare in this forest sequesters about 2 tons of carbon per year.

If we look on the global scale then we find that there are about 2 billion hectares of semi arid shrub and grassland, which if planted, even partly, will sequester a remarkable percentage of the global anthropogenic atmospheric carbon. That is several times the quantity, which the Kyoto agreement speaks about and about which there is still disagreement. Additionally there are vast desert areas under which are found tremendous quantities of fossil water, which can be utilized to plant olives, date palms, and other productive trees.

An important constraint from the sustainability of the hydrological and hydro-chemical systems, which has to be taken into consideration, arises from the fact that most trees remove by their roots, only fresh water from the hydrologic system and leave the salts in the subsurface. This causes the load of salts in the water cycle to increase towards the outflow. Natural flow systems drain out the salt load either to the sea or into an inland salt marsh or lake, (sabkha, shott, dasht etc.), where the salts are evaporated. Thus any regional project of re-planting semi arid and arid zones, should be preceded by a regional hydrological and hydro-chemical flow model. The results of the running of this model will enable to decide about the number of the trees on each watershed, the rate of the increase of salt content, planting more salt tolerant trees down-stream, and deciding the location of an outlet area, either natural or artificial as a sinkhole for the salts.

Indeed countries, like the USA, China, Australia, South Africa etc. have already adopted the policy of creating plantations for commercial as well as carbon sequestering purposes. The present paper urges an international effort to plant trees in the regions considered until now not fit for forestation because of their aridity.

It is claimed that the arid and semi-arid regions should be targeted because they are empty, the land in these areas has a negligible economic value, and last but not least, large quantities of water are wasted. Thus, although from the narrow commercial and short term point of view the production of wood in these regions is not economic, yet, when all marginal benefits are considered on a long term global scale, the planting of woods in these regions will prove economical. The marginal benefits are: sequestering atmospheric carbon, augmenting precipitation, reducing soil erosion, producing wood for various industries, promoting the bio-sphere and the vegetation-sphere on the basis of which tourist industry can develop and thus produce income for the people in these regions, most of which are under-developed.

In conclusion, turning a wasted global resource into a beneficial one by re-planting the arid and semi arid regions should become an international project.

Mainstreaming Climate Adaptation in Watershed Management in Northwest India

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Key Words: climate variability, climate change, adaptation, watershed management, mainstreaming

Background:
Water stress, groundwater over-exploitation and degradation of water resources are increasing in many parts of India, due to a widening gap between demand and availability. Agriculture is by far the biggest user of water. In the state of Gujarat for example, agriculture is responsible for over 90% of all water consumption. Natural variability of precipitation in the Indian monsoon climate poses severe risks to agriculture and water management. With climate change, rainy seasons may change and intensity and frequency of extreme events, such as droughts and floods are likely to increase. Any climate change driven rise in temperature will further compound water and food scarcity, either through increased evaporative demand or direct temperature effects on plants 1.

Additional pressures that also increase regional vulnerability include increasing water demand and low water productivity, water quality deterioration and salinization. Adaptive capacity, in particular the ability to bridge drought periods is generally decreasing 2.

Method:
We overlay regional climate scenarios for India with district-wise maps of socio-economic indicators, i.e. information on adaptive capacity, in order to identify particularly vulnerable regions. From stakeholder dialogues in a well established and long-term Indo-German watershed management project, we compile a list of coping strategies and screen them for their climate adaptation potential.

Results:
A considerable number of ongoing hard (structural) and soft (non-structural) watershed management options in Gujarat and Rajasthan, as well as national policies and practices are addressing current climate variability. In doing so, they also build resilience towards future climate change impacts. However, we also identify critical thresholds of climate change, beyond which current (no-regret) adaptation options are no longer sufficient. Examples of such critical thresholds include a certain number of consecutive drought years or severity of droughts and subsequent severe drops in groundwater levels, when land use options such as grazing or rainfed agriculture are no longer feasible or when groundwater extraction for irrigation is no longer possible.

We also find that the impacts of climate extremes, such as droughts, strongly depend on the “pre-disposition” e.g. the situation of natural resources but also adaptive capacity at the onset of the event.

In order to pro-actively prepare for future climate change as simulated by regional climate models, specific portfolios of adaptation measures are required. Such portfolios can draw from local experience with current climate variability. Also, initial compendia of adaptation measures have been compiled from experience around the world 3.

One result of our assessment of adaptation options is, that income alternatives / livelihood diversification outside of agriculture will increasingly be necessary to reduce climate risks.

Conclusions:
Stakeholder dialogues in different watersheds in Gujarat and Rajasthan indicate that there is little awareness of the potential effects of climate change. Current pressures on rural livelihoods, e.g. from droughts and resource degradation are so severe, that pro-active adaptation measures to future climate change are of low priority. Given this situation, any new adaptation measures to climate change also need to improve current livelihoods in order to be accepted and implemented. Also, capacity building, i.e. a

translation of climate scenarios and climate impact assessments is a pre-requisite for any participatory approaches to climate adaptation.

In a next step of the project, we plan to hold more formalized stakeholder dialogues on these issues, using e.g. Bayesian Believe Networks.

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Implementation of INMAS Strategy, Coping with Climate and Water Related Hazards in Sri Lanka.

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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. They are such as sea level rise, shifts of climatic zones and changes in precipitation patterns. Also, climate change is very likely to increase the frequency and magnitude of extreme climate variability, such as droughts, flash floods, and storms. And also indirectly effects in terms of water related hazards. Its adverse impact of climate change will be most striking in the developing nations, because of their geographical and climatic conditions, high dependence of natural resources, and their limited capacity to adapt to a changing climate and they are the most vulnerable. (IPCC2001). Over 96 % disaster related deaths in recent years have taken place in developing countries. Often extreme events have retarded the development process for decades-UNDP

Sri Lanka is one of the prime example of a country that is particularly vulnerable to today's water related hazards and climate. Last December, the Tsunami waves have devastated so many cities rendering thousands of people homeless, about 80 % of the costal fishing areas have been destroyed by flooding, affecting more than 30 million people and causing 38000 fatalities. Economic loses were estimated at US$ 4.5 billion. As well the country severally affected by the worst drought last 2001,and 2002 respectively, devastating entire paddy lands. The power cuts that plunge people in to darkness every day as the water in the hydropower reservoirs sinks to critical level. The next year flood menace came to the country inundating entire cropping lands and destroying thousands of homes and property costing around US$ 1.2

Mitigating risk and coping with these menace we had to adjusted our development plans to cater basic needs, water, sanitation by securing food for growing population while protecting ecosystems and efficient use of water resources for sustainable development.

As a policy response to the above situation Sri Lanka government place great emphasis on adopting more engineering base foreign funded projects by building dams, storages and irrigation settlements. However, they did not performed no or little positive results.

With the realization of increasing capital expenditure on the engineering solutions and low level positive results of same, Sri Lanka government shifted its policy approach from engineering solutions to Integrated Management of Agricultural Settlements (INMAS) by strengthening institutional and management capacities and to devolve responsibilities to the stakeholders to manage their own water sheds and irrigation systems.

INMAS is a locally based, geographically specific planning process that in theory is a highly participatory practice and allows for the comprehensive management of the water shed and the irrigation systems with the active involvement of the local community as the main stakeholder group. It involves co management of resources through which decision-making, responsibility and authority in respect of water shed and irrigation management are shared between the government and the stakeholders. Their decision making body is the Project Management Committee (PMC). The INMAS program is now considered a key component of the Sri Lanka's National Water Resource Policy.

The coping mechanism adopted by the agency officials and stakeholders, in alleviating the negative impact of the water stress situation was the both parties agreed and the higher management efforts done by the PMC. It is an interdisciplinary team of experts,

incorporating Engineers, Agronomists, Economists, Sociologists and with experienced Stakeholders. There are 41 Major Irrigation schemes under the INMAS projects commanding about 157,800 ha.. 772

Farmer Organizations formed based on hydrological boundaries. 41 PMC s are operating to facilitate the participatory decision making process. These projects improved their performances up to 85 %, equity of allocation and involvement of stakeholders, timely decision taken and water use efficiency was 80% (IWMI2001). Out of 1212 Distributary and Field canals 1023 canals within the projects turned over to Farmer Organizations formally through an agreement for operation and maintenance and water distribution. People's company own by the beneficiaries of the schemes had been setup and they managed the main and distributary canal systems.

Protecting the eco system, reforestation promoted to 36 projects in upper watersheds, while 50 % reduced overharveting and exploitation by enforcing low with the Forest Department. In the water stress situation in paddy cultivation, after the consultation, on and off (Wet and Dry) mode experienced, re using the drainage water by damming in lower part of the canals also remarkably increased. Promoted sprinkler irrigation as hard solutions. Soft solutions, like training and awareness programs, work shops, field visits also conducted with the funding of NGOs, and Commercial Enterprises on farm water management, protection of water sheds, post harvest processing and flood mitigation and many of the above interventions contributed to the development of the watersheds.

Multi-agent modelling of climate outlooks and decision making on a community irrigation scheme in Limpopo, South Africa

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A major uncertainty in river basin management is the social behaviour of actors in allocating water and responding to multiple stresses. Seasonal climate outlooks provide one tool to help decision makers allocate resources in anticipation of poor, fair or good seasons. The aim of the 'Climate Outlooks and Agent-Based Simulation of Adaptation in South Africa' (CLOUD) project has been to investigate whether individuals who adapt gradually to annual climate variability, are better equipped to respond to longer-term climate variability and change in a sustainable manner. Seasonal climate outlooks provide information on the expected annual rainfall and thus can be used to adjust seasonal agricultural strategies to respond to expected climate conditions. A case study of smallholder farmers in a village in Vhembe district, Limpopo Province, South Africa has been used to examine how such climate outlooks might influence agricultural strategies, how this climate information can be improved to be more useful to farmers and how it can be disseminated more effectively. Empirical field data has been collected using surveys, participatory approaches and innovative computer-based knowledge elicitation tools (KnETs) to investigate the drivers of decision-making with a focus on the role of climate, market and livelihood needs. This data is used in an agent based social simulation which incorporates household agents with varying adaptation options which result in differing impacts on crop yields as a result of using or ignoring the seasonal outlook. The use of the seasonal forecast is influenced by peer groups and associated successes and failures.

The design of the agent-based model of the community irrigation scheme provides an insight into the responses of farmers to seasonal climate outlooks and the potential to adapt to climate change by allowing the coupling adaptive strategies to a crop model (CROPWAT) driven with rainfall and temperature derived from 140 year runs of HADCM3. Key variables are the skill of the forecast, the social communication of the forecast, and the range of available household and community-based risk coping strategies. An asymmetry in forecast use is clear, with forecasts of wet years being more valuable for dryland farmers, while a forecast of a dry year and possible limitations on available water for irrigation is of importance for marketing farmers. Farmers alter their behaviour according to their memory of past climate, their interaction with other farmers, and their belief/trust in the seasonal forecast. However, the use of seasonal outlooks is also affected by farmers' own experiences of past climate as this may affect their 'perception' of forecast information. Therefore, not only is the accuracy of the forecast important to ensure that farmers can trust it over time, but their own experiences of climate variability as well as climate extremes must also be taken into account. Extreme events seem to anchor the memory of farmers who use the forecast and this may affect their interpretation of forecast information. The ability to develop adaptive strategies which are sustainable in the long-term is additionally important due to the possibility that the accuracy of a forecast may decline at some future date and this is an event which farmers should ideally be able to cope with.

Using innovative agent-based social simulation techniques we study how these factors influence the success of the farming community as the climate varies over annual, decadal and longer timescales, including the effect of changes in the accuracy of the seasonal forecasts. This research provides a novel approach for exploring adaptation within the climate change context and considers how climate information can be tailored to the needs of vulnerable groups such as small-scale farmers to encourage their use and thus, in turn, the adoption of long-term sustainable coping strategies.

Role of Watershed development Programs in augmenting Groundwater Resources through Recharge

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Over the years, groundwater has emerged as an indispensable resource for irrigation in the hard rock areas of the Indian subcontinent, where hydro-geomorphologic factors are not favorable for natural recharge of the resource. Groundwater as a source of irrigation is gaining prominence in water starved semi-arid region of the country. Since the advent of green revolution, groundwater in hard rock areas is reeling under stress due to overdraft owing to competing demands from agriculture, domestic and industrial sectors. Even though the extraction of groundwater is a modest of 30 percent of the potential, the rate of extraction of groundwater is greater than the natural rate of recharge in several places. This has resulted in secular or long-term overdraft and cumulative well interference. The resulting initial and premature failure of dug-wells, dug-cum-bore-wells and shallow tube wells and the subsequent loss in economic investment are colossal. Besides, life of irrigation wells and their groundwater yield are gradually declining due to overdraft of the resource without regard to recharge. This affects the user cost of groundwater for different uses and users for the present and future generations. In short, the resource is coming under increasing pressure as it is being pumped to the surface at an alarming high rate. Hence, scarcity as well as indispensability of the resource calls for a need for conservation of groundwater. In this regard, it is important to point out that Watershed Development Programs is one of the vital approaches through which this valuable resource can be conserved.

A watershed is a catchment area from which all water drains into a common point, making it an attractive unit for technical management of water and soil resources. It is an integrated approach to development with the objective of improving the quality of life of farmers. In areas where access to surface water is limited and availability of groundwater is significantly dependent on recharge, Watershed Development Programs provide rich opportunities for augmenting the resource through recharge. In fact, groundwater recharge is one of the important parameters often used to assess Watershed Development impacts. The rise in demand for groundwater for irrigation use has promoted rapid extraction of the resource, which in turn has induced cumulative well interference. Given the distribution of land holdings, obscurity in property rights and frequently occurring droughts, interference among wells is a negative externality in the hard rock areas of India. The negative externality in well irrigation is reflected in terms initial or premature well failure, drying up of wells because of new well(s) coming in, large degree of losses in yield of wells, deepening of the existing wells due to fall in water level, etc. Watershed Development Programs play a significant role in reducing this negative externality by augmenting groundwater resource through recharge. The role of watershed Development programs in internalizing the negative externality is realized in terms of certain physical and economic benefits. The physical benefits include enhancement in life of irrigation wells and higher yield of wells. Reduction in extraction costs and increased net returns per acre-inch of groundwater used are the economic benefits derived from Watershed Development Programs.

This paper seeks to develop an analytical framework for assessing the role of Watershed Development Programs in augmenting groundwater resources for irrigation through recharge. It presents an economic analysis of contribution of watershed structures to groundwater recharge. In other words, an attempt has been made to estimate the economic contribution of the water harvesting structures in watershed development project to groundwater recharge and thereby to farm income. Besides, some of the externalities associated with the use of groundwater resources for irrigation, in watershed areas have also been addressed. The study also intends to examine the equity issues involved in the sharing of benefits accrued due to groundwater recharge activity from watershed treatments. Finally, the paper highlights some useful policy approaches to counter groundwater depletion.

Strategies to cope with the climate variability and change in the Murray-Darling Basin, Australia

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Murray-Darling Basin Commission

The Murray-Darling Basin covers 1 million square kilometres spread over the five States and Territories of Australia. Though it is only 14% of the land-size of Australia, 70% of irrigation in Australia occurs in the Basin and it is a major contributor to the Australian economy accounting for more than 40% of national agricultural produce. The Basin is managed by a multi-jurisdictional body, called the Murray-Darling Basin Commission (MDBC), which has representation from the Governments of the five Basin States and the federal Government of Australia. The Basin is currently facing many environmental problems eg. Salinity and other water quality problems, land degradation and loss of bio-diversity. A number of policy initiatives, eg Cap on Water Diversions, Basin Salinity Management Strategy, Integrated Catchment Management (ICM) Policy, Interstate Water Trading, Restoring the Environmental Flows in the rivers, have been taken by the MDBC to address the current problems. Already extremely variable rainfall in the Basin is likely to become more variable in future due to climate change. Higher temperature coupled with likely reduction in rainfall is likely to reduce the water availability. This is likely to exacerbate the social tension for water sharing between the States and within States between different sectors of economy and environment. MDBC recently identified six risk factors namely: climate change, reforestation, increase in groundwater use, farm dams, bushfires and reduction in return flows from irrigation, which may threaten the long-term water supply (quantity and quality) security in the Basin. The Commission in order to formulate adaptive policies to deal with long-term water supply risks (eg Climate change) to the Basin is working towards the integrated assessment of risks. Along with investigations into the other risks, the Commission has initiated a major multilateral Initiative known as Southeast Australia Climate Initiative (SEACI) to investigate the impacts of climate change and variability on the Basin water resources. The SEACI project will revolve around three themes, current climate regimes, climate change projections and short-term climate forecasting. The climate change projections will be run through an intergraded catchment modelling framework to assess the impacts of climate change along with other risk factors on the Basin water resources. The paper discusses the structured measures taken by the Commission to assess and cope with the risks of climate change and variability along with other risks to water resources.

Quantifying nutrient transport impacts of future climate and regional development scenarios in the Swedish Norrström drainage basin

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Today, water quality management within drainage basins and in associated coastal and marine waters is one of the main environmental concerns in the Baltic Sea Region (BSR). Within listed pollutant Hot Spots for the Baltic Sea in Sweden, reducing nutrient loading remains a major long-term challenge. The Norrström basin is, in Sweden, one of the most important in terms of population (over 1.7 millions) and land area (22 000 km2). Within this basin, the suburbs of Stockholm and its region of influence have spread to more than 100 km from the city and many industries have settled around one of the basin's main lakes, the Lake Mälaren. The water quality of Lake Mälaren is essential for the regional supply of fresh water and for water resources management in the drainage basin of the BSR. Parts of the basin are covered by heavily exploited agricultural areas, which are considered to constitute a main reason for why eutrophication remains a serious problem in many inland and coastal Swedish waters. The Norrström basin includes two of the most eutrophic lakes in Sweden, namely the Lakes Mälaren and Hjälmaren with Phosphorus content above 25 µg/l.

With regard to the considerable stakes in the region and potential additional pressures from climate change and population development, we have used the Norrström drainage basin for a case study, aiming to: 1) assess qualitative and quantitative impacts from climate change on surface and sub-surface water flows and coastal loading of Nitrogen and Phosphorus; 2) estimate potential effects on Nitrogen and Phosphorus emissions and coastal loads of possible future regional development scenarios for population and modifications in life style in a 30-year horizon; and 3) identify critical parameters/processes for modeling of catchment-scale nutrient transport that need further investigation in order to improve knowledge, and model reliability and relevance for use in a water resources management context.

With these aims, we implemented the PolFlow model of catchment-scale water and nutrient flows, embedded in the PCRaster Geographical Information System environment, for quantifying water and nutrient loads in and from the Norrström basin over a 30-year time horizon. We formulated scenarios for changes in water quality and quantity due to climate change and population development, using current climate change predictions that anticipate significant temperature and precipitation increases. Results indicate a mild impact from climate change on surface flow rates, and substantial effects on sub-surface residence times. Different scenarios for possible population development affect nutrients loads slightly. Using source apportionment and sensitivity analysis, we also identify a number of critical model parameters/processes to be further studied, in order for future results to be more reliable and useful in a water resources management context.

Eutrophication problems in coastal and marine waters world wide emphasize the significance, for the scientific community as well as the whole society, of relevant quantification of catchment-scale nitrogen transport from land to coast. In addition to investigating nutrient transport impacts of future climate and regional development scenarios, we compare directly some aspects of different catchment-scale nitrogen budget models, showing that they use and base management recommendations on quite different process representations of and spatial resolution approaches to, for instance, in-stream nitrogen attenuation. By direct comparison of three such different process-resolution approaches to modeling nitrogen loss rates in streams of the same drainage basin, we show that commonly used spatial aggregation of catchment-scale nutrient transport models may lead to different artifacts, yielding different coastal nitrogen impact predictions and practical management implications for the same independent underlying data. We clarify and quantify why such possible model artifacts may be highly important for both the scientific guidance and the practical management of efficient measures for reducing coastal nitrogen loading within drainage basins world wide.

Assessment of the Water Resources Vulnerability of Belarus to the Climate Change

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The most important problem for Belarus is that distribution and quality of water resources are not uniform. Water resources are characterized by a high sensitivity to the climate change.

The territory of Belarus is a watershed for the Baltic Sea and the Black Sea basins. To assess changes of water resources to a climate change, two methods are applied: statistical and water-balance.

The analysis of the precipitation during the last century shows that in the beginning of the last century the output of the precipitation was higher due to the dominant western form of the atmospheric circulation forms.

Warming in the 20s-30s of the last century was accompanied by the reduced precipitation specifically in the western part that led to the runoff reduction and, hence, to negative differences of the Dnieper and Western Dvina rivers' runoff during 1929-1945.

The discharge of rivers for periods with high-wind velocities appeared to be lower than for periods with low-wind velocities. This is explained by the reduced evaporation during periods of low-wind velocities.

Dynamics of extreme discharges over 100-year observation period in different months has been studied for the two big rivers.

Analysis of climatic change effect on the underground water regimes of the biggest rivers has revealed that annual variation in the in the ground-water level has a specific climate-related regularity.

The spring peak is observed from end-May to early-June, and the highest rise in ground-water level is observed in April. In the summer season, it is defined by temperature and precipitation of the previous one-two months. In this case, an inverse relationship with temperature of previous months was revealed – increasing temperature decreases ground-water level.

Analysis revealed the existence of an annual cycle, as well as cycles lasting 3-4 and 6-7 years. It is not possible to identify cycles of a longer duration because of short series of observations.

Asynchrony in variation of major runoff types is characteristic of large Belarusian rivers. The comparative analysis of the medium fluctuations of the river runoff as well as maximum and minimum runoff from 1965-2000 shoes that the increase in the Pripyat river runoff can be explained by the climate change.

The analysis of spectral density of time series of lake levels has revealed availability of a long-period component of 20-30 years for most Belarusian lakes.

A single-humped curve of the annual variation of lake levels with the peak in April-May is characteristic of dry years (1951, 1959, 1964). The double hump curve with peaks in March-April is characteristic of humid years (1987, 1990, 1998) (the spring peak begins 1 month earlier than in dry years), and the second peak is less pronounced and occurs most frequently in fall-early winter.

Warming observed over the last thirteen years has affected the temperature and ice regime of rivers, lakes and water reservoirs in Belarus.

The experiments on models of the Naroch lake ecosystems allow the following conclusions to be made. 1. The lakes with a higher lake area/basin area ratio and minimum mean annual lake levels provide a better indication of the climate change. 2. A mild water heating does not cause significant changes in the system dynamics, and only minor changes in the component biomass and shift in dates of biomass peaks are observed. The effect of heating on weeds is more pronounced in spring and early summer seasons and the replacement of species groups (carnivores by filter-feeding organisms) is observed in the zooplankton community.

The water temperature transition through 4 0C and 10 0C a week earlier than usual was observed for Belarusian water reservoirs, while in fall, the transition through 4 0C and 10 0C occurred 4-8 days later than usual. The same tendency has been also revealed for water temperature of 0.20C. As a result, the ice-free period increased. Rising temperature in the surface layer contributes to early active weed growth period and increases its duration (spring phytoplankton development).

At present nearly 1 million 400 thousand ha have been reclaimed in Polessie region. The drainage reclamation effected both physical and geographical and hydro geological conditions of the area. In addition to ground water recession, drainage has resulted in the reduced radiation balance and transpiration moisture flow.

The drainage reclamation changing the soil water-air regime significantly changes the regime of many rivers. After reclamation, the drainage network density increased several-fold (2.5-4.9), thereby creating more favorable runoff conditions.

Drainage most significantly effect water resources of small watersheds up to 2,000-3,000 km2 in area (due to the reduced total evaporation and drawdown of ground water storage).

When designing climate change influence to the surface water resources, the following scenarios were considered:

Scenario 1 – mean annual air temperature increases by 2 °C compared to the current level with the precipitation remaining unchanged;

Scenario 2 – reduced annual precipitation by 10% with air temperature remaining unchanged;

Scenario 3 – annual precipitation reduces by 10%, while mean annual air temperature rises by 2 °C;

Scenario 4 – Degree of peat formation (through drainage) and percentage of forestry area (through felling) in the watershed area reduce and the river network density (building irrigation and drainage canals) and percentage of tilled area (intensive cultivation of new agricultural land) increase by 5, 10, 20 and 30% of the current ones, with climate conditions remaining unchanged.

The projected climate warming would result in a negative response of aquatic ecosystems as a whole and its components and floodplains, being most sensitive landscapes, would be affected most.

Lake Nasser Management, Integration with Risks Posed by Climate Changes

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Egypt's large and tightly packed population makes the country highly vulnerable to climate change. The 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.

The High Aswan Dam (HAD) proved, since its construction, its importance for mitigating risks posed by water-related hazards and securing Egypt's water supply for achieving food security. Over the past years, consecutive droughts and high floods occurred, the water levels in Lake Nasser have reached its lowest and highest. The low and high reservoir levels have been caused by a sequence of dry and wet years. In the eighties period, the HAD level reached its lowest, and without having a strong hazard backstopping system, Egypt would face a serious drought problem. During the high flood years (during the nineties), the level in the Lake reached its highest water had to be spilled to the TOSHKA depression and the Nile. Without having a robust system that can mitigate the impacts of different risks, the water availability and food security in Egypt would be danger.

The impacts of global warming on the Nile basin precipitation patterns are examined. Annual historical data sine 1900 is analyzed at different areas on east, west, middle and upper Nile areas. Also, the relation between rainfall and temperature at different regions on the Nile is checked based on historical available daily Mean Areal Precipitation (MAP) and temperature data. A relation between temperature and precipitation over the Blue Nile basin has been developed. In addition to that, different emission scenarios studied and some of them chosen to be an input to scenario generator model, MAGICC & SCENGEN. Also, 16 GCMs are checked and four of them are used to study the impacts of climate change on the precipitation and temperature changes on the Nile basin. To this end, the long-term anomalies (till 2030) of precipitation changes due to global warming are generated at different regions based on the developed relation and the outputs of the scenario generator.

To study the sensitivity of different catchments to precipitation changes, the hydrological elasticity has been calculated using the Nile Forecast System (NFS) hydrologic model and it is found that the hydrological elasticity of the White Nile is the lowest and the Blue Nile at Khartoum is the highest. The changes in precipitation developed from climate models have been used as a multiplier to historical monthly precipitation and these data are disaggregated using statistical downscaling to daily precipitation and used as input to the hydrologic model to simulate the impacts on runoff.

The main findings of this study indicate that the global warming will have higher impacts on the precipitation rates over the Blue Nile basin than the impacts on the White Nile basin. The study also indicates that there will be shifts on precipitation season at different areas over the Nile basin.

The study indicates that there will be precipitation change on the Blue Nile and the White Nile precipitation over the next three-decades. These changes in precipitation have been simulated using a distributed conceptual rainfall runoff model to study the impacts of these changes on the inflows to High Aswan Dam (HAD) then lake Nasser simulation model have been used to simulate the performance of the lake over the next three decade due to these changes.

The main findings of the study indicate also, that the inflow to HAD will change. These changes will lead to change of the operation of HAD, that have been simulated and the results shown that there should be a change in the way of operating HAD.

Climate Change impact to the Water Resources of Eastern Caucasus (Kura basin) Rivers and ways of its mitigation.

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The objects of this study are climate change impact assessment to the water resources of Kura river, its tributaries Araz and Ganikh (Alazan)and local rivers which fall directly into the Caspian Sea, determining of ways of mitigation of Climate change ant its negative impacts to forming of the Kura basin rivers water resources.

Kura with its vast river system is the key water provider or, as hydrologists say, is the main water artery of the Caucasus. The researches shows that total water resources of Eastern Caucasus rivers (The Kura basin rivers and directly falling into Caspian Sea rivers , including the Samur and Astarachay rivers) make up 31.5 km3.

At present water resources of Kura and Ganikh in Georgia and water resources of Araz in Turkey, Iran and Armenia in result of water intake and partly in connection with negative impact of climate change are decreased by 20% as a result of water intake. Also by taking into account of water losses for different reasons from the channel (river-bed) of Kura river lower course, one may find that available at Azerbaijan Republic water resources of Eastern Caucasus at present is less than natural ones by 30 %.

Climate change impact assessment on run-off of Eastern Caucasus rivers is given in this work. The spatial-temporal assessment of changes of the run-off, temperature and precipitation over the river basin has been undertaken. In accordance with GISS and GFDL-3 climate change models and a scenario with regard to an air temperature increased by 2 degrees, an appropriate model was developed to assess the change of annual and seasonal values of water discharges and the ecological flow of rivers under the climate change.

Results of this work show that annual and seasonal water resources and ecological flow of Eastern Caucasus rivers may in all three of given climate change models decrease by 20% with an air temperature increase.

Identification of adaptation fusibilities of water resources to remove negative consequences of climate change is the final stage of quantitative assessment of vulnerability. Basic task of this stage is to identify feasible adaptation measures, which should be realized with purpose to prevent climate change consequences and to contribute stable development of the country. It is shown that without measures of adaptation will be an arid situation under all climate change scenarios and a more difficult situation by GFDL-I scenario, that is where water resources may be reduced about by 40 %.

In this case the most vulnerable will be energy, agriculture sectors, provision of population with fresh water and ecological conditions of rivers. For different branches of economy climate change impact assessment carried out and ways of its negative consequences mitigation were been determined. Several adaptation measures are given .

As one of ways to execute necessary adaptation measures to facilitate water resources management in condition of water deficiency it is prepared some project proposals directed to increasing of forest areas in the basins of small and large rivers and creation of water protection zones and water reservoirs(which may also be used for production of hydro energy instead of thermal power plants). The amounts of underground waters have also been indicated for use in different region as sources of safe drinking water. Available for use in this purpose capacity of which makes up approximately 25-30% from surface waters.

Others relates to decreasing the water losses through improvement of water supply and distribution system and use of modern technology, adoption of measures on use of water recycling and treatment practices, increasing of efficiency of water use, transfer to integrated water resources management on the basis of ecosystem approach.

Implementing of mentioned measures may play positive role for decreasing the negative impact of climate change to water resources of the basin.

Use of hydro energy potential of rivers lead to decreasing of use of fuel(mazut) for production of energy by thermal power plants, resulting with decrease of emissions of greenhouse gases into atmosphere . Actually thermal plants are located at large cities and there are huge energy losses during its production and dissemination, in result of use of up to date technology. Most of rural areas may more effectively produce hydroenergy resources of nearest rivers rather than use energy of remote thermal power plants.

For the Alazan pilot river basin is calculated the degree of decrease of CO_2 emission in the case of use of hydro energy resources of the basin instead of thermal energy(mazut). Results of research show that in this case we will not have such amounts of losses of energy occurred during transportation of thermal energy from power plant located at distance about 300 km and because of bad condition of disseminating system. Produced hydro energy will be transmitted to nearest residential areas located at the basin of the river. Effective use of hydroenergy potential of region may approximately halve the use of fuel(mazut) and lead to mitigation of amounts of CO_2 emission from the energy sector of the region.

Evaluation of Long Range Flow Forecasting possibilities in the Brahmaputra-Jamuna River using El Nino/Southern Oscillation (ENSO)

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Brahmaputra-Jamuna is one of the largest rivers in the world ranking fifth in terms of discharge and is occupied by some underdeveloped countries like Bangladesh. Bangladesh is primarily a flood plain country. Growth in population and extensive developments in the flood plains have changed the flood risks and made the country increasingly vulnerable to major losses during large floods. The nature of flood hazards in Bangladesh is such that it is not possible, both economically and technically, to take on solely structural mitigation approach. Moreover many non-structural measured are considered unsuitable for Bangladesh. These include flood plain zoning, compulsory acquisition of flood prone land, relocation etc. Flood forecasting and warnings are seen as the key elements in disaster preparedness, which in turn will reduce flood damage and human sufferings to a great extent. With a start in 1960, significant efforts have been made for the improvement of flood forecasting system. But unfortunately, still flood forecasts are limited to issuing short time forecasts of water levels with respect to a danger levels at small number of points in selected river.

The aim of this paper is the assessment of long range flood forecasting possibilities using the El Nino Southern Oscillation index. The El Nino/Southern Oscillation is the dominant pattern of short-term climate variation, and is therefore of great importance in climate studies. Some recent studies show the teleconnection between stream flow of different rivers and the El-Nino Southern Oscillation (ENSO cycle).This paper presents an overview of the relationship between ENSO and stream flow in the Brahmaputra-Jamuna and the potential for flow forecasting at least in part. The seasonal forecast of stream flow is very invaluable to the management of land and water resources, particularly in Bangladesh to improve the predictability of severe flooding. The analyses show that dry conditions in these rivers are associated with El Nino events while the wet conditions are related to La Nina events. Moreover it is found that the wet season flow (Flow of July-August-September) is linked with the sea surface temperature (SST) of July-August-September (of) of that year. For individual months strong correlations are found between flows and of sea surface temperature of equatorial Pacific Ocean. of one or two month lag. As the peak flow is primary concern of flood forecasting, so it will be very helpful if a forecast model can capture the teleconnections between wet season flow and predicted SST of that time. Using several ENSO forecast model (Like General Circulation Model, Markov model etc) it is possible to forecast coming El Nino and La Nina episode and sea surface temperatures with a lead-time of one year for equatorial Pacific Ocean. So possible teleconnection between ENSO and stream flow may improve the forecasting lead-time while the hydrologic forecast through rainfall-runoff modelling could provide a lead time of the order of the basin response time, which is several days or so. This short time is not sufficient enough for flood preparedness. Another problem of traditional flood forecasting system of Bangladesh is unavailability of adequate and authentic data of upper riparian countries. This problem can be mitigated through this ENSO based Statistical Forecasting system as it does not require rainfall or other climatological data from upstream countries. This forecasting system requires predicted sea surface temperature data and river discharge data of the previous years. With a forecasting lead time of few months to as long as one year, this ENSO based forecast model will be extremely helpful for flood prevention, preparedness, response and recovery. As the Ganges –Brahmaputra river basin is one of the most populous river basins of the world and is occupied by some of the world's most underdeveloped countries like Bangladesh, any reduction in the uncertainty about the flood in the Brahmaputra-Jamuna River would contribute a lot to the improvement in flow forecasting as well as to the fate of people.

Vulnerability to Flood Hazards: Adaptation and Coping Mechanisms in Two River Basins in India and Nepal

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Presentation of topic and analysis of issue:
Global climate change can increase frequency and magnitude of extreme weather events such floods and droughts. Particularly vulnerable are the developing world economies, which do not yet possess the necessary infrastructure to cope with the impacts of these calamities. One such extremely vulnerable zone is the Pakistan- India- Nepal- Bangladesh belt of South Asia. Population of these countries is extremely vulnerable to flooding and drought hazards. It is therefore necessary to build up the coping capacity of the population in the region in order to reduce their vulnerability to such climatic disasters. Thus country-based studies have been undertaken to with funding from the Asia-Pacific Network for Global Change Research (APN) and the Hansen Institute for World Peace, San Diego State University, USA to analyze the existing conditions and adaptation/coping measures adopted in these countries. The ultimate objective of these individual studies, which are a part of an aggregate overall South Asia scenario development process, is to prescribe means to generate a stronger coping potential to extreme events in these economies.

This paper focuses on vulnerability to flood hazards and associated adaptation and coping mechanisms in the selected hydrological units (SHUs) or hotspots in two river basins in India and Nepal. The selected SHUs were the Mahanadi delta in eastern India and the lower Bagmati watershed in Terai in Nepal. Household surveys and PRAs (Participatory Raid/Rural Appraisals) were conducted in the hotspots to understand the current impact, vulnerability and adaptation to floods. This analysis is imperative to devise measure to improve adaptation and thereby reduce vulnerability in future thus ascertaining future well-being of the people.

Discussion of Results/Findings:
Vulnerability: Poor agricultural communities are extremely vulnerable to hydrological calamities like floods. The severity of damage is further enhanced in the three selected SHUs due to the lack of proper flood forewarning systems. Thus the population is often caught unprepared. Floods extensively damage standing crops, property, grazing ground for cattle, affect drinking water supply and in general cause huge loss of agricultural and livestock productivity. The food security of the flood affected zones is endangered. Loss of livelihood, human life, livestock and outbreak of waterborne diseases like cholera, diarrhoea, jaundice, typhoid and other infectious diseases are common during floods. Beside private property, floods (and accompanying landslides in hilly terrains) cause extensive damage to public infrastructure like road and rail links. To safeguard against these impacts, the population in each of the three SHUs have undertaken adaptation measures that enable them to better cope with these calamities.

Reactive Adaptation Measures: In the Mahanadi flood plains, the farmers have changed the cropping pattern to reduce flood damages. In the flood prone Nayagarh district, the farmers usually cultivate Champeswar – a local variety of paddy tolerant to water stagnation. It can sustain almost seven days submergence with only 50% crop damage. If however, the water stands for more than ten days, the entire crop is lost. The seeds are generally available from Government depots or have been individually stored using traditional means of storage. The reduction in the supply of agricultural output causes the price of essential commodities to rise. However, the presence of government administered fair price shops in all the villages, somewhat undermine the worst effects of floods and avoid food scarcity. To cope with the adversities of income loss during floods, the most common strategies are to maintain contingency funds or undertake extensive borrowings. The loans are often taken from the informal sector comprising of friends, relatives and local moneylenders. Undertaking labour work in unaffected neighbourhoods or migration in search of jobs is also prevalent. To save property, construction of flood resistant houses or walls round the dwellings is also common. Investment in sheltering materials like polythenes is also undertaken. However, the most popular individual initiative coping method followed is storage dry foodstuff, grains and medicine during normal times to use during floods. Some report on crop insurance has also been obtained. Institutional support in the form of government support and NGO aid is also forthcoming during floods. These aids generally complement the support received from the informal sector. Food relief constitutes the major share of all forms of institutional relief. Aid in the form of clothes and seeds are also adequate. The government also provide seed aid to support future agricultural activities. However, monetary loans are not much forthcoming.

The survey indicates that during floods, on an average the price of the staple food rise by 28 % in the Bagmati hotspot in Nepal. Thus flood inflicts severe economic stress upon the people living in this flood prone area. To cope with such adversities, the stakeholders of the Bagmati watershed have adopted various coping mechanisms. To avoid agricultural productivity loss, plantation of flood tolerant paddy, sugarcane and banana crops are common in the flood prone areas of the region. Evacuation of people, livestock and other essentials; seeking of temporary shelter; and cash loans; clothes, seeds and building material aids from the relatives, friends, villagers, government and the relief agencies are the common conventional methods of coping actions as emergency measures by an individual household. In preparedness for flood, households construct wooden benches above the expected flood level. Dissaving, storage of food, clothes, medicine, plastic sheets etc. are also undertaken. To supplement income loss, loans, extra wage labor, land mortgage, and sale of property are also undertaken. There is also person to people warning system for imminent floods. This system is based on the weather forecast, information on rainfall intensity and water level of the Bagmati River in Kathmandu, and cloud condition in the upper catchments of the river. In addition, dismantling house structure and emigration are other means of adjustment.

Influence of climate warming on hydrological regime of lakes and reservoirs of Belarus in the years from 1988 to 2002

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For an assessment of climate warming influence on hydrological regime of lakes and reservoirs the data from 14 lake stations having 35–75 year time series were used.

Increase in air temperature by 1.1îÑ during the last 15 years (1988-2002) and a specific air moisture regime in Belarus have caused the changes of course of the basic processes in lakes and reservoirs, in particular, in thermal, ice and hydro-chemical regimes. Dates indicating seasonal variations in water temperature Dates of crossing of water temperature through the certain thresholds (+0.2, +4 and +10°C) have significantly changed in autumn and in spring during 1988–2002. Within the last 15 years spring phenomena occurred before the average terms. Dropping of water temperature below 10, 4 and 0.2îÑ in the autumn was not so unambiguous in the study period.

In the study period, the crossing below 0.2îC took place earlier than average, despite of the tendency for lengthening of the ice-free period. In the previous period, the date of dropping of water temperature below 0.2îC took place in the third decade of November through the second decade of December. For the last 15 years the date has shifted earlier, on the average, by 7 days. Surface layer water temperature The most significant deviations from the long-term average values were observed in springs. The mean water temperature in April in the observed lakes and reservoirs of Belarus during the study period was 1.6 °C higher than the long-term average. In the following, monthly air temperature and water temperature anomalies were compared. Air temperature in May for the period 1988–2002 was a little bit below the long-term average (0.2°C) while the water temperature in lakes was higher by 1.1°C.
Deviations of water temperature for summers averaged 0,4 - 1,3îC for the period of 1988-2002. In October, anomalies of water temperature of +0.3îC were observed, while anomalies of air temperature were +0.1îC. The water temperature in the first decade of November preserved a positive anomaly of 0.3°C while in the second and a third decade negative anomalies of --0.2 …--0,1°C were registered.
As the shift of a winter nucleus to the beginning of winter is characteristic for at least a half of years of the study period, more than 50% of cases of ice phenomena on lakes were observed in December. Evaporation In connection with air temperature increase, ice-free period lengthening and increase of surface layer water temperature during 1988-2002, it would be interesting to look how these changes were reflected in evaporation from lake surface, for example of Naroch lake. The rise in surface layer water temperature by 0.9-2.4îC for the last 15 years has caused an increase in the annual evaporation from a water surface. Annual evaporation during 15 years averaged 602 mm which is 71 mm higher than in the previous period. Ice regime Related to air temperature increase, beginning and end dates of ice phenomena have changed, as well as ice cover freeze-up and break-up dates. During the last 15 years the beginning of ice phenomena on the majority of lakes and reservoirs in Belarus was observed 1–5 days earlier than in previous period. Dates of freeze-up beginning on all lakes and reservoirs were registered, on the average, 6 days earlier. During 1988–2002 ice cover break-up, end of ice cover period and clarification from ice on lakes were observed 14-15 days ahead of multi-annual mean dates.
Ice thickness regime has changed. The average value of the maximal ice thickness on lakes became lower than long-term average by 13 cm during the warming period.

As a result of the warming of the last 15 years the shortening of the ice cover period in average by 11 days and the lengthening of the ice-free period in average by 15 days became characteristic for lakes and reservoirs of Belarus. Hydro-chemical regime The change in air temperature, which induced the increase of surface level water temperature; the shift of dates of crossing by water temperature of the thresholds of 0.2, 4 and 10°C; and the resultant lengthening of the ice-free period contributed to early entry of aquatic plants to the phase of active growth (or spring phytoplankton development) and the lengthening of the active growth phase. The moderate water warming does not produce significant changes in dynamic of aquatic ecosystems; only minor changes in biomass quantity and in dates of biomass quantity peaks take place.

Resume
1.Climate warming in the end of XX century was reflected on thermal, ice, water level and hydro-chemical regimes of lakes and reservoirs in Belarus. 2.Water temperature at a shore zone and surface water temperature have increased. 3.In 1988–2002 dates of crossing by water temperature of the thresholds of 0.2, 4 and 10°C in spring and autumn were changed considerably. This influenced the regime of emergence and destruction of ice phenomena. 4.Evaporation from water surface has increased during 1988–2002 as a result of the increase of air temperature, the increase of a surface layer temperature and the lengthening of ice-free period. 5.The change in air temperature, which induced the increase of water temperature; the shift of dates of crossing by water temperature of certain thresholds have changed the length of vegetation period in lakes and reservoirs, which produced changes in biomass quantity.

Flood Hydrograph Reconstruction Approach For A Tidal Sarawak Kanan River

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Sarawak Kanan River is one of the tidal rivers frequently affected by flood in Sarawak, Malaysia. As common to most tidal rivers, especially in the high rainfall monsoon region, the river is vulnerable to any variability due to the effect of climate changes. Over the years, development has been concentrated in the middle valley town of Bau, where it is the center of administration and the commercial center for the district. The town of Bau and surrounding area is a well-known flood prone area, for it is geographically located in the floodplain of Sarawak Kanan River.

Recently, major floods of February 2003 (with rainfall return period of 50 years order) and January 2004 (with rainfall return period of 100 years order), had Bau and surrounding area flood-stricken. Thousands of people were affected, and a lot of property damaged. These two extreme events in two consecutive years could have been an indication of changes in frequency distribution due to the effect of climate change.

The Department of Irrigation & Drainage (D.I.D.) Sarawak is the regulating body that monitors the hydrological data in the Sarawak Kanan River system. Being a tidal river, there are 2 river gauging stations in Sarawak Kanan River, namely Buan Bidi station and Siniawan Station. Buan Bidi gauging station is located upstream of Sarawak Kanan River far beyond the reach of tide, measuring the water level and river flow through a developed rating curve equation. Siniawan gauging station is downstream, measuring only the water level. In between these two stations laid the town of Bau and several kampongs (villages) with a total population of about 42,000 people. The area is left with little hydrological information to ponder with, thus indicated a need to reconstruct past flood events to have a better explanation of the flooding scenarios in the mentioned area.

As a flood-prone area that has already developed, it is not conceivable to leave the river systems in Bau area untouched. Reconstruction of flood hydrographs on the Sarawak Kanan River is essential to provide protection, control and decision support system for future development.

For this purpose, the Sarawak Kanan River and its floodplains were modeled using one-dimensional hydrodynamic modeling approach, with inputs of the observed hydrograph of upstream Buan Bidi sub-catchment and the lumped synthetic hydrographs of un-gauged tributaries basins. Due to the data availability, the approach used was to serve as a useful indicator of flushing performance of Sarawak Kanan River rather than to build a complete predictive model along the river stretch.

InfoWorks River Simulation (RS), a Wallingford Software model, coupled with its embedded Geographic Information System (GIS) application had been used in this study to capture the hydraulic response of the Sarawak Kanan River and its floodplains in those two extreme flooding conditions. The focus area for modeling is a stretch of Sarawak Kanan River from upstream Buan Bidi to the downstream small town of Siniawan. The length of river stretch is about 23 km, where 5 points of un-gauged inflows are coming from a total of 295 sq-km catchments areas.

This paper outlines the methodology for reconstructing the flood hydrographs of an un-gauged stretch of Sarawak Kanan River. It appears that for most situations, which were simulated for model validation in this river stretch, the approach and InfoWorks RS one-dimensional model provide acceptable accuracy in the computation of magnitude and timing of flows. The paper also shows the used of adopted approach and modeling parameters for simulation and studying the effect of worst-case condition of probable maximum precipitation event. The result provides information of which areas that will be affected, depth and the duration of the extreme flood. This information is important input in dealing with the variability of the expected disaster in extreme events due to the climate change.

Climate change, urban flood, and adaptation for Dhaka City

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Issue: According to the latest IPCC projections, the average global temperature may increase by 10C to 50C by 2100, leading to changes in mean precipitation and sea level globally. Bangladesh – a low-lying delta with a long coastal belt – is particularly vulnerable to the impacts of climate change. It may face more frequent extreme events such as floods and drought, and as much as 11% of the country may become permanently inundated due to sea level rise.

The impacts of climate change may be very serious in rapidly growing urban areas. By 2050, more than half of the population will be living in urban settlements and the government is committed to protect major urban centers due to their economic significance as part of the national water policy. In this regard, flood protection embankments have already been built around major cities such as Dhaka, Chittagong, Rajshahi, Comilla and so on. Among these, Dhaka City, as the capital of Bangladesh with about 10 million inhabitants, has received the highest priority. The Dhaka Integrated Flood Protection Project (DIFPP) was prepared as part of the Flood Action Plan (FAP) studies after the devastating flood of 1988. By 2004, about one half of the project has been completed that protects the western block of the city.

However, the original DIFPP did not take into account the possible impacts of climate change on urban flooding. As such, the existing embankments may turn out to be inadequate if the floods induced by climate change exceed the design flood in future. In this backdrop, this study will analyze the potential impacts of climate change on the intensity of flood in Dhaka in the years 2030 and 2050, and suggest possible adaptation and mitigation measures.

Methodology: In order to assess these impacts, mathematical models (e.g., GFDL 01, Geophysical Fluid Dynamics Laboratory, 1% transient model) have been used to generate projections on climatic parameters for 2030 and 2050. These climatic parameters are superimposed on long-term trends of observed data for several hydrologic stations within Bangladesh to develop country-specific projections. The parameters are then used to develop flood hydrographs at three locations in the Ganges-Brahmaputra-Meghna system. Rating curves at these locations are used to estimate corresponding water levels, which along with the projected sea levels, were used to derive the boundary conditions for the rivers surrounding Dhaka City. Finally, the boundary conditions, contribution of the internal runoff, and information on the existing flood protection embankments have been incorporated in the scenario analysis.

Findings: As per GFDL 01 based simulations, following changes have been predicted: the mean seasonal temperature may increase by 0.70C (2030) to 1.10C (2050) in the monsoon, and by 1.30C (2030) to 1.80C (2050) in the winter. Similarly, the precipitation is expected to vary by +11% (2030) to +28% (2050) in the monsoon, and -3% (2030) to –3.7% (2050) in the winter (base year is 1990). In short, both the monsoon and the winter are likely to become more extreme as a result of climate change.

The predicted climatic variables have been linked with the peak discharge and runoff volumes of the Ganges, Brahmaputra and Meghna rivers to develop hydrographs at specific locations. The discharge hydrographs at these locations show that the maximum water level will cross and remain above the danger level for 20-30 days, which is a significantly worse flood situation compared to 1990.

The worsening of floods in major rivers will make Dhaka City more vulnerable by increasing water levels in the rivers surrounding the city. This potential danger in term of increased flood level has been estimated with the help of rating curves and correlation analysis. The analysis has incorporated the additional impact of discharge due to pumping of rainwater from the city.

The average existing embankment height in the west part of the city is 9.4m. The projected peak water levels indicate that in all parts of the city, floodwater will overtop the existing embankment by 0.22m in

2030, and 0.35m in 2050. In other words, to provide adequate protection against flood in 2050, height of the existing embankment will have to be raised by about 1.0m. In addition to protecting the city from external floods, adequate pumping capacity has to be installed to protect the city from water logging caused by more intense monsoon. Presently, the total capacity of the existing pumping stations is about 60 cumec, which has to be increased to 70 cumec by 2050 based on 7-day average design rainfall. The capacity requirement is much higher for 2-day average design rainfall – the cumulative capacity should be 105 cumec in 2030 and 120 cumec in 2050.

Recommendations: The height of the present embankment need to be raised by about 1m to guard against the increased flood water level. The water logging issue may be addressed by increasing the pumping capacity, and reclaiming the lakes and canals of the city. In addition, better flood forecasting, enhanced internal drainage and prompt inter-agency co-ordination will improve the overall flood management of the city.

The Recent Northern Hemispheric Drought: Implications for Drought Mitigation and Transboundary Water Flows

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Improved knowledge of the relationship between climate variability, terrestrial ecosystem activity, and watershed hydrology is important to understand the changes in spatio-temporal patterns of hydrosphere-biosphere-atmosphere interactions that may arise from climate change. In particular, future climate perturbations are likely to result in substantial global and local changes in precipitation regimes. As a consequence, exchange processes at the biosphere-atmosphere interface may have long-term impacts on watershed hydrology including water availability for domestic, industrial and agricultural use as well as transboundary water flows.

Global climate in recent years was characterized by a period of geographically extensive and prolonged drought episodes in the Northern Hemisphere, which limited moisture availability for plant growth, and affected terrestrial ecosystems primarily in central southwest Asia and North America. These changes is biospheric activity are associated with perturbations in the ocean-atmosphere circulation system arising from fluctuations in sea surface temperatures. Because of the potential sensitivity of the global hydrologic cycle to climate change, this period of extreme drought provides a unique natural experiment to help scientists understand how perturbations in the ocean-atmosphere system affect water flows, terrestrial ecosystems, and by extension, transboundary water budgets, agricultural production and food security of entire countries.

At global scales the response of vegetation to climate perturbations has been widely observed using satellite-based measurements of normalized difference vegetation index (NDVI), which is proportional to the amount of photosynthetically active radiation absorbed by vegetation and indicative of terrestrial ecosystem productivity.

In the first part of this work, we hypothesized that observed patterns of reduced plant growth between 1999 and 2002 were related to a recent hemispheric-scale drought caused by anomalies in global sea surface temperatures. To test this hypothesis, we examined (1) spatio-temporal correlation between 1981-2002 NDVI time series produced from National Oceanic and Atmospheric Administration (NOAA) Advanced Very High Resolution Radiometer (AVHRR) data and global precipitation, and (2) the link of principal modes of precipitation variability with sea surface temperatures.

The analysis shows that satellite-based observations of NDVI reveal large and geographically extensive decreases in vegetation activity in Eurasia and North America between 1999 and 2002. In 2001, 73% of central southwest Asia exhibited NDVI anomalies that were more than one standard deviation below 21-year average conditions, and in 2002, fully 95% of North America exhibited below-average NDVI. Spatio-temporal dynamics of NDVI, precipitation, and sea surface temperature data reveal that synchronous patterns of ocean circulation anomalies in the Pacific, Atlantic, and Indo-Pacific are strongly correlated with observed joint variability in NDVI and precipitation in the Northern Hemisphere during this period.

In the second part of the analysis, we estimate the impact of the hemispheric-scale drought on surface runoff and transboundary water flow using empirical models. Specifically, runoff was estimated from a combination of weather station and satellite data and calibrated against observations of river discharge where available. The resulting runoff fields are then used to estimate water balances for major watersheds of the Northern Hemisphere as well as transboundary water flow. The results have important implications for the mitigation of widespread and synchronized patterns of drought impacting entire regions at the same time.

Understanding Water-Related Disaster Through Geohazard Survey and Assessment

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The Philippines is considered one of the most beautiful country in the tropics. However, because of its geographic location within the circum pacific rings of fire, it has become highly vulnerable to natural disasters that are geologic in nature such as earthquake, volcanic eruptions, as well as climatic variability causing tropical cyclones and floods. Because of this, the Philippines has to contend with geological hazards (or geohazards) most of the time. Geological hazards or geohazards are natural hazards which result from geological phenomena. These could be endogenous in origin (such as earthquake and volcanic hazards) or exogenous in origin (such as mass movement or landslide, floods, accelerated erosion and drought.

In the 2004 global report of the United Nations Development Programme (UNDP), the Philippines ranked as the third in terms of number of people exposed to earthquake and tropical cyclones annually. Uncontrolled human activities such as settlements in the flood plains, urban congestion and development activities in the uplands have exacerbated the impacts of natural hazards.

The 2003 landslide in Panaon Island in Southern Leyte and in Surigao City has prompted actions for the need to address geohazards including water-related disaster through the conduct of a systematic geohazard assessment and mapping of areas susceptible to such phenomena. Both Southern Leyte and Surigao City were located in that part of the country which are subject to extreme rainfall condition that often trigger mass movement or landslides and flashflood. While the threat of landslide and flashflood in these areas may have subsided at present, the instability of these and other contiguous areas due to its geologic composition and the amount of rainfall it receives remain and would continue to pose threat to the local population. It has become imperative that a systematic geohazrd assessment and mapping be conducted to identify unstable sites so that appropriate measures can be instituted. As a tropical country with an annual rainfall of more than 2,000 mm, the Philippines has to live and cope with the reality that water which is the most important element in life is also a major threat to the lives of thousand of Filipinos.

To address problems of geohazard, especially those that are triggered by water in the form of excessive rainfall, a study on the development of a mitigation scheme for geological hazards was undertaken by the Department of Environment and Natural Resources (DENR) as part of the Environment and Natural Resources (ENR) Shell Programme which under the auspices of the United Nations Development Programme (UNDP). The study which was implemented in March to December, 2004 and intended to generate information on the vulnerability of portions of the pilot areas to natural hazrds like landslides, flooding, subsidence, coastal degradation, tsunamis, earthquake and similar geologic events, and make these information available to decision makers, planners and other national and local authorities. These information can well provide basis for land use planning and development and more importantly for disaster management and risk mitigation. The study was also designed to better prepare local communities to manage and cope with disasters and risks related to geological hazards. The approach adopted involved the characterization of various events in terms local conditions (past occurrences of landslides, flash flooding, subsidence) together with the identification of areas or sites susceptible to different geologic and water-related events. The main concerns of the project were flooding, rain-induced landslides and other mass movements, subsidence, ground instabilities and coastal storm surges. Furthermore, actual flooding surveys and landslide inventory were also conducted with the communities as provider of information. These were done using survey questionnaire and checklists

The project necessitate the use of Geographic Information System (GIS) to collect, manage and analyze data in order to come up with the geohazard maps. There were six regional pilot areas selected on the basis of landslide and flooding events being experienced as well as criteria such as population and extent of growth and level of economic development. The selected pilot areas for the study were Easter Rizal, Panaon Island, part of the Naga and Legazpi City, the Cagayan de Oro-Gingoog coastal strip, part of Tagum and Davao City as well as part of Surigao and Butuan City.

The final outputs of the project were geohazard susceptibility maps of the pilot areas of the scale 1:50,000 and 1:10,000. The plan is to complete the geohazard mapping of the whole country in the next 2 years. From a macro planning perspective, the geohazard maps produced by project provided immense value to policy makers, land use planners, investors and agencies involved in disaster management and risk mitigation, urban planning, housing development, and land use planning. These maps are now used as basis for comprehensive land use planning, in the issuance of zoning regulations and in the preparation of a national disaster management framework and plan. By carefully considering the susceptibility of certain areas to particular geologic and water related hazards, the government can come up with safe and realistic programs for disaster management, risk mitigation and land development. Thus, ensuring disaster and risk preparedness at the same time minimizing damages to life and property. It is of utmost importance that geohazard survey and assessment be considered as one of the solutions to address and cope with water related hazards and climate variability brought about by climate change.

Impacts of Climate Change on Design Floods for Dam Safety in Sweden

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Since 1990 new guidelines for hydrological design of the Swedish hydropower system is being implemented. The technique is based on a critical combination of extreme precipitation extreme snowmelt and an operation strategy for multi-reservoir systems. Hydrological modelling is a central component, as is a prescribed design precipitation sequence.
At the time when the guidelines were developed it was not possible to account for possible consequences of a changing climate. This has, however, been considered a potential threat in the light of recent development of the climate issue.

A project "Sensitivity analysis of the Swedish dam safety guidelines", with joint funding from ELFORSK and the dam safety authority (Svenska Kraftnät), has been initiated aiming at analysis of these new risks. Similar studies are being conducted also in Finland.

The question of how climate change will affect the Swedish hydropower system is very complex. To simplify the analysis some constraints have been applied, for example the operation of the system is assumed to be the same as in present climate, i.e. the reservoir levels are lowered before the spring flood, which is used to fill up the reservoirs. Additionally the analysis will focus only on high hazard dams, which are characterised by significant risk to life, considerable risk to infrastructure and sensitive environments.

No attempts to change the methodology as described in the guidelines from 1990 will be made, only changes to adjust them to a climate as suggested by regional climate models. The sensitivity analysis will be based on four different regional climate scenarios from the Rossby Centre Atmospheric Ocean model (RCAO), forced by boundary conditions from two Global Climate Models, HadAM3H and ECHAM4/OPYC3, and two emission scenarios, SRES A2 and B2. The scenarios correspond to the time 2071-2100.

The sensitivity analysis will to large parts focus on changes to the 14-day design precipitation sequence. Preliminary results suggest that the largest daily precipitation can increase by as much as up to 35% in some parts of Sweden. The dam safety guidelines also include a seasonal correction on the design precipitation sequence to account for that convective precipitation (high intensity) does not occur throughout the whole year. This seasonal correction will be analysed and most probably adjusted since a warmer climate makes larger parts of the year exposed to convective precipitation.

In addition to changes of the design precipitation sequence, the snow storage is lifted to the 30-year level before the spring snowmelt and the soil moisture deficit is set to zero, i.e. saturated soil. Instead of using the 30-year snow storage from present climate conditions, a new level will be calculated using scenario climate data as input for the impact simulations.

When these modifications have been implemented to the guidelines, simulations will be performed for four important Swedish dams and one of the large lakes.

The project is to be finalised in 2005 and the result will be reported as an ELFORSK report and in a scientific paper.

Global Change and the Effects on Industrial Water Use in the Catchment Area of the Upper Danube

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Water affects all social, cultural, economic and ecological aspects of our daily life and forms the basis for functioning material cycles and therefore a clean and stable environment. As a consequence of the limited view of the world individual scientific disciplines aren't able to describe the complex connections and reactions between nature in general, water in particular and men. They cannot develop sustainable development under changing boundary conditions. In the context of Ecological Economics and the discussion about Sustainable Development therefore inter- and transdisciplinary science is often claimed. For this in the last years diverse research projects have been arranged, particularly to overcome the problems of conjoint research of social and natural science. Major difficulties of combined research are thereby often the different scales for room and time.

To ensure the integration of socio-economic aspects and natural sciences for a sustainable use of water resources within the framework of the project GLOWA-Danube researchers of mire than ten sciences have gathered. The overall aim of this project is to develop and validate integration tech-niques, integrated models, and integrated monitoring procedures for the functional type of a catchment in mountain forelands of the humid latitudes and to implement them in the network-based integrated environmental Decision-Support-System DANUBIA. The single models contain the major physical and socio-economic processes that are essential to model the water fluxes in mountain-foreland situations. They are regionally transferable and applicable for a wide range of catchements. The models of the project are exemplarily adjusted to the Upper Danube Basin, which covers an area of approximately 80,000 km², mainly including parts of Bava-ria, but also smaller parts of Baden-Wurttemberg, Austria and Grisons in Switzer-land. In this catchment area many water specific problems are exemplarily bundled (for example vulnerability as a result of climate changes, up- and downstream con-flicts, water quality and environmental protection).

The integration of the different disciplines is based on informatics. An essential attribute of DANUBIA is its modular and object-oriented concept. Based on the meta-programming language UML it is possible to define general interfaces between the singular expert models and interchange information and data between them. Socio-economic disciplines (environmental economy, environmental psychology, agricultural economics, water management and tourism science) are thereby bundled in the object "actors". They are linked with each other by single interfaces and connected with the natural sciences, which are also thematically bundled, with a joint interface called "Actor-Controller". Thus socio-economic data can be transferred to the models of the natural sciences and vice versa.

The part of the ifo-Institute in this interdisciplinary project is the development of the economic component of DANUBIA. The main aim amongst other things is the modeling of industrial activity and water use. For this the economic model RIWU (Regional Industrial Water Use) has been developed. Using data from official statistics from the year 1995 the regional economic model was estimated for administrative districts.

But within DANUBIA results on the level of administrative districts are problematic. To allow for a preferably simple exchange of data between the models by the UML-interfaces the so called Proxel (Process Pixel) as a consistent sacling within DANUBIA was defined. One Proxel is equivalent to one square kilometer. This grid solution ensures that the different scaled results of the single models are available at a consistent and comparable level. The spread of scale of the individual models goes from a few square meters to several square kilometers or administrative units and vectors. Due to the concept of the Proxel the results of all these different scales have to be converted to Proxel values. The basic information of a Proxel are identi-cal for all disciplines. They contain a numbering (Proxel-ID), which defines all Prox-els clearly, its geographical positioning, topographic data and the composition of land use. Based on this all disciplines widen the Proxel-information with data gen-erated by their models. The disaggregation of the economic data is made by the help of remote sensing data and the identification of industrially used areas.

After numerous tests DANUBIA passed the proof of concept. So in January 2005 to different scenarios can be calculated to simulate the relevance of po-tential climate changes and the effects on the catchment of the Upper Danube. In the first “wet” scenario the climatic conditions of the year 2002, which had rainfall far above average, will be calculated five times in a row. Thereby water shortage is not expected. In the second “dry“ scenario the climatic conditions of the year 2003 with a very low precipitation will be calculated five times in a row. It is possible that under these conditions there won’t be enough water for all human needs. The economic model RIWU was adapted, so that in case of wa-ter shortage – that means industrial enterprises don’t get as much water as they need for their normal economic development – industrial water demand gets reduced and adjusted to the lower supply through an adjustment of internal wa-ter prices. This has effects on economic development and thus the GDP and household income of affected administrative districts. Comparing GDPs and household incomes of the single administrative districts for the two different scenarios the relevance of climate changes referring to water for the economic development in the catchment of the Upper Danube can be calculated.

Climate Change and Water Resources Security in North China

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The issue of water shortage and related eco-environmental degradation in the North China is one of the major emergency problems in China. As runoff generated from mountain area is significant decreased and over developing water resources, it result in serious water and eco-environmental problems□such as drying-up of river system, ground water decline, lake & wetland degradation, and water pollution in plain area etc. It was shown in the case of Haihe River Basin that among the total rivers of 10,000 km, the rivers of 4,000 km have been turned to be seasonal rivers. Comparing with the beginning of 1950s, the wetland area within the Basin decreased from 10,000 km2 to 1,000 km2 at present. Over-extraction of groundwater, this area covers nearly 90,000 km2, 70% of the plain areas. Comparing with that of the end of 1950s, the accumulated over-extracted groundwater is 90 billion m3. Water and soil loss area in mountainous region□110,000 km2, rating two thirds of the mountainous area. The sandstorms induced by desertification endangering Beijing and other cities. Thus, the problems of water shortage and related eco-environmental issues in North China have become the most significant issue to impact sustainable development in this very important region that are political, cultural and economic center of China.

This paper addresses these emergent issues by the case study of Haihe River Basin in North China. The new advantage on water international study and background of causing these problems from natural change and particular human activity are analyzed. Key points are addressed as four aspects:

(a) the study of the water cycle process impacted by climate change and high intensity human activity, where climate change influence on continue drought in this region was addressed, and human activity was discussed,
(b) water utilization related to new economic partner change, such as saving water model,
(c) study on eco-hydrology, and interaction of water and ecology impacted by climate change and human activity,
(d) reasonable water allocation that including Water Diversion from South to North and saving water issue in local areas.

Major conclusions of present researches are given as follows:
As the 21st century commences, the water in north part of China is under more pressure from more directions than at any time during the existence of this continent. These forces on water will mount as the century unfolds, causing the water scarcity affecting the Yellow, Huai and Hai river basins at present, to develop into a water crisis. that the question is: can science and society avert a world water crisis in the 21st Century? New challenges on hydrological research and water resources management must be faced under the multiple pressures to water-related professionals, policy makers and other stakeholders. It must be addressed that water resources development is controlled by the human behavior in adaptation, utilization, transformation, development and protection of the water environment. However, until now, people are still in a process of learning in the world, including all aspects of the natural water resources and their laws of variability. One should be very careful when dealing with the sensitive and difficult problem of water resources development and utilization, particular in northern China. The nation should spare no efforts in the implementation of the principle of sustainable development and be prepared at all times and in all places to correct mistakes that have been made and resulted in violation of the objective laws ruling water resources. Hydrological research on environmental change will certainly play an important role in understanding causes of water crisis and providing wise management strategies for water resources. Despite the daunting problems facing North China, there are a number of different avenues where research has contributed towards improving the situation. In particular, we have highlighted the role of field experiments in improving water use efficiencies and of computer models that offer insight into catchment-scale hydrological processes. Water security continues to remain the outstanding problem, however, and no one solution is likely to overcome it. It will require a concerted effort from scientists from a range of disciplines and catchment manager before the threat of severe water shortages – and the associated threat to the environment – can be alleviated.

Workshop 3:

Water Provision Across Sectors and Jurisdictions

Potential and options for the use of partially or untreated urban wastewater in agriculture: An African perspective

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Wastewater use in urban and peri-urban agriculture is common reality in Sub-Saharan Africa and increasingly becoming a strong research and development focus. In many countries, the majority of the available freshwater is used for irrigated agriculture. With a general global increase in water scarcity, irrigated agriculture now faces stiff competition for water from other sectors like domestic water use and industries hence the need to look for alternative water sources. Urbanization is also on the increase, putting more pressure on food and water resources, while producing large volumes of wastewater.

Wastewater irrigation can be beneficial as wastewater is a reliable and cheap source of water and nutrients to crops and is contributing remarkably to livelihoods and urban food supplies. However, the use of untreated, diluted or partially treated wastewater, which is a common reality in Sub-Saharan Africa, can pose environmental and public health risks. The major challenge therefore is to optimize benefits from wastewater irrigation and to minimize its associated risks. Developing pragmatic approaches for policy makers, planners, local authorities, wastewater farmers and consumers could do this. To start a corresponding dialogue and to put wastewater irrigation on the national and international agenda, the research community is challenged to produce health risk-reducing approaches appropriate for low-income countries where wastewater treatment is hardly effective or viable at any conventional scale.

In a response to this challenge, the sanitation and agricultural research sectors are joining hands with municipalities to explore integrated options along the contamination pathway. These comprise the (i) search for safer water sources and/or production areas, (ii) decentralized household- and community centred approaches for wastewater treatment and use, (iii) EcoSan and productive use of faecal sludge, (iv) on-farm risk reduction through simple water filter, improved shallow wells and safer irrigation practices, (v) the reduction of post-harvest contamination in markets, and (vi) effective washing methods for contaminated crops in kitchens of households and restaurants.

There will be interdependency in the efficiency of actions at different entry points which calls for an integrated planning framework. The paper presents an overview on options currently under exploration by IWMI, IRC and partners and their likely economic and social sustainability and impact under different conditions. This also considers the institutional and legal capacities needed and highlights research and development gaps.

Sustainable Urban and Rural Water Supplies in Australia

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Presentation of the project/topic
Most of Victoria's water consumed in rural and metropolitan areas is produced by surface runoff from "open" or multiple-use catchments.

There are 39 catchment basins in Victoria. The majority of water supply catchments within these basins are in mountain ranges or hill country receiving 1000 mm average annual rainfall or higher; others receive less than 700 mm. The variability of climate, terrain, soils and vegetation in these latter catchments combine to provide the potential for land degradation. Multiple land use in these catchment environments makes production of high quality water difficult to achieve.

The quality of water supply in many rural towns is now assessed as being below World Health Organisation standards for potable water supply because of pressures of land use and land development. The costs of treating water to a potable standard are borne by the water authorities, which then charge consumers. The primary goal of Government policy is "to ensure the sustainable development of the State's water resources while maintaining healthy waterways". Much of the current pressure for new development and demand for water has arisen from an increase in the number of farm dams being constructed. Current streamflow management plans do not protect rural and urban water supply catchments from overcommitting available water. Plans require planning allocations for irrigation and commercial dams but not for domestic and stock dams. These smaller dams store large volumes but are not considered. This situation exposes a gap in resource management controls and is not addressed by recent legislation.

Elevated nutrient levels in reservoirs are due to eroded soil colloids and fertilisers transported by surface runoff, effluent from animals with access to waterways and poorly maintained septic systems. Stormwater runoff from townships, roads, and car parks usually contains heavy metals, animal faeces, sediment, fertilisers and hard rubbish. Algal blooms in water supply reservoirs indicate poor water quality.

Analysis of the issues
Remediation of degraded water is expensive. Treating water for domestic purposes reduces levels of certain bacteria, and removes sediment and colour. Costs increase as treatment becomes more complex.

A better alternative is to focus on catchment management practices. Land managed appropriately within its capability to sustain water production will not degrade. At present, 124 Special Water Supply Catchment Areas have been proclaimed across Victoria. Of these, 46 have had more detailed studies in sub-catchments and have Special Area Plans which define and limit land use. The preparation of Special Area Plans requires extensive consultation with stakeholders to address Government policy and local land management issues. A Special Area Plan allocates responsibility for implementation, costs, and duties and responsibilities of individual landowners.

Discussion of results/findings
In the development of Special Area Plans, there is a need to provide income payments for landholders using land according to its capability to produce high quality water. Landholders providing "ecological services" for the community (with potential higher costs, training, new equipment) and who reduce commercial returns should be entitled to payments to supplement income. There is a similarity to National parks, which provide ecological services for the wider community using tax revenue.

Land capability studies should form the basis of Special Area Plans. Effective communications with landowners should address technical issues and land use conditions. Land capability studies should be completed independently of market forces. Government has responsibilities for sustainable use and management of natural resources and policy objectives. Land capability studies should be peer-reviewed independently for quality assurance. Planning and water authorities will need to actively manage lands with lower capability to prevent degradation of land and water quality.

The issues of concern relate to -

- Present legislation does not provide for staffing levels to implement and monitor land use conditions now or in the future. There is a reliance on the stakeholders "doing the right thing".
- In the past, remedial works were subsidised by government. Now, under the "user pays" principle, costs dictate whether or not land use conditions in Special Water Supply Catchment Area Plans will be implemented.
- There are financial incentives for some rural landholders. Stakeholders are generally unaware of the potential benefits for application in water supply catchments.

Some alternatives to achieve sustainable production of potable water -

- There is a need for government to provide payments as well as technical support for landholders who rehabilitate catchments.
- Involvement of the community in the planning process would give the stakeholders a sense of ownership and ensure conservation of the land and water resource for future communities.
- An awareness program is needed in the local community.
- Government needs to implement, enforce, upgrade existing Water Supply Catchments based on community needs and developments in water resource management.

Conclusions and Recommendations

There are many landowners unaware that they own land in designated water supply catchment areas. Water authorities with responsibilities for all aspects of water utilization and distribution to consumers must be involved in ensuring sustainable use of catchments. Government need to work with landowners. Resources must be invested to make the community aware of land use conditions within water supply catchments. The training of technical personnel with knowledge of land and water management is an ongoing issue for responsible authorities. Government expenditure should be regarded as an investment in improving land use and management practices. The public benefit is in the production of high quality water in a sustainable manner.

Protecting Natural Capital such as Water across Sectors & Jurisdictions while Meeting the Resource Needs of the Future by Using the Net Gain Principle

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The North American Great Lakes Basin is considered one of the most important international freshwater resources in the world. It constitutes more than 20% of the world's surface freshwater and is home to more than a third of the population of Canada and one tenth of the population of the United States. In Ontario alone, which is the largest urbanized area in Canada, 66% of residents obtain their drinking water from the Great Lakes. The Great Lakes Basin ecosystem faces pressures due to human activities, such as urbanization and unsustainable water resource management practices - consider that North America has the highest rate of per capita water use and that in Ontario water use is predicted to increase by at least 2.5% every year over the next twenty years! These practices, combined with the significant population growth expected in the Great Lakes region, will continue to stress the Basin's capacity to meet the resource needs of the future. To reverse these powerful trends, Great Lakes stakeholders are developing new tools and principles to help manage our shared water resources in the Basin and achieve development that is truly sustainable.

Pollution Probe is developing one of these tools, which is called the Net Gain Principle; it is also referred to as a Resource Improvement Standard. Simply put, net gain means a net environmental benefit. Applying the net gain principle means that when a change in water or land use is proposed, that this change should only occur if it results in a net environmental benefit, namely an improvement in the ecological services of the ecosystems that would be affected by the proposal. Pollution Probe is encouraging policy and other decision-makers to adopt net gain as the overarching principle against which future water resource and growth management decisions should be made. It is only with the net gain principle that we can stop depleting natural capital such as water, and go beyond to undo some of the existing environmental damages.

The concept of net gain emerged in the Great Lakes Basin as a guiding principle in an international agreement designed to manage water withdrawals and diversions out of the Basin. Great Lakes stakeholders are concerned that the growing demand for water in the south-western United States and the impacts of climate change on water levels in the Great Lakes will harm the Basin ecosystem. They are calling for an Agreement that will protect, conserve and enhance this valuable resource. Developing an agreement that integrates the concerns of all Great Lakes stakeholders has been a challenging process – after all, the Great Lakes are shared by Canada, the United States, and numerous states, provinces, tribes, first nations and local governments, all of which have various levels of responsibility in water management. It is still under development and is referred to as the Great Lakes Charter, Annex 2001 (the Annex).

Under the provisions of the Annex, before a new water withdrawal proposal is accepted, the applicant must demonstrate that the proposed water withdrawal initiative will include an improvement (a net gain/resource improvement) to the ecosystem integrity of the Great Lakes Basin. An improvement has been defined as "additional beneficial, restorative effects to the physical, chemical, and biological integrity of the Waters and Water-Dependent Natural Resources of the Basin resulting from associated conservation measures, enhancement or restoration measures…restoring environmentally sensitive areas…"

To support the implementation of this international agreement, Pollution Probe worked in partnership with other Great Lakes organizations to develop an ecological currency approach that would identify and quantify resource improvements (or net gains) across a wide range of water withdrawals. An ecological currency is a unit of exchange used to compare the ecological changes of an ecosystem (i.e., ecological gains and losses) that are measured in terms of the quantity and quality of ecosystem functions and services. The approach includes a series of steps, tools and approaches that an applicant for a proposed new water withdrawal can use to help identify, evaluate and quantify improvements.

Through our research, we have found that net gain could be very helpful in watershed-based source protection, water resource and growth management planning initiatives. Using watersheds, which do not have regard for jurisdictional or political boundaries, as the basis for planning initiatives would acknowledge the effects that an upstream community can have on the quantity and quality of a downstream community's water supply. Using the ecological currency approach, watershed managers could assess the ecological value of ecosystem impairments and improvements in watersheds and make informed decisions on the relative merits of transferring water from one sector to another and one improvement action over another. With this information watershed managers could apply the net gain principle, allowing for some development while also protecting and enhancing natural capital – this will lead to a net improvement in the overall integrity of watersheds.

Today Pollution Probe is working in partnership with local watershed managers from the Toronto and Region Conservation Authority to identify practical mechanisms to apply the net gain principle in the development and implementation of watershed management plans. Two watersheds of the Great Lakes Basin, called the Duffins and Carruthers Creek watersheds, are currently being used as pilot case study areas.

Pollution Probe would appreciate the opportunity to present our findings on the ways to apply the net gain principle to protect and enhance natural capital such as water, while meeting the resource needs of the future at the Stockholm Water Symposium. We look forward to presenting the ecological currency approach and how the net gain/resource improvement standard will be applied in the Great Lakes Charter Annex – we believe that international delegates would benefit from learning about this international agreement designed to manage water withdrawals from a water resource that crosses a country and numerous jurisdictions and sectors. Considering that growth and development in major urban centres is inevitable, international delegates participating in World Water Week must collaborate and learn more about powerful principles, such as net gain, which would allow for development that is sustainable, while also protecting and enhancing natural capital, such as water.

A Water Soft Path for Ontario, Canada: Barriers and Opportunities

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In Canada, the conventional approach to seasonal water supply shortages and water quality degradation is to increase water supply and expand wastewater treatment service. As emblems of progress, the response of public officials, supported by science and technology, extended pipelines and outfalls, constructed dams, and developed deeper wells. By the 1990s, an alternative approach to supply side water management gained public attention known as water efficiency and water conservation.

However, these alternative approaches have recently been criticized for serving merely as 'stop gap' measures during times of periodic water shortage. Others have suggested that water conservation is truly not about long term behavioural change, but rather, about marginal water use reduction to allow the continuation of conventional growth and development.

Water soft path analysis, in contrast, focuses on change to both total demand for water and the ways in which water is delivered and used. This alternative approach is modeled on the highly successful analysis of alternative energy futures known as the soft energy path. Water soft path interprets differences in water quality as opportunities rather than as problems, and derives policy conclusions by working backward from preferred future states rather than by projecting forward from the present.

Water soft path is distinct from more mainstream programs of water conservation and water efficiency in three important ways. First, soft path delivers water services and qualities matched to user's needs rather than just delivering quantities of water. In other words, water demand is not for the resource itself, but for the services provided by that resource. By looking at water as a bundle of services, rather than as a commodity, many more options can be conceived to satisfy demands, which in turn reduces the pressure to increase supplies. For example, the purpose of irrigation is to grow crops. Using water of drinking water quality for such purpose is not only wasteful, but unnecessary. Integration of wastewater or some other source of lesser quality water is reflective of a water soft path approach. Second, soft paths are typically more compatible with decentralized, local management. Soft path incorporates approaches to natural resources management that rely on a multitude of distributed, relatively small-scale sources of supply coupled with ultra-efficient ways of meeting end-use demands. Third, soft path includes local communities in decisions about water management, allocation, and use. Therefore, the real differences between soft and hard paths are not the technologies per se but different socio-political choices about human relationships to, and thus governance of, natural resources.

In contrast to most natural resource studies, for which the key issue is information about sources and supply, soft path studies depend most critically on information about uses and demand. Whereas sources and supply of natural resources tend to be static and therefore subject to periodic inventory, water uses and demand are more dynamic and subject to spatial and temporal variability. As a result, information on water use and demand is often inconsistent or unavailable. Community water purveyors in Ontario number in the thousands, users in the millions. Municipal and community water demand records are not standardized. Similarly, consumption records by sector are not consistently maintained.

This paper recommends that analysis of water soft paths in Ontario (and other provinces in Canada) be continued to the point where alternative water futures and appropriate policies can be defined to move the province toward a sustainable and equitable future based on water soft paths.

Two conclusions underlie this general recommendation. The first is that all provinces in Canada, and certainly Ontario, face water futures that will definitely be different from those of the past. For both economic and ecological reasons, further expansion of water supply infrastructure will likely be constrained. Better systems to provide drinking water and better management of wastewater have already been demanded, almost regardless of cost, by the public.

The second conclusion is that an alternative approach to formulating water policy is available and, if not fully tested, is sufficiently promising to suggest that its application would, at a minimum elucidate the character of the different water futures and indicate more appropriate policies and programs for the future. A water soft path analysis might prove persuasive enough on any of several grounds – economic, ecological, social – to demand serious consideration by decision makers at the management and the political level.

This paper explores the methodological and statistical feasibility of conducting a water soft path analysis for Ontario. At this time, the prospect for such an analysis in Ontario, Canada, looks promising.

This paper is based on the findings of a July 2004 study conducted by Friends of the Earth Canada that was supported by a grant from the Walter and Duncan Gordon Foundation in Toronto.

Agricultural Development and Secured Urban Water Supply – Case study of the Umbeluzi River in Swaziland and Mozambique

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The Umbeluzi River in southern Africa is shared by two countries Swaziland and Mozambique. The river starts at the westerly mountains in Swaziland and flows in an easterly direction into Mozambique and joins the Indian Ocean via the Espirito Santos estuary south of Maputo City. The total catchment area of the Umbeluzi River basin is 5400 km2. 40% of the area is in Mozambique, 58% in Swaziland and 2% in South Africa.

The metropolitan city of Maputo has today approximately 1.8 million inhabitants that are dependent on the fresh water supply from the Umbeluzi River. Apart from the estuarine flow requirements, the Maputo intake is the most downstream user in the river. At the same time extensive areas are irrigated for sugar cane plantation in the central catchment area upstream the border to Swaziland. The present use by Maputo City is approximately 50 million m3/year, against the 220 million m3 used annually for irrigation in Swaziland.

The surface water resource of Umbeluzi has vast economical impact on the two countries. The Maputo area is the major contributor of the Mozambican GDP. The economic expansion that started after the end of the civil war gives continuously increasing water consumption as living standards rises, more industries are established and the urban population growths. In Swaziland the sugar cane industry is the main source of income for the country and its economical growth is partly dependent on the expansion of the sugar cane plantations.

Recent studies have shown that by approximately 2007 the water resources of the Umbeluzi River is fully utilised meaning that without water management, either as water demand management or technology change, the most downstream user, the Maputo City, will experience shortage of fresh water supply. Water Governance of the Umbeluzi water resource is therefore a key for future stability and development in the region. Currently a water resources assessment of the Umbeluzi River basin is jointly conducted by the governments of Swaziland and Mozambique aiming to prepare the basis for negotiations for a water-sharing agreement between the two countries. There is a common determination of the two countries to reach an agreement regarding the use of Umbeluzi River in line with the SADC protocol on shared watercourses.

Water apportionment, in international rivers, between agriculture and urban water supply is, however, not a simple question of trade off analysis where an economic or social function can be maximized in terms of benefit. Closer study of the present water management in the Umbeluzi River, made by the authors, shows that the existing water storages are operated on a separate basis focusing only on local needs for which each storage was constructed. The results of this management are that the urban areas in the downstream end of the river basin suffer water shortages that could have been prevented with an optimal management.

A monthly water balance analysis using the Water Resources Yield Model (WRYM) indicates that if the upstream storage built for irrigation is operated to support the downstream urban users in a drought situation the safe yield for Maputo increases by 30%. The WRYM model, however, is inflexible in the sense that it only optimises water use with the planning horizon of one month. If the upstream storages would be operated with a planning horizon of six months, and combined with seasonal forecasting, the safe yield of Maputo would probably increase much more than 30%.

To implement an optimal water management in the Umbeluzi River basin is, however, extremely difficult. The upstream storage used for industrial production of sugar cane in Swaziland was initiated and funded by the industry. Operating this dam to secure water supply for the downstream Maputo City in Mozambique on a six months planning horizon would definitely be a trade off for the sugar cane industry. The longer the planning horizon is, the higher is the risk that water is used inefficiently because the forecasts will be more uncertain. To be on the safe side much water must be stored, and not used for irrigation, to allow downstream allocation if a drought situation occurs. On the other hand, the longer the planning horizon is, the higher security for water supply to Maputo.

An optimal water management in the Umbeluzi basin therefore demands a neat balance between the profit demands of the private irrigation sector in Swaziland and the municipal responsibility to provide water in Mozambique. Indirectly it will also be a balance between the economical developments of the two sovereign countries sharing the Umbeluzi River.

In addition to the general water scarcity there are large deficiencies in the water demand management in both countries. Maputo's water distribution network today has estimated 60% losses. In Swaziland large agricultural areas are irrigated through furrow systems. A conversion to sprinkler or drip irrigation would save a large amount of water. Rehabilitation of distribution network or changes of irrigation systems, however, demands high investments costs.

The conclusion of the study in the Umbeluzi River is that optimal and dynamic allocation of water, in a bi-national river basin with large water users from different sectors, is very difficult to implement. It demands a full understanding of the system and a mutual will to share the water. It further demands advanced technical tools to find the optimal balance between the different water uses. A hydrometeorological monitoring network with high reliability is requested to support both the technical tools as well as the operational planning. Finally, to avoid conflicts between sectors or countries and to operate and maintain the tools and monitoring network a high and equally distributed institutional capacity must be present at all involved stakeholders.

Planning for environmental flows: an advanced least cost approach to Sydney's demand-supply balance

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This paper describes a project which evaluated demand- and supply-side options and scenarios (combinations of options) for meeting Sydney's water needs, including new environmental flow requirements over a 25 year period. The project employed a customised evaluation methodology focused on balancing demand and supply over the study period. The method builds on existing least cost planning (LCP) approaches to options evaluation and integrates qualitative assessments of social, environmental and risk criteria together with cost analysis.

Sydney faces a number of challenges in balancing water demand and supply over the next 25 years. Current consumption is more than the 600 GL/a that can be supplied at the current required level of supply security. The population is expected to grow by nearly 1 million to total 5.2 million over the period of the study. Further, current flows from storages are inadequate: long-term river health in the important Hawkesbury-Nepean system will require an increase in environmental flows.

To meet these challenges, the New South Wales (NSW) Government set up an interagency taskforce to develop a water plan for Sydney. As a key input to this plan the Institute for Sustainable Futures was commissioned to development a tailored evaluation framework and to model and evaluate demand- and supply-side options and scenarios for Sydney. Significantly, both Sydney Water Corporation (the retail supply utility) and the Sydney Catchment Authority (the bulk supply utility) provided data, information and expert advice on many of the options for the project.

The evaluation framework

The full evaluation framework used in the study comprises a spectrum of costs and other criteria included in the assessment of options. The evaluation framework applies the LCP 'societal cost' and 'total resource cost' cost tests which evaluate cost effectiveness from a whole of community perspective. The total resource cost represents only those costs to utility, government or customers. The societal cost is equal to the total resource cost plus the value of greenhouse emissions. All further externalities were then represented by the three qualitative indexes for: feasibility/risk, social impact and environmental concern.

Option analysis and scenario composition

Options were first ranked by levelised cost. The use of levelised cost, calculated in the manner described by Fane et al (2001), means that the framework treats source substitution, bulk supply and demand management options in an equivalent manner in terms of relative costs. Option modelling and analysis took account of the interaction between options when combining options into scenarios.

A number of different scenarios for Sydney were analysed in the study. The combination of a quantitative and qualitative evaluation process allowed a range of social, environmental and risk considerations to inform the economic analysis through the various scenarios developed. Scenarios were built based on the following principles: lowest levelised cost options (where feasible) implemented first; and minimum total present value cost of meeting the demand-supply balance (under the requirements and constraints imposed). The scenario analysis was constructed to allow assessment and discussion of the trade-offs and inherent choices concerning the exclusion of options (on qualitative grounds) and choosing between different environmental flow regimes.

The results of the analysis

The analysis of more than 30 supply-side, reuse and demand management options resulted in a ranking by societal and total resource unit cost, as well as the potential for each option to close the supply demand deficit by 2011 and 2029. These options were then filtered to ensure that there was no double counting, and combined to build scenarios.

The results of modelling these demand and supply scenarios were presented in tabular and graphical format, and are presented in this paper. One such scenario described and presented in this paper is the ‘risk plus one’ scenario for one environmental flow regime (demand and supply side respectively). The ‘risk plus one’ scenario excludes those options which were both rated as a high concern in the qualitative assessment on the risk index and also a high concern on either the social or environmental indices.

Discussion

Taken together the results of the analysis show that major opportunities exist on the demand-side to cost effectively reduce Sydney’s demand for potable water supplies an provide the preferred level of environmental flows. It was estimated that a total of at least 115 GL/a in savings are available by 2029, at a unit cost less than the cheapest supply–side option.

However, while demand-side options are generally more cost effective than supply-side alternatives, the analysis also demonstrates that a combination of both demand- and supply-side options will be required in order to meet Sydney’s demand-supply balance and provide environmental flows for the Hawkesbury-Nepean.

The evaluation framework developed is an advance on previous LCP methods and provided a consistent and transparent evaluation method for demand management, source substitution (rain tanks, local reuse) and bulk supply alternatives for Sydney. The approach could be applied to other regions

The need to manage this issue within an adaptive management framework, and to ensure that the demand management opportunities are exploited to the fullest extent possible, is reinforced by the uncertainties that exist in predicting future demand for water and future supply constraints.

Realisation of sustainable development: efficiency and equity in water resource management

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Significant political change in South Africa has given rise to a new era in water resource management. The focus changed from a supply driven to a demand driven management approach, with the emphasis on a sustainable approach where social and environmental issues are considered equally important, rather than a mere economic growth approach. This is reflected in the Constitution of Republic of South Africa (1996). The South African National Water Policy (1997) and the National Water Act (1998) were promulgated, where the specific purpose of the National Water Act is to ensure the nations' water resources are protected, used, developed, conserved, managed and controlled in an equitable, efficient and sustainable manner. Whereas previously water was owned by the land owner: water has become an indivisible national asset with the Minister of the Department: Water Affairs and Forestry acting as the trustee of the nation's water resources.

To support the objective of sustainable development a number of radical changes were required in the approach of water (resource) management. The highest priority water use stipulated in the act is to provide water for the purposes of the Reserve. The Reserve is divided into the basic human needs Reserve and the ecological Reserve. Reserve means the quantity and quality of water required to provide in basic human needs, typically 25 □ per person per day within 200 m walking distance, to protect aquatic ecosystems to secure ecologically sustainable development and use of the relevant water resource. A water allocation priority framework approach is followed to allocate water to uses identified by stakeholders, through a catchment visioning process. The process takes account of the Reserve, existing water uses, international rights and obligations, identified strategic water uses and water for future use.

Methods to determine the quantity of water available for use have been developed and are generally available. The challenge now is to develop methods to determine stress levels and the allocatable resource from a water quality perspective. These will then be implemented in an integrated and structured manner to ensure efficiency, sustainability and equity. This challenge is complex due to the nature of water resource management, the requirement to integrate water quantity and quality and to make decisions in a multi-criteria environment.

A suite of management instruments has been developed to assist in determining the allocatable water component of a water resource. These instruments form part of the iterative decision-making framework for making the Policy operational through resource allocation and licensing. These management instruments consist of a catchment visioning guideline, a guideline for determining stress levels, procedures to determine water quality objectives and the allocatable resource, guideline for converting objectives to end-of-pipe discharge standards, and a monitoring and auditing guideline. Much of the above is consolidated in a decision support system.

• Catchment Visioning Guideline
The first step in the framework is the development of a catchment vision. The guideline facilitates the generation of a catchment vision and goals that informs the water allocation process. The practical process for developing a catchment vision culminates in the disaggregation of the vision into component management objectives. An agreed level of protection and development (management class) is the result of the catchment visioning process.

• Guideline for determining stress, objectives and the allocatable resource
The aim of the guideline for determining stress, objectives and the allocatable resource is to provide a practical, consistent approach, by integrating the results of the catchment vision, level of protection and development (management class) and Reserve and to provide an approach to operationalise the objectives

in the evaluation of licence applications through the allocatable resource. The implementation of the guideline is supported by a MS Excel tools. The guideline for converting objectives into end-of-pipe discharge standards provides an input to licence conditions towards compliance with the resource objectives.

• Decision support instrument
A decision support instrument (software program), "Assessment of Considerations for Water Use Applications" (ACWUA), has been developed to allow multiple criteria decision analysis, which utilises indicators to inform decisions on licence allocations. Evidence in terms of indicators is characterised on the basis of impact (extent to which criteria are met) and uncertainty (confidence in evidence).

ACWUA guides regional authorities, by supporting decision-making despite incomplete, imprecise, and variable information. The decisions are based on multiple criteria such as socio-economic factors, race and gender considerations and alignment with a catchment strategy. While it integrates and presents information to inform decision-making, the responsible authority should evaluate the available information and ACWUA results in making a decision.

• Guideline on monitoring and auditing
The guideline on monitoring and auditing for compliance and state of the resource provides practical guidance on how to compile a monitoring programme for resource directed water quality management and how to determine compliance to the objectives. These methods revolutionise water resource management from a water quality perspective in support of sustainable development, efficiency and equity.

The purpose of this paper is to highlight challenges in diffusing new instruments in diverse user environments and induce changes in operational behaviour. The realisation of the philosophy and principles of sustainable development, efficiency and equity will be demonstrated by using a South African case study.

Economic Instruments for Efficient, Sustainable and Equitable Water Demand Management: Lessons for Developing Countries

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There is a growing realization that water is not a free good because providing it at the right place, at the right time and of right quantity and quality involves scarce economic resources. Therefore, water has been recognized as an economic good, owing to the fact that its services are being exploited indiscriminately, leading to depletion and degradation. Since there is a supply constraint, the focus now is on the demand side. The discrepancy between the demand and supply imposes 'social cost' in terms of welfare foregone for the society, especially for the poor. It has been established that provision of good quality water to households in developing countries would contribute to eradication of poverty. However, providing water in an efficient, sustainable and equitable manner is a difficult task, because of the existence of equilibrium trap (Singh et al. 1993) in the water sector in developing countries. This deep-rooted equilibrium trap is characterized by low investment in the water infrastructure, low service, low willingness to pay for poor quality service by the households, low revenue leading again to low investment. How to break this equilibrium trap is a major challenge for the planners and water sector experts. However, since water has become an 'economic good' the development economists suggest that 'market based instruments' (MBIs) such as pricing, tax or subsidy, could be effectively used for shaping the demand side factors for managing the water resources in such as way that even the poorer section could be served better. Therefore, this paper investigates: (i) the experiences of few developing countries which have used MBIs and came out with mixed results; and (ii) various modalities and economic and institutional requirements for using the MBIs to manage water at the household level.

The experience with the MBIs in developing countries suggests that there are two major issues that require proper investigation. One is, when we talk about MBIs, it is found that the pricing of water is used to deal with management of water at the household level. However, the major issue is regarding the decision about level of price that determines the outcome of the policy decision. If the price is either too low or too high, the overuse of water is the outcome. This is so because volumetric pricing is not practiced in many countries. Therefore, the question arises about the optimum level of pricing that would result in efficient use of water. Some economists suggest that the water should be priced on the basis of the marginal cost of providing additional amount of water to the households, while the marginal cost is equal to the marginal direct cost (such as operation and maintenance), marginal external cost (i.e. wastewater treatment cost) and marginal opportunity cost (i.e. cost of alternative use) (see Rogers et al. 2002). The difficulty here is, estimation of costs such as external cost and opportunity cost. Also, if the cost is too high then the price of water will also be very high, leading to affect the poorer section most. Hence, water pricing and other related issues depend mainly on how effectively the policy makers take into account the 'demand-side' factors into their policy formulation. Many studies have identified 'lack of inputs' from the users as the reason for failure of many water supply schemes in developing countries. So, the focus now is on the demand-side. Users' perception about the quality and type of service, quantity and quality of water supplied, time of supply, the nature of the supplier (government, NGOs or private sector), level of initial payment to connect to particular improved service, level of monthly tariff, method of payment, mode of payment, decision about metering, etc do really matter for the success of efficient use of water on a sustainable basis. Many 'willingness to pay' based studies have found that households are willing to pay even more than the actual cost of providing water, if the water supply programmes and their components are designed according to the preference of the households. Therefore, demand-side management can be better achieved by way of designing the MBIs, with more inputs from users.

The second major issue is, appropriate institutions. Because, functioning of MBIs and serving poor people depend mainly on the institutions. For better functioning, MBIs require proper institutional arrangements such as adequate infrastructure, monitoring, appropriate incentives and disincentives, clear-cut policies, flexible rules, etc. In developing countries, not only these institutions are very weak but also there are discrepancies between institutions different levels. Even though MBIs could be used to achieve efficiency, achieving equity requires different kinds of supporting institutional arrangements such as regulation, provision of specific type of service (such as public taps) exclusively for poor, issue of subsidy coupons so that the poor could buy water at a subsidized rate, etc.

Therefore, this paper elaborates on the advantages and disadvantages of using MBIs, the need for incorporating demand side information in designing pricing policies, institutional constraints that prevent the effective use of MBIs, remedies on the institutional front, etc. In conclusion, this paper provides additional policy prescriptions that are relevant for shaping the demand-side aspects of managing water in an efficient, sustainable and equitable manner in water starved developing countries.

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Introducing a Realistic Water Pricing Regime in Urban Local Bodies

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Jabalpur, a city of about 1.2 million people, is situated in an area well provided with water resources, being fed by two reservoirs, Khandari and Pariyat, the rivers Gaur and Narmada as well as a number of hand pumps/tubewells. The Jabalpur Municipal Corporation (JMC) manages the drinking water supply and the current water available from all sources is about 28 MGD. Out of this 4 MGD is supplied to bulk consumers including various manufacturing units. Thus the remaining 24 MGD works out to a supply of 20 gallons per day per capita, which is well below the per capita standards for the country. This is due to expanding population but lack of commensurate increase of water supply. The two reservoirs as well as the Gaur river cannot be exploited any further, so that the only potential source of water supply is the river Narmada, which is fortunately located quite close to the city so that minimal pumping is required to get the water to the city. It may be added that overexploitation of groundwater resources has led to rapid fall in groundwater levels, and now the needs of substantial parts of the city have to be met by water tankers. During summers the number of tanker trips increases to around 250-300 trips per day. Maintenance of water supply at adequate level requires JMC to be financially self-reliant. Deciding the water charges payable by various users falls under the domain of the JMC's general body. But the collection of water charges is much less than the expenditure. There is considerable deficit because billing is not related to the water consumption but is on a fixed rate depending on the diameter of water connection pipes. The prevailing water charges, fixed in 1997-98 as per the directives of the state government, were uneconomical and were uniform irrespective of quantity of water consumption in the absence of proper metering. In 2000-01, the operational expenditures stood at Rs 130 million whereas the water charges were Rs 80 million, out of which only Rs.56 million was collected on account of collection inefficiency.

A scheme called Narmada Phase III, which would augment the water supply to the city by about 40% had been languishing for the past 10 years due to funds crunch. From January 2000, the Corporation decided to give priority on completion of the scheme. The project cost was around Rs.130 million, which included the state government share of Rs.34 million. The corporation approached HUDCO, a Central government financial undertaking, for a loan of Rs.96 million in 2001. On account of the good terms of the Mayor with the state political leadership, the state government immediately disbursed its share.

On submission of the project report, HUDCO asked for a guarantee from the state government for repayment and a unambiguous resolution from the Corporation indicating how water charges would be increased to ensure repayment. Though no systematic survey was conducted, the general perception through interaction with individual citizens revealed that the consumers were willing to pay more to get better water services. However, the Corporation did not agree to any kind of an increase for residential consumers and only a token increase for commercial consumers, on account of possible repercussions of increased charges on their vote bank. The state government asked the Corporation to reconsider its stand. This time the corporation agreed to an increase in water charges for commercial consumers but not for residential consumers. In spite of the corporation's stand, the HUDCO agreed to sign the loan agreement in October 2002 with the Municipal Corporation conditionally on the corporation securing the state government guarantee. The state government on pursuance by the Mayor gave the guarantee in January 2003. HUDCO has started making disbursements from October 2003. The project is nearing completion now. However, water charges have still not been increased till 2004-05. The study revealed that in an unmetered water supply scenario, across the board subsidy of water charges benefits the rich consumers more than others since they have more availability of water due to more storage capacity on the same monthly fixed charge per connection, while the local body suffers from financial deficit. Though the public may be willing to pay more provided reasonable services are made available to them and reasons for the water charges increases are explained to them, elected bodies lack the willingness to increase charges since they are afraid of backlash affect of the decision on their vote bank. The study also reveals that the state government did not insist on economically sustainable water charges while issuing the state government guarantee. Thus a fully competent local body did not have to take a decision on increasing water charges which could have marked a beginning towards financial self sustainability of the local body.

Quantitative Cross-Sectoral Analysis of Water and Pollutant Cycling in Catchments

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Water is as essential to sustainable development as it is to life and ecosystem status and dynamics. Over the last century, the demand for water for human activities has increased at least six fold (with human population increasing “only” three fold), in total and in the separate household, agricultural and industrial sectors. This growth of used water quantity has also been accompanied by increasing water pollution and deterioration of aquatic ecosystems by various pollutants from different water using/impacting sectors. These different sectors and their water uses and pollutant loads interact with closely coupled water systems (soil water, groundwater, streams, lakes, wetlands) in the topographically given catchments, or drainage basins, that capture precipitation on land and channel it further to aquifers, streams, rivers, lakes, and further downstream to coastal and marine waters, across political boundaries. The flows of water and pollutants between the linked natural and engineered-economic water and water using/impacting systems and sectors need to be appropriately understood, quantified, monitored, managed, regulated and not least communicated to stakeholders in order to achieve efficient and sustainable development and management of water quantity and quality.

We use input-output analysis (IOA), originally developed for quantification of capital flows in economic systems, for the quantification of catchment-scale water and nitrogen flows across natural waters and relevant engineered-economic systems/sectors in the Swedish Norrström drainage basin. This basin is located on the east coast of Sweden, includes two major lakes Mälaren and Hjälmaren, and has its coastal water outlet in the Swedish capital Stockholm. Water and pollutants transported by water to the basin outlet discharge into the Stockholm archipelago before reaching the Baltic Sea. The basin area is characterized by traditional agriculture in the west and the industrialized Stockholm region in the east, and is one of the most important basins in Sweden in terms of population (over 1.7 million inhabitants) and land area (22 000 km2). The basin comprises parts of 6 counties and more than 50 municipalities, and constitutes (with the addition of smaller adjacent costal catchments) one of total five Swedish districts (the Northern Baltic Proper district) for basin-scale water management, following requirements of extensive new EU water legislation (Water Framework Directive).

The Norrström basin suffers from nutrient loading to its own inland waters and constitutes a main Swedish contributor of nitrogen loads to the Baltic Sea. A steadily increasing population implies also increasing pressures on natural water resources, and not least on the lake Mälaren, which provides drinking water for the Stockholm region and other areas. The chosen IOA application to and results for the Norrström basin is thus both interesting for methodological quantification and exemplification, and of great regional importance.

In general, results of IOA application to water and nitrogen flows within and from catchments enable relatively simple, compact and transparent quantification of: i) integral catchment behavior of water and pollutant flow responses to various changes in the linked natural and engineered-economic water sub-systems/sectors of a catchment; ii) water and pollutant flow interactions between the various sub-systems/sectors of a catchment; and iii) external water and pollutant flows between a catchment (and its subsystems) and other geosystems (atmosphere, coastal zones) and geographic areas outside the catchment. The proposed IOA quantification is highly transparent and readily communicated to stakeholders, and identifies clearly important information and data gaps that require improved monitoring and more detailed dynamic characterization. Furthermore, the IOA tool does not only quantify the human impacts on water environments, but also the impacts of different environmental target formulations and regulations on the engineered-economic systems and sectors that use/affect water for meeting various human needs.

Quantification of catchment-scale cause-effect relations and feedback mechanisms between natural water and engineered-economic systems and sectors is not commonly handled by traditional hydrologic-biogeochemical flow and pollutant transport models. Such quantification is provided by the proposed IOA approach to catchment-scale water and pollutant flow quantification across sectors and jurisdictions, and is necessary for meeting the strategic challenge of maximizing a society's benefits from various possible uses of available water resources, while ensuring that basic human needs are met and the environment is protected.

Water Resources Allocation Model of River Basin: A Case Study of the Haihe River Basin in China

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Water resources are basic natural resource and strategic economic resource. Water resources are also crucial factor for eco-system in China. Sustainable water resources use provides support for sustainable development of the whole society. Water issue is a very serious problem in the 21st century. The Ministry of Water Resources put forward the new idea that water resources sustainable use supports sustainable development of the society. So it is a new problem that how to manage and allocate water resources of the river basin orienting to sustainable use and development. Water resources allocation always solves the competitions and conflictions between different water users and multi objections of all levels. Water resources allocation model is an important tool for decision makers to solve these problems. This article develops water resources allocation model that is a group decision model with multi layers and multi objectives. This article introduces idea, decision variables, objective function and constraint of the model. And the solution of the model is presented. Water resources allocation model takes GDP as economic objective and COD as environmental objective. The model is subjected to some constraints, such as water demand constraints of different users, water availability constraint and food production constraint, and so on. The model applies games theory and can satisfy the need of water resources allocation and management in river basin. So the model can serve decision makers for rational allocation and scientific management of water resources.

Water scarcity in the Haihe River Basin is very serious. The average annual water resources are only 37.2 billion m3 and per capita water resources are only 305 m3 that are 1/7 the average value in China and 1/27 in the whole world. Per capita water resources are also less than the standard of absolute stress with 500 m3 per capita per year. With economic development, more and more water will be demanded and used in the Haihe River Basin and exceed loading capacity of water resources. So water development and irrational management consequently result in serious social and ecological problems. In the past time, water development focused on meeting the demand of economic growth and put little consideration on ecosystem protection. So ecosystem degraded and deteriorated. With urbanization promotion and industrial economic growth, other water users exploited agricultural water, which has direct impact on food production and security in the Haihe River Basin, even China.Optimization allocation of water resources could play an important role in sustainable development of the Haihe River Basin. So The article applies Water Resources Allocation Model of River Basin to the Haihe River Basin. The article takes 1998 as the current year, and discusses the optimization allocation schemes of water resources and feasible path to optimization schemes in the Haihe River Basin. The allocation schemes of different scenarios are presented too. Main conclusions are as follows: (1) Current water use isn't rational and crop planting structure needs to be adjusted. Rational water allocations have to consider historical and current water use of different users. Otherwise the allocation schemes are unfeasible. It is inefficient that management institution of the river basin makes water allocation scheme alone. Water allocation needs all water users to participate and coordinate. Coordinative allocation of different calculation units prompts rational water use. However, the compensate policies are important in the process of the coordination.(2) Water resources in the Haihe River Basin, including 4.1 billion m3 water resources diverting from the Yellow River, can support sustainable development of the Haihe River Basin by adjusting crop planting structure, water saving and sewage treatment. (3) The measure of rational water allocation in the current year is adjustment of crop planting structure. This measure can reduce 11.37 billion m3 of irrigation water that can be allocated to ecosystem and other water users. The detailed method is to make a plan of wheat planting according to the condition of water resources. (4) Reducing 20% the per unit area yield of crop has little impact on water resources allocation, but has great impact on total output of food product.

Key scientific challenges of water availability for the Western United States

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In the American West, the availability of water has become a serious concern for many communities and rural homeowners. Water of acceptable quality is harder to find because local sources are allocated to prior uses, depleted by overuse, or diminished by drought stress. Some of the inherent characteristics of the West add complexity to the task. The most rapidly growing States in population are in the Southwest—the most arid region on the continent. There is evidence that the climate is warming, which will have consequences for the Western water supplies, such as increasing minimum streamflow and earlier snowmelt events in snow-dominated basins. Endangered species are disproportionately represented in the Western States, and water availability now means sustaining riparian ecosystems and individual endangered species. Periodic inventory and assessment of the amounts and trends of water available in surface water and ground water are needed to support water management. The widespread perception that the amount of water available is diminishing with time needs to be replaced with fact. For the major Western rivers, there is either no long-term streamflow trend or the trend is increasing. In contrast, systematic information is lacking to make broad assessments of ground-water availability, but for specific aquifers where data are available, the aquifers are being depleted.

The complexity added to the issue of Western water availability by these and other factors gives rise to a significant role for science. Science has played a role in support of Western water development from the beginning, and the role has evolved and changed over time along with society's values. The role for science is discussed in three phases—development and construction, consequences and environmental awareness, and sustainability. The development and construction phase includes some historical accounting of water development for the West and how some precedents set then, still exist today. Science has played an important role in objectively pointing out the consequences of this initial phase, such as converting the Nation's rivers to reservoirs, effects of ground-water pumping on surface water in streams, land-surface subsidence, and changes in water quality brought about by the disposal of wastewater and manmade chemicals into the Nation's waterways and aquifers. The sustainability phase reflects the present efforts of water managers and other natural resource managers to sustain water supplies beyond the present generation. Sustainability, as presently interpreted, goes beyond mere water availability for water supply, and includes ecosystems and even individual species. Sustainability by this definition is superficially appealing but is and will continue to be a significant challenge for science to translate into a measurable water-management strategy. A sustainable water supply for a community would ideally provide enough water to support a growing population and economy, even during protracted periods of drought—a tall order. There are many scientific challenges surrounding a sustainable use of water resources, but five key challenges are discussed in this report: (1) the determination of a sustainable level of ground-water use that meets identified management needs, (2) artificial recharge in the long-term, (3) selected water-use strategies such as desalination and water reuse, (4) sustaining valued ecosystems, and (5) sustaining individual endangered species. In order to achieve sustainable use, scientists, managers, policy makers, and water users at large will need to develop, communicate, and use scientific information in more effective ways. New collaborative ways of conducting monitoring and research, across disciplinary lines will be needed to develop quantitative habitat requirements for ecosystems and endangered species. The new role for science will be to support environmental decision-making to achieve some new level of sustainable use that will provide an assured supply of good-quality water for humans and for stream and riparian ecosystems.

Spatial Variation in Water Supply and Demand across River Basins of India

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A comprehensive river basin level assessment of water supply and demand for India is presented. Nineteen river basins covering entire India is considered in the analysis. Several factors including spatial variation and growth of population, urbanization, agricultural production and consumption and their associated water needs and domestic, industrial and environmental water needs are considered. The study analyses water supply and demand across river basins and classifies the river basins according to water scarcities and agricultural production surpluses or deficits. Issues that are important for future water supply and demand at river basin level are also presented.

Four indicators namely degree of development, depletion fraction, groundwater abstraction ratio and ratio of value of crop production and value of crop demand are used to identify issues mainly concerning water scarcity and crop production at each river basin. Then the river basins are classified into five clusters based on these indicators.

Cluster one comprising river basins with six percent of the Indian population are classified as physically water-scarce, have food crop production deficits and imports food crops from other basins.

Cluster two basins are physically water-scarce but have significant food crop production surplus. They produce nearly 27 percent of the total food crops of the country. Water scarcities in this group are due to overdevelopment of water resources, especially for irrigation.

Economically water-scarce and food-deficit basins, numbering eleven and having 75 percent of the Indian population, are grouped into cluster three. Classification of this cluster is influenced by the Degree of Development which is 39 percent. Most basins in this cluster will either have to increase their water sector investments to overcome issues related to water-scarcity and food deficit or will have to increase food imports. Increasing the water productivity, which is very low at present, would also be another option to overcome food deficit.

Non-water-scarce and food-sufficient basins, numbering three, fall into Cluster four. This cluster has only five percent of the total Indian population and contributes to ten percent of the food crop production. River basins in this cluster have a low degree of development, low depletion fraction but with some crop production surpluses. There is high potential for further water resources development in these basins.

Cluster five is classified as Non-water-scarce and food-surplus basins. Three river basins fall under this cluster which has seven percent of the Indian population and produces 21 percent of the food crops. Basins in this cluster have significant production surpluses. Water resources in these basins can be further developed to increase food production.

Overall, the results show that 88 percent of Indian population lives in river basins that experience some form of water scarcity or food deficiency or both. The surplus food crop production in some clusters offset the deficits in others. But some of the basins producing surplus food crops being water-scarce, this trend does not seem sustainable on the long run. Besides, increasing demand for domestic and industrial water needs will decrease water diversions for agriculture. Further, increasing environmental degradation concerns would also put pressure on committed environmental flow requirements, thus further decreasing the share for the agriculture sector.

In conclusion, the spatial dynamics of water scarcity across river basins highlights several issues that are needed to be considered when planning future water sector developments in India. Population growth and urbanization considerably increase the need for increased domestic water diversions. Under the United Nations medium population growth scenario, by 2025, India will have to feed another 207 million people. Water withdrawals for food crop production to this population alone will be an additional 252 km3 (based on the current agricultural requirements). Further, increasing awareness on environmental flow requirements to sustain ecosystem functioning would be another contender competing for water in all the basins.

Coping with and Ensuring Water Security in Tamilnadu, India through Eco-system based Integrated Watershed development

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'Water Security' implies providing of access to water and making it available where it is needed to the growing population in a timely, adequate and affordable manner. The paper does not attempt to present any plans or findings on water provision across sectors and jurisdictions; but it makes out a case for the augmentation of usable water through eco system based watershed development approach and thereby facilitate the provision of adequate water to meet the competing demands across sectors and regions.

India is contemplating to implement a mega project of interlinking rivers as a long term measure of drought mitigation and flood protection in the various dry and wet zones of the country and to transfer water from surplus river basins to the deficit basins and across sectors. A project of that magnitude will not only take a few decades for completion, but will create only pockets of greenery along its path. It cannot provide water to distant areas where the cultivated lands have to still depend on local water harvesting or on ground water. Therefore a medium term proposal is presented to augment the country's water potential to meet the growing water needs of sectors & regions through an ecosystem based integrated watershed development, by prioritizing the watersheds that would meet the immediate needs of critical areas spread over large tracts.

Tamilnadu State situated in Peninsular India, faces acute scarcity of water. This state receives an average annual rainfall of 979 mm. About 97 percent of the surface water potential has been utilised already while the utilisation of ground water potential has been 65 percent. One of the state government's water resources institute estimated that the total demand for water by different sectors is likely to be 35,820 Mm3 in the year 2025 as against the available water resources potential with a supply capacity of 28,361 Mm3. The expected short fall of roughly 7500 Mm3 raises alarm and warrants adoption of appropriate measures on a war footing to make good the critical water deficit.

At the instance of the State Planning Commission, Tamilnadu, DHAN Foundation a professional development organisation based at Madurai, conducted a study on the present status of water resources and their utilisation. The authors, as a part of the study team proposed a new concept of 'People led Water Security' with an integrated approach of developing around 19,000 micro watersheds of about 500ha each in this State on Eco-system basis. The study report suggests a 20 year action plan with adequate resource allocation and strategy to be approved by the state government. One of the key development strategies proposed is taking up people led "Tank based Watershed development" since the irrigation tanks irrigate nearly 6.33 lakhs hectares of cropped area directly and they also contribute to the recharge of ground water in dug wells and tube wells.

The approach, strategy and the proposed measures to meet the anticipated water deficit through conservation and augmentation measures for each category of the following ecosystems have been formulated.

1. Hilly and forest based watersheds
2. Canal irrigation based watersheds
3. Tank based watersheds
4. Groundwater based watersheds
5. Rainfed agriculture based watersheds
6. Coastal area watersheds
7. Urban watersheds
8. Wastelands dominated watersheds

DHAN Foundation has been implementing watershed development programmes in the following four categories of ecosystems over a period ranging from two the six years with people's participation in the various districts of Tamil Nadu.

- Tank based watersheds
- Groundwater based watersheds
- Rainfed agriculture based watersheds
- Coastal area watersheds

It conducted several field studies to assess the impact of these development works and also collected the assessment of the benefits as perceived by the local people who were actively involved in the planning and implementation of these projects.

Results and Finding
The results of the impact studies made are highly encouraging and beneficial as enumerated below:

- Significant rise in water table and augmentation of ground water potential
- Perceptible increase in soil moisture resulting in increased crop production by more than 50 percent
- Increase in cropping intensity from 100 to 150 percent and more
- Crop diversification resulting in increased income to farmers
- Change in the quality of ground water resulting in increased irrigated area
- More assured availability of fresh drinking water in rural areas.

Recommendations
The impacts enumerated above will be even more pronounced in the proposed watershed development works which will be appropriate and specific to the characteristics of each category of the ecosystem based watershed. They will not only recharge the aquifer and enhance the groundwater potential greatly, but also capture the rainfall runoff and store it in several thousands of surface tanks and ponds to augment the total water supply. As compared to the major irrigation projects, these works will be quite cost effective and help to provide reliable water supply to large areas, dispersed over the entire state.

Application of Dynamic System for Sustainable Urban Water Supply: A Case Study in Hanoi City

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The Vietnamese capital of Hanoi is located on the 11,000 km2 Red River Delta of northern Vietnam. The Red River is the largest river that runs through Hanoi from northwest to southeast, with a width of 1-1.5km through the central districts. The river, however, was not exploited for municipal water supply in Hanoi, because of a large seasonal fluctuation of the water level and because of its extremely high turbidity. Groundwater instead has been easily exploitable all around the city and has been abstracted for driking water sypply since the beginning of 20th century. At present, 8 water treatment plants (WTPs) and a number of small water stations using groundwater from a confined aquifer (so-called Pleistocene or Lower Aquifer) lying between 40-70 m in depth beneath the ground level, supply 446,000 m3/day of water to a population of 1.16 million in urban districts (Hanoi Water Business Company, 2004).

In recent year, Hanoi City, including 9 urban and 5 sub-urban districts has been urbanized developed rapidly. The population in 2000 was over 1.5 million people and is predicted to reach 1.75 miliion and over 2 million in 2010 and 2020, respectively (General Statisic Office, 2001). As consequence, the domestic and industrial water demand as well as for public services have increased steadily due to the expansion of the city, industrial development and population growth. But due to the limited exploitation capacity, the established system will be soon insufficient to meet the increasing water demand. Land subsidence was observed and intensive exploitation of groundwater formed a big cone depression of groundwater level in the central of Hanoi City. In the view of the upcoming water shortage, it is obviously necessary to establish an intergrated plan for water use and development with focus on the long-term security and stability of the water supply system. The research was therefore planned to identify and evaluate effective strategies for achieving sustainable water management objectives.

In this study, system dynamic was used to describe the dynamic relationship between aquifer storage, groundwater recharge, water supply and demand in the Hanoi water system. The model was developed using Stella version 8.0 software (High Perfomrance System, Inc., 2003) and was then used to simulate the effect of policy or management ideas. The model output was used to continue the discussion of potential policies and management options.

Critical management question is What is the sustainable rate of aquifer exploitation which does not exceed the natural rate of groundwater replenishment and How to extent the point at which demand exceeds supply further into the future. The results show that to maintain sustainable aquifer storage, the exploration should not above 700.000m3/day. Due to difficulties in management of private wells, a maximum pumping rate of 600.000m3/day is recommended. The model results also reproduce the general trend that defined the water management problem. The total water demand will reach 650.000m3/day by the year 2010, and over 800.000m3/day by 2020. The demand therefore exceeds supply in approximately 2010.

Management options fall into two basic categories: increase supply and reduce water use. The first option considers surface water as the alternative water source. The second option is to test the effect of reducing residential use, industrial use and non-residential use. The reduction of residential use could be achieved though the use of more water-efficient appliances, low-flushing toilet, or price-based incentives to decrease personal water use. Although the industrial and commercial uses only 5% and 13%, respectively, of the municipal water supply by the year 2003, these figures would considerably increase in the future. The reduction of non-residential use could be reduced through industrial water reuse and recycling, or using treated municipal waste water for cleaning of road or watering of tree. The integrated strategies which combine increasing water supply and decreasing water use was also tested.

All tested options move the point at which demand exceeds supply beyond 2010, but some options appear to be more effective than others. The reduced of residents use by 10% would shift the point for only few more years. And the same affect would be achieved if we reduce the industrial use and non-residential use by 20% by water reuse and recycling. Using river water of up to 300.000m3/day as the additional source for water supply extended the crossing to the year 2020. Combining a suggested increase in supply with water reuse and recycling in industrial and non-commercial sector has a greater effect than any single policy; it keep supply above demand up to the year 2030. Even thought it would be expensive to use the surface water, but increasing supply would eventually be necessary and this option has been considered in the Hanoi Mater Plan up to 2010. The dicussion centered around what surface water source would be chosen: from the local available Red River or interregional transfer from the upstream Da River.

The model clearly presents that using surface water as alternative source and water reuse and recycling are key factors to sustainable water management in Hanoi City. The use of model not only allows policy-makers and stakeholders to participate in the evaluation and comparison of different policies in water management, but also help citizens better understanding the basis for management decision.

Introducing Agency into Water Resource Simulation Models

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Typically water resources systems models assume that water demand is related solely to climatic factors and ignore the role of decisions taken by actors operating under differing objectives, perceptions and constraints. This poses a problem for water planners trying to develop equitable and sustainable water management plans in a river basin context. For example, WEAP21 is a comprehensive, easy to use water resources management tool, developed by the Stockholm Environment Institute, which supports the information and decision-making needs of water planners and stakeholders by trying to balance water supply and demand under various climatic and hydrologic conditions. It is distinguished by its integrative approach to simulating water resource systems and by its policy- and scenario-driven orientation. WEAP21 considers components on the demand side of the equation (e.g. water use patterns, equipment efficiencies, re-use, prices, hydropower, and irrigation) as well as the supply side (e.g. streamflow, groundwater, reservoirs, and water transfers).

However, the model is limited by the fact that human-environment interactions and feedback as well as the impact of heterogeneity in the behavior of individual actors on emergent water demand are not considered within the model design. It is anticipated that emergent water demand estimates based on a 'dynamic' representation of the cumulative influence of individual water use decisions at the local level will enhance the quality of information used in developing integrated water management plans, since the context in which individual water users operate will be considered in the analysis. This will be accomplished by replacing traditional ‘demand nodes’ in WEAP21 which are based on climate forcing, with an agent based model where the actions of the agents are determined by numerous endogenous and exogenous factors, including the simulated state of the water supply system.

In agent based modelling, an agent is a self-contained entity which can control its own

actions, based on its perceptions of its environment. The aim of agent design is to create entities, which can be individuals, households or institutions for example, which interact intelligently with their environment responding to signals that are drivers in their decision-making behaviour. These drivers can be identified from empirical observation of the target system, using participatory techniques. The social aspect of agent behaviour means that agents do not succeed or fail based solely on their own characteristics and constraints but additionally on their social networks, while agent activities can also take place against a backdrop of global environmental change. For instance, agents can act based on long-term or short-term climate predictions. Climate can also affect the success or failure of personal decisions or management regimes. Agent based programming can be distinguished from procedural programming in its explicit representation of stakeholders, as agents, and this close correlation between the modelled agents and real actors provides an opportunity for the involvement of stakeholders in the validation of the model. The agent-based modelling process also allows the sharing of viewpoints between stakeholders and actors participating in the model building process and the testing of system perceptions.

This paper will discuss the possible design of such an agent-based extension to the WEAP21 model and the improvements that it may provide both to some agent based social simulations which highly abstract environmental and hydrological processes, as well as to ‘water evaluation and planning’ models such as WEAP21 which eliminate behavioral social processes altogether.

Interlinking of Rivers with Reference to Contemporary Social Needs - A Case Study of India

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Water is a prime natural resource, a basic human need for sustaining life, and a precious national asset, and is required for all the activities of man for drinking water supply, Irrigation requirement, power Generation, Industrial development and therefore planning, development and management of water resources need to be governed by national perspective.

We Indians are currently engaged in seriously debating the pros and cons of the proposed interlinking of the rivers nationwide. While the task force set up in December 2002 for this purpose by the government of India has swung into action, strong opinions are being expressed through the media and in gatherings, taking extreme positions.

India is one of the wettest countries in the world. Its average annual rainfall is 1170mm, with cherrapunji in the northeast corner getting drenched under 11400 mm and the sands of jaisalmer as the other end of the scale pulling along with 210mm. Unfortunately the country has a singular habit of not making use of its blessings. Even though by 2025 A.D. India will use only a fourth of the total rainfall, it is expected to face the threat of shortages two decades from now. The reason for this is that India cannot hold on to all water it receives.

Indian water policy has so far concentrated on highly visible large dams reservoirs and canal system, ignoring the highly cost effective minor water projects, such as tube wells, dug wells and tanks. However impressive, the dams should in press hands outs, it is miserable fact that India has so far not managed to arrest the devastating annual cycles of floods and droughts.

The Government of India in the year 1980 has formulated a National Perspective plan for water Resources Development of the country which contemplates interlinking of the rivers. The (N.P.P) National perspective plan comprises of two components,
1) Himalayan River Component and
2) Peninsular River Component

In the Himalayan River Component fourteen (14) Inter-basin water transfer links have so far been identified. The peninsular river component has identified sixteen (16) Inter-basin links till date.

The national water development agency (NWDA) was set up in the year 1982, to study the components of N.P.P in detail; to formulate proposals and schemes for the development of the country's water resources for optimum utilization with equitable distribution to achieve balanced economic growth and social justice.

Expected social impacts
The project shall have both positive and negative social impacts as detailed below

Positive impact
1) Large scale continuous employment for many
2) Assured and sustained irrigation water supply raise food production.
3) Assured protected water supply
4) Improvement in communication facilities.
5) Availability of additional pollution free power and hence more industries.
6) Enhancement of economy both in rural and urban sectors.
7) Relegation of drought and attendant problems to the negligible dimensions.

Negative impacts
1) Rehabilitation of rural and tribal in habitants, wherever it becomes necessary.
2) Resettlement of all the displaced persons in gainful employment

Conclusion:
On a long term perspective, there is a silver lining of stoppage of state expenditure on ,cessation of conflicts between states on account of river water sharing.

The GLOWA Volta Project: A Framework for Water Resources Decision-Making in a Transnational West African Basin

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Background and Motivation: The Volta River Basin occupies over 400,000 km2 within the sub-humid to semi-arid West African savanna zone. The basin is shared by six riparian nations, among which Ghana (42% of basin area) and Burkina Faso (43%) are the most important in terms of population, water use and economic activity. Basin precipitation averages around 1,000 mm per year, with a steep south to north gradient, but less than 10% becomes usable as runoff due to high evaporation rates. Historically, rainfall is erratic and unreliable, a situation likely to be exacerbated as a consequence of global climate change. The Basin is extremely sensitive to alterations in climate, as small changes in precipitation lead to proportionately larger changes in runoff, a process amplified by rapidly changing land cover.

Basin inhabitants are largely rural and poor, with per capita incomes falling well below Sub-Saharan African averages, and only 37% (Burkina Faso) to 62% (Ghana) have access to improved sources of drinking water. Basin population is expanding by over 2.5% annually, effectively doubling every 28 years. Irrigation, although presently limited in extent, is the dominant consumptive use of water in the northern and central basin, and competes directly with hydro-power generation in the south for available water resources. The demand for water to serve these and other uses is anticipated to increase dramatically, with irrigation demand in Ghana alone projected to increase by a factor of six over the next 20 years. Complicating this situation is the absence of a Volta Basin Authority or similar legal framework to regulate and allocate flows across international borders and to enable coordinated development of the Basin's water resources.

The GLOWA Volta Project (http://www.glowa-volta.de), initiated in 2000 and funded by BMBF (Germany), is conducting a comprehensive, integrated analysis of the physical and socioeconomic determinants of the hydrologic cycle within the Volta Basin, with emphasis on the impacts of projected global climate change and alterations in land use and cover. GLOWA Volta is an interdisciplinary "research cluster" project involving climatologists, hydrologists, geographers and other physical scientists working in coordination with agricultural economists, sociologists and anthropologists. The overall project objective is to design and to implement a scientifically sound Decision Support System (DSS) for the sustainable development of water resources in the Volta Basin under changing climatic, land use and socio-economic conditions.

Discussion of Preliminary Results: The Decision Support System under development for the Volta Basin consists of an integrated suite of mathematical simulation models utilized in the context of formal and informal consultation with stakeholders. Bio-climatic data obtained from a network of experimental observatories established by the GLOWA Volta Project and partners within the basin, in combination with remotely sensed data on water and energy fluxes and land cover changes, is used to calibrate and validate models of mesoscale climate (the Penn State University Climate Model MM5), surface and groundwater hydrology (Water Simulation Model WASIM-ETH) and land use/land conversion. These models are linked via shared variables such as precipitation, soil moisture and runoff. Physical models of water resources are in turn linked to nested bio-economic optimization models of the water sector at small catchment, sub-basin and full basin scales. These hydrologic-economic models are developed on the basis of structured household surveys, which examine access of households to safe water supply, determinants of household water demand, household expenditures on water, water-related health indices, factors motivating migration and factors driving land use change. The resulting DSS can be used to evaluate the impacts of specific policies or interventions as overlaid on the likely future state of climate within the basin. Individual DSS components also serve as stand-alone decision support tools: short term Volta Basin forecasts generated by MM5 are already available online (http://www.glowa-volta.de/atm/forecast.htm), assisting farmers in determining safe planting dates.

The prototype DSS is undergoing preliminary development and testing within the White Volta Pilot Project, encompassing much of northern and eastern Ghana, through which Integrated Water Resources Management (IWRM) policies and practices are being evaluated. An additional rationale for selecting the White Volta was that it is an international basin, shared with Burkina Faso, within which only limited technical cooperation on water resources management has been initiated. In the White Volta Basin, the Ghana Water Resources Commission (WRC) has identified the following water sector problems: (a) flooding, (b) water shortage, (c) lack of comprehensive institutional and legal framework, and inadequate information and data for water management, (d) high fluoride concentrations in groundwater, (e) water pollution and improper land use, and (f) high salinity of groundwater. The specific objectives of the White Volta pilot program are to identify and motivate stakeholders for collaboration and participation in IWRM; to establish the institutional framework for IWRM; to develop a Water Action Plan; and to monitor and evaluate the IWRM process, all with a view toward wider application of the lessons learned in the White Volta setting.

One of the most promising outcomes of the GLOWA Volta Project is its capacity development initiative, which has produced over 10 PhD graduates from within the Volta Basin over the past four years. This initiative ensures that the required expertise is available locally to sustain the project and ensure its successful implementation, as these graduates assume responsible roles within the water resources decision-making bodies of their respective countries.

Sustainable Water Management in Colombia

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Water is both a fundamental right and collective heritage; it is inherent to the preservation of nature and local people's livelihoods. Equitable and safe access to water resources in satisfactory conditions of quality, quantity and natural variability, is therefore vital to the sustenance of ecosystems and cultures. This paper, by way of a critique, raises some of the viewpoints and challenges faced by marginalised sectors of Andean society (e.g. youth, women, urban poor, micro-enterprises) and traditional communities (e.g. ethnic groups, small-hold farmers, fishing populations). The chapter concludes with a call for groups from diverse sectors to work together on these challenging issues, across political, economic and social divides.

Water, Poverty and Environmental Services

This investigation takes the perspective that water management policies should be clearly recognised as an issue of social and environmental justice and as an entrusted collective responsibility of government, private sectors and local communities. It also tries to address the myth of public participation and describes the obstacles, which hinder social groups to exercise truly active roles in water management. Finally, it considers certain implications of increased hemispheric cooperation in environmental services and technologies, identifying priorities towards social and ecological security in the water sector.

Before discussing in more detail the implications of trade in environmental technologies and services in the water sector, the stark realities of many Latin American countries should be highlighted. Foremost, a continuing drive for technological and economic development, within a framework of trade globalisation, has not been capable of guaranteeing water security for local populations. Development projects more than often have shown to both worsen existing socio-economic inequalities in society and produce adverse impacts to the natural environment.

From this standpoint, social and environmental movements are calling for indemnification of an accumulated 'ecological debt', due to the historical destruction of cultural and ecological heritage in the South, as well as recognition of the illegitimacy of external financial debt. Those who abuse the biosphere, transgress ecological limits and enforce unsustainable patterns of resource extraction should be held accountable for their actions.

From the perspective of water management, it is apparent that many Latin American river basins clearly reflect the distribution of power and the dominant socio-economic trends in society. Often, an authoritative minority overexploit water resources, while marginalised and impoverished people, especially traditional rural and indigenous communities, are the first victims of water ecosystem deterioration. In this line of discussion, it is important to point out another recent trend in international summits and forums, which refer to the role of water, biodiversity and natural resources in general, in the provision of environmental services. Here we should recognise that local communities that live in close interaction with their natural surroundings, have long understood the generosity of ecosystems to sustain their livelihoods.

What is new in these political dialogues is that environmental services are given an economic value and are entering evermore as another component of the global market. This position has serious pitfalls, and could clearly accentuate the privatisation and inequitable distribution of natural resources in the South. In relation to water management, this concept has led to the view that one does not necessarily have access to water by right, but by what one is willing to pay, or by the degree of 'value-added' economic benefit of a particular water use. Ironically, policy makers have scarcely focused on providing incentives to local communities that protect essential water producing ecosystems for urban and industrial users.

Water Conflicts in the Colombian Context

The fragility and increasing deterioration of water resources in Colombia is everyday more evident. Once considered among the top five countries abundant in water production, today the nation figures in the 15th to 20th position. Although Colombia is often regarded as privileged in water resources in comparison with other nations (geo-climatic conditions represent an annual precipitation of 3,000 mm), these figures hide many of the true realities. For example, the Magdalena - Cauca hydrographic region produces 10% of the nation's water balance, but supports 70% of the Colombian population. Other studies show that only 46% of the population is being supplied with potable water of acceptable quality. It is evident that increasing socio-economic, environmental and political conflicts will furthermore aggravate this situation.

Economic development models and urban centred policy orientation have increasingly driven water management in Colombia (as in other neighbouring Latin American countries) towards privatisation, export-oriented strategies and infrastructure intensive projects; water appropriation and exploitation are the dominant characteristic. This focus has failed to protect the fundamental ecological functions of aquatic systems and has generated a chain of enduring socio-cultural impacts in local populations. The following case studies demonstrate the scale and magnitude of this situation:

The Flower Growing Industry
The flower-growing industry, with its main centre of development in the savannah plains of Bogotá, is frequently highlighted by the national government as a demonstrative industrial sector in Colombia. In fact, flower production represents one of the top five product exports, with annual sales of US$600 million, 85% of which are in the United States. However, hidden behind these 'cold' economic figures are the grave impacts caused in water ecosystems, as well as the related health problems in predominately women workers.

Water consumption in flower production is estimated at 200 - 300 m3/hectare/week, frequently depleting precious groundwater reserves at the detriment of the basic needs of local communities. Moreover, the industry widely employs toxic pesticides such as aldicarb, dichlorvos, dichloropropeno and methavin, classified internationally as having high risks to human health and the environment.

Hydroelectricity and Export Crops
The Urra I hydroelectric dam, constructed and financed by a multilateral consortium, is located 30 km south of Tierra Alta (Córdoba) and forms part of the Sinú river catchment. The dam flood area is calculated at 7,400 hectares. The total estimated cost of the project is $US800 million, with an installed capacity of 340 MW and an effective project life of only 20 years according to independent experts. Additional to this absurd economic picture, are the irreversible impacts caused to tropical forest and mangrove ecosystems, the habitat loss of important fish species, the disruption of traditional fishing economies, the intensification of the regional armed conflict and the violation of cultural and territorial rights of the Embera-Katio indigenous population. The hydroelectric dam has also be seen as a key piece to implementing a mega-development project in the region, based on export-crops such as palm-oil plantations and shrimp farming.

Oil Production
Barrancabermeja is the oil production capital of Colombia, located on the river Magdalena and surrounded by a natural system of marshlands that constitute a vital biodiversity reserve. These wetlands have been chronically affected by oil spills and wastewater discharges during more than 80 years of oil production in the region. On the 7th of May 1999, one of the most serious recent incidents occurred when the Llanito 18 oil well over-pressured, releasing 250 barrels of crude oil over an area of 17 hectares. Oil contamination has placed local flora and fauna at serious risk and the oil companies have been negligent in so-called 'clean-up' operations. Local fishing communities have calculated that the natural recuperation of the area will take more than 60 years.

Urban Water Supply
For more than five years, local peasant communities and environmentalists have been campaigning against the construction of a new water supply project for the metropolitan area of Bucaramanga (Santander). The water supply plan conceives an infrastructure intensive dam and tunnel scheme that will seriously affect highly fragile cloud-mountain-forest ecosystems. Total investment for this project is estimated at $US200 million, which will signify multinational privatisation of water services, increased public water tariffs and benefits in particular to construction industries and landowners that seek to increase city urbanisation at all cost. Civil movements opposing the privatisation of water-supplies in Colombia, have also recently been seen in the regions of Cauca and Risaralda.

Coca Crop Eradication
The coca crop eradication plan in different regions of Colombia, including national parks, represents a severe threat to indigenous peoples and ecosystems. The $US1.3 billion aid programme for combating drug-trafficking has to-date largely involved indiscriminate aerial spraying of large areas of tropical forest with Roundup Ultra herbicide. Eye-witness reports have denounced the poisoning of local food crops, water contamination, destruction of native vegetation and related health problems in local and indigenous populations, particularly children. The long-term benefits of this crop eradication scheme have been shown to be extremely limited.

Fluvial Transport
A growing concern in Colombia is the tendency to privatise large river stretches for fluvial transport schemes, since government sectors and foreign investors perceive them as 'strategic' to further trade liberalisation. Proposed navigational projects include: Orinoco - river Meta, the Atlantic-Pacific canal interconnection and La Plata - Amazonas - Putumayo. The consequent social and environmental impacts at regional, national and international levels are generally unknown, project expectations alone have generated a wave of violence and internal displacements in various regions.

Determining Factors in Water Conflicts
This brief panorama of water conflicts in Colombia is sufficient to highlight a series of recurring and interrelating factors that directly threaten the integrity of water ecosystems, as well as the cultural and social identity of local communities that directly depend on them for common property resources.

It is possible, from this perspective, to highlight several key determinants. First, 'development' continues to be conceived in strictly economic terms, where social equality and environmental sustainability issues are virtually ignored. Second, private and 'national interests' of an elite minority often appear to prevail over and above the collective needs and rights of local populations. Third, there are rising indicators of social and economic injustice, and this injustice constitutes a main cause of the impoverishment of ecosystems and cultures. Fourth, trade globalisation models seem only to increase the levels of debt (economic and ecological) for developing countries. Fifth, there are insufficient opportunities for active and meaningful participation of local actors in policy-making, in particular marginalised sectors of society. Sixth, there is insufficient recognition of the enormous potential of cultural and biological diversity in tropical countries, which ironically could be a source for alternative energy and sanitation technologies. Seventh, increasing urbanisation is physically and socially creating increasing distance between rural and urban people, creating ecological and political catastrophes.
Towards a Social Vision for Water Management

The construction of viable alternatives to counteract the growing wave of negative impacts that threaten the water security of local communities has been the topic of many regional, national and international forums. In consequence, a wide range of non-governmental organisations (NGOs), grass-root organisations, donor agencies and environmental bodies around the planet are advocating that a series of guiding principles be included in water policies.

Together, the civil society organisations involved in these initiatives have elaborated a series of recommendations. First, they have recommended that the overriding primary goal of water management should be to safeguard the vitality and diversity of ecosystems, while at the same time to enhance the livelihoods and quality of life of local people who directly depend on them for common property resources. Second, they recommend undertaking this work by empowering local actors through effective participation and social water management schemes that embody traditional knowledge and forms of organisation, as well as locally developed technologies.

Third, they signal an urgent need for a horizontal and democratic means of dialogue between genders, cultures and social classes, aimed at the construction of sustainable water management processes. Fourth, they have noted the need to build open, accountable and representative authorities that are both responsive to the needs of local communities and capable of resolving water issues from a holistic and interdisciplinary approach. Fifth, they have rejected all government and multilateral involvement in destructive intervention schemes that directly affect the integrity of water ecosystems to nurture cultures and biodiversity.

Sixth, they call for further applied research and traditional knowledge exchange, to better understand and strengthen the role of local peoples in the management and conservation of water ecosystems. Seventh, they signal the urgent need for long-term investment programmes and incentive schemes directed at the protection and restoration of ecologically strategic ecosystems, in particular those in serious danger from climate change.
Eighth, they call for the implementation of innovative educational and awareness-raising programmes that can foster attitudes, beliefs and fundamental values related to equitable and sustainable use of water resources. Ninth, they also highlight the need to establish up-to-date knowledge and information sharing networks on the state of water resources, systems that can allow both social actors and regional institutions to take opportune and effective decisions.

Appropriate Technologies and Water Policies
Above, a series of dominant conflicts and challenges are highlighted. These are central to sustainable water management in Latin American countries. In considering the implications of trade liberalisation and hemispherical cooperation in water technology and services, we must bear the current situation clearly in mind. It is also important to reflect foremost on questions that permit a more holistic understanding of the situation, that is to say, an in-depth analysis of the socio-economic contexts and political frameworks that have given origin to the grave ecological and social problems that characterise water management in Latin American societies today.

This reflection should lead us to fundamental and radical changes in the way we propose to face this water crisis. It should lead to the development of alternatives and solutions where local communities are the principal actors in cooperative water management schemes. It implies that urban and rural populations should be able to jointly carry forward effective and equitable water sanitation programmes, based on their interrelated social and ecological dynamics. It also suggests that attention should be placed on preventing contamination at its source, as well as strengthening schemes that promote the social production and sustainable use of water.

The development of appropriate water technologies requires technologies that facilitate the distribution of social and environmental benefits while minimising negative impacts. This is a scientific problem, but moreover a political one;

in other words, technological development in the water sector should allow us to advance towards a humanitarian society that guarantees truly sustainable conditions of equilibrium with our natural and social surroundings. It is therefore not only sufficient to think of improvements in water infrastructure and services; in proposing real and lasting change, we must come to terms with the type of society that we are currently living in and the one that we aspire for our children to collectively inherit. More efforts should be focused on strengthening sustainable community-based projects that provide innovative alternatives to conventional water management thinking, for example: enhancing and conserving water producing ecosystems, civil society natural reserves, rainwater harvesting and distribution, agro-ecological farming techniques, associative water supply and eco-sanitation schemes, rational water use and recycling technologies, etc.

Finally, we could reflect on the following words of wisdom: “A growing collection of scientific evidence now suggests what indigenous people have been declaring for many years: life as we now it, is in grave danger. We can not ignore the consequences of this evidence. We must learn to live with this shadow and seek to pursue the light that can restore natural equilibrium. We have to question the way that technology is being used in order to sustain the life of Mother Earth”.

The Water Demand Management Challenge – National Water Master Planning in Jordan

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Presentation of topic and analysis of issue:
Jordan's precarious water situation calls for making use of all available means to bridge the gap between scarce water resources and increasing demands for water in the future. Due to a high natural growth rate and the influx of refugees, the Jordanian population has developed in ways that don't go with water availability - quantitatively, spatially and temporally. This situation is likely to aggravate in the future. In order to develop strategies to cope with such a situation, the Jordanian Ministry of Water and Irrigation (MWI), supported by the German Technical Cooperation (GTZ), developed a digital National Water Master Plan (NWMP). The NWMP consists of text documents, outlining recommendations on issues such as environment, economics, institutional and legal development, as well as water resource and water use status quo and development. These documents are complemented by a software toolbox, which assists in refined water demand projection, virtual water transferring, budgeting of water and allocation to different sectors and regions.

After introducing the NWMP and its tools, this paper focuses on how the gap between the projected resources and demands in Jordan can be reduced using different water demand management tools, including inter-sector allocations and water transfers.

Discussion of results:
Balancing of water resources and demands without spatial and inter-sector reallocation is resulting in a negative water balance within the planning horizon of the NWMP (2005-2020). Balancing for the NWMP was based on three different balancing units, representing political, hydrological and socioeconomic boundaries. In addition to the spatial and temporal resolution, balances can be presented for different climatic year types (wet, medium, dry) and demand related scenarios. The scenarios can be created using the various pre-processing modules in the NWMP software toolbox.

Based on a scenario that uses unrestricted demand, it is foreseeable that especially the irrigation demands cannot be met. Due to the foreseen completion of a large number of investment projects on both the demand and the supply side, as outlined in MWI's investment plan, the deficit in the balance between water resources and unrestricted demand will be lowered from around 450 MCM/a in 2005 to 370 MCM/a in 2020. This is despite the population growth and the resulting growth in municipal water demand. An equal water balance by 2020 can only be reached if water transfers from less populated areas to the urban centres are altered and augmented, the share of municipal water consumption among the sectors is increased at the expense of agriculture, and demands in all sectors are restricted. Transfer systems do not only encompass drinking water transfers, but also transfers of treated wastewater in order to substitute fresh water in irrigated agriculture. These kinds of transfers will significantly increase in volume during the planning horizon. A successful run of the balancing module for the planning horizon 2005-2020, based on a realistic demand scenario due to a large array of water demand management measures, showed that an equal water balance can be reached in Jordan by 2020.

Conclusions and Recommendations:
As most of the renewable water resources that can be exploited at reasonable cost and acceptable environmental impact are already tapped, water management in Jordan has to shift to alternative resources of water, efficiency gains, and to a reallocation of resources between sectors. Alternative resources include desalinated water (brackish groundwater and sea water), and treated wastewater (to replace freshwater used in irrigated agriculture). Efficiency gains can be pursued through reduction of administrative and technical losses in the distribution networks (Unaccounted For Water), and through a combination of water demand management (WDM) measures, both on the infrastructure and the behavioural change sides. Of the different sector demands, namely municipal, tourism, industrial, and

irrigation agriculture, the municipal and irrigation agriculture demands show the greatest potential for conflict. Policy support is needed in order to gain the necessary public approval for reallocation between sectors. At the same time, it has to be guaranteed, that all regions of the country, urban and rural, can be provided with an equal share of water per capita.

The NWMP has enabled MWI to shoulder the difficult task of balancing and allocating water for future generations. The NWMP and its toolbox can also serve as a management example for other water-stressed countries.

Workshop 4:

Tailoring Water and Sanitation Solutions to Reach the Millennium Development Goals

Decentralization as a tool for optimizing Rural Water Supply & Sanitation Sector service delivery mechanism– Experience in Sri Lanka

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Sri Lanka has a population of 19 million of which 78 percent live in rural areas. As a result of the high priority accorded by successive governments for the development of the Rural Water Supply and Sanitation (RWSS) Sector, the country has been able to reach its present water supply coverage of 70 percent. However, some rural areas still lack safe drinking water supply and adequate sanitation facilities. The government has set an ambitious target of providing safe drinking water and basic sanitation to 85 percent of the population by year 2015 and 100 percent by year 2025. This complies with the Millennium Development Goals (MDG) set by the United Nations.

Long years of experience witnessing deteriorated RWSS facilities prompted policy makers and funding agencies to develop strategies to overcome the seemingly inherent problems in village service delivery. Among different approaches attempted over the past decades, the 'Demand Driven', 'Community Centered' and "Community Managed and Owned" approaches were found best for actively involving communities in project implementation, thereby improving the potential for sustainability to reach the MDG. However, all major rural water supply projects implemented in Sri Lanka during last few decades were centrally managed for service. This arrangement proved to be highly successful for RWSS project planning and construction. Nevertheless, main drawbacks in this mechanism were; (i) Little or no back up support can be expected during maintenance stage by the project implementation agency due to non existence of proper back-up support mechanism after scheme commissioning, (ii) Little opportunity to Local Authorities who are legally entrusted to provide public services to communities, to develop their capacities for back-up supports and to undertake future WSS programs.

The Government, taking this important issue into consideration has embarked on a significant sector reform program aimed at improving long term sustainability of rural water supply and sanitation investments. The reforms aim to mainstream community-based RWSS through decentralized implementation arrangements involving Provincial Councils (PCs) and Local Authorities (LAs) as key stakeholders in the implementation process. In Sri Lanka, PCs and LAs (which are operating under PCs) are the main public institutions serving community under the decentralized administrative set up introduced in late 80's. The importance of local government involvement in the provision of RWSS has been addressed under government's sector reform program, which entrust PCs and LAs with the key responsibility for RWSS development.

In 2002 Sri Lanka Government with World Bank support initiated the Second Community Water Supply and Sanitation Project (2nd CWSSP) embracing the National RWSS Policy and with the target of providing safe water supply and adequate sanitation for 1.4 million people in approximately 1,100 rural villages through decentralized project implementation approach. This was the country's first ever effort to assign Local Government Bodies with the responsibility for the provision of RWSS services to rural communities under a major donor funded project.

Generally Public Sector in Sri Lanka is not attuned to innovative participatory approaches. They are governed with pre-structured government regulations and perform within the prescribed framework without much flexibility. The 2nd CWSSP's forward-looking principles and procedures are specifically designed to counteract constraints associated with public institutions by introducing community participation, devolution of authority to the local level, contemporary administrative, management and financial systems, and a culture of service to rural communities.

This new standard for RWSS, has been enthusiastically embraced at provincial and local authority levels, which can see the worth of their new roles through the positive impact on beneficiary communities. PCs and LAs, having experienced this new approach, will now sustain them through self-interest. News of the 2nd CWSSP's successes in mobilizing rural communities, changing personal hygiene behavior, and equitably embracing poorer villagers, has reached the highest levels of government, prompting calls for the project approach to be assessed by central, provincial and local government in other areas of rural development and adopted where appropriate.

Compared to centralized, project oriented approach, introducing decentralized project implementation approach is a slow process which needs more effort and resources. PCs and LAs are generally constrained by resources and manpower and under pressure to fulfill their obligations to the society. The project of this nature adds more pressure to those institutions. However, benefits getting from institutionalization of RWSS implementation process are substantial. The key benefits are better focus on sustainability due to PC/LA involvement, enhanced ability to handle RWSS project with own expertise and resources in future and faster decision making ability. The lesson learned is that with clear strategies and commitments of participating stakeholders, inherent weaknesses in the public system can be overcome.

There was a risk of having more political interference due the decentralized approach as PCs and LAs are under political leadership. Nevertheless, the project received substantial support from political leadership and very little political interference or negative impact observed during project implementation. The main reasons for this positive outcome are that the project's clear and transparent policies, timely and systematic project awareness program and effective coordination at all levels of project implementation.

Catchment Area Management in Transition Economies: The Bregalnica River Basin Management Approach, Macedonia

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Presentation of topic and analysis of issue: Macedonia as a middle-income country with a GNP per capita of 1980 USD may not be expected to be in the focus of the initiatives to reach the Millennium Development Goals. Yet, like many transition economies, it suffers from regionally scarce water resources, encounters severe pollution from untreated communal wastewater and has a legacy of outdated industrial and agro-industrial complexes leading to water contamination hot spots. With its history of central planning, Macedonia features standardized and often insufficient or outdated water sector infrastructure. Access to public sanitation is rather limited with only 60% of total population connected, and wastewater treatment is restricted to three settlement areas in the vicinity of natural lakes. Inappropriate tariff structures and unsatisfactory collection rates for invoiced public services aggravate the lack of funds to improve the situation. At the same time, different economic sectors with development potential for the country (particularly agriculture and tourism) compete for different uses of the limited water resources to achieve their full economic potential.

Macedonia's water resources management is currently subject to fundamental institutional and regulatory changes. They are due to several factors, including the country's overall transition process, its preparation to EU accession and its decentralization efforts. Traditionally, there has hardly been any sub-national responsibility for water resources management. The now increasingly strengthened municipal responsibilities comprise the provision of basic infrastructure. Responsibilities are shifted from the national to the local level with no intermediate state level (province or similar) to balance and coordinate the use and the protection of water resources. The introduction of a River Basin Management (RBM) in Macedonia shall fill this gap.

Macedonia has already made substantial efforts in this direction by revising its water law to include a RBM approach; it also sought the support of Switzerland to follow the new approach as a pilot case in the Bregalnica river basin. Switzerland's longstanding experience with decentralized solutions, including municipal responsibility on provision of basic infrastructure, tariff setting for utility services and in fiscal matters, may help to find solutions which are locally adapted and cost-efficient.

The responsible Macedonian ministries and the municipalities in the Bregalnica river basin together with the Swiss State Secretariat for Economic affairs (seco) have initialized a process that shall make the Bregalnica RBM a pilot case for the region and other countries with similar framework conditions. The Bregalnica river basin is a sub-catchment of Vardar River, which drains 80% of Macedonia and crosses the border to Greece, thus, reaching inter-regional importance.

Discussion of results/findings:
1. Cost recovery for water supply and sanitation services is the main issue and concern regarding the sustainability of basic infrastructure service provision. It is also an important indicator on whether the services provided are perceived to be satisfactory by the population.

2. There is a clear need for cooperation between municipalities and other stakeholders on water resources management, as well as for continuous support from the central and ministry level for strategic planning, setting up appropriate legal standards, clearly defined responsibilities, etc.. For decentralized solutions of urban sanitation (both high- and low-tech) to be sustainable it is crucial that synergies within the region on planning, operation and maintenance, along with management be captured.

3. There is not only one single sustainable solution for proper water supply and sanitation, even within one region; it's a mixture of different technologies and organizational settings which yields overall

optimal solutions. The selection of an adapted solution depends on the specific environmental pressure and state situation, as well as on the economic status and development goals of the site.

4. A regional or intermunicipal co-operation without financing mechanisms for regional priority projects remains academic. In the Bregalnica RBM, this financing mechanism shall be achieved through the establishment of competitive RBM fund.

Conclusions and recommendations:
The work on the pilot case Bregalnica RBM shows that in Macedonia technical knowledge on water sector planning is available, although extendable through cooperation with industrialized countries. Joint approaches to tailor water supply and sanitation solutions in transition or developing countries may be fruitful for both sides as long as sufficient attention is paid to the coordination among different donors.

Regional cooperation to improve water resources management and to direct new investments to basic infrastructure solutions which are adapted to the site characteristics require a joint understanding of the regional priorities. It is therefore recommended to dedicate sufficient resources to develop and establish a regional priority needs and measures plan through stakeholder integration. Having set a joint understanding on the guiding objectives and principles, openness can be kept during implementation regarding different parallel initiatives, forms of sponsorship and types of technologies.

Giving high priority to cost recovery issues and regionally administrated financing mechanisms may proof to be a powerful incentive to encourage the selection of sustainable solutions.

"Use Now, Pay Later": An Innovative Approach to Increasing Access to Improved Latrine Facilities in Rural Communities in Ghana.

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Presentation of Topic and Analysis of Issue: Achieving the Water and Sanitation Sector Millennium Development Goals will require innovating approaches and efficient use of resource with commitment from project beneficiaries. Sanitation, in particular, which has become a 'stepchild' to water supply provision will need extra effort at all levels to facilitate the achievement of set goals. An innovative strategy that Professional Network Association (ProNet) has developed with the support of project beneficiaries is the "Use Now, Pay Later" strategy. This strategy has led to an increase in sanitation coverage by 500% within a year.

ProNet started implementing integrated water, sanitation and hygiene promotion in the Upper West Region of Ghana in 1995 with funding support from WaterAid, a UK Charity and UNICEF. Under the programme communities are supported to have access to improved water points, mainly hand dug wells fitted with hand pumps and latrine facilities. The focus of the programme is to improve the health of the members of the participating communities by reducing water- and sanitation-related diseases through adoption of better hygiene practices. Thus, water and sanitation facilities are provided to facilitate the adoption of good hygiene practices and change in high-risk hygiene-related behaviours at household and community levels.

Most communities perceive water supply provision as whole communal issues whilst sanitation in terms of provision of latrine facilities is a household affair. Hygiene promotion and adoption of better hygiene practices cut across the individual, household and community levels. Therefore mobilising for construction hand dug wells is easier than for a household latrine. With the sanitation component of the programme households in every "hand dug well community" is supported to construct a latrine facility, mainly VIP and soak-aways behind their bath houses. This is to address the immediate problem of unsafe disposal of human waste and appropriate management of solid and liquid waste to improve environmental hygiene.

Trained latrine artisans selected from the community promote and construct the facility for a fee from the beneficiary household. The household further digs the pit; provides materials and builds the superstructure. The project on the other hand provides 'stimulant packages' in the form a few bags of cement and PVC pipe. All these requirements notwithstanding, the households have to make upfront cash payment of Seventy Thousand Cedis (an equivalent of US$7) as a non-refundable commitment fee. This is used to pay the latrine artisan on behalf of the household. Such an amount must be paid before the household could benefit from the intervention.

During the period of 1995 and 2001, the total latrine coverage was 80 VIPs per year representing 21% of the population. This became a concern to the project staff and therefore investigations were commissioned into the causes of low demand for latrine facilities by the households.

The investigation revealed that the households do need the facility and are ready and willing to demand for the facility. They are also prepared to make both in-kind and cash contributions to the project. However, the timing of the payment of cash upfront has been the obstacle to the household demand for the latrine facilities. The underlying reason was that construction period of the latrines coincides with the dry and lean season when farming activities have ended and people hardly have enough to spend. The upfront payment requirement, especially paying the entire amount at once, worsens further an already bad situation.

The community members suggested that they should be allowed to benefit from the latrine programme and the commitment fees paid during the harvesting season when the financial burden is reduced. They also propose to select a trusted member of the Community-based WATSAN Committees to collect the fees on behalf of the project and that there should be a monthly instalment payment over a period of 12 months. The term coined by the community members for this arrangement was "use now, pay later".

Following from this, ProNet decided to pilot this option in two Districts in 2003. Consequently, systems for collecting the instalment payments were designed and implemented. Latrine artisans and WATSAN Committee members were given orientation on the "new" approach, their roles and information to be disseminated to the potential beneficiaries. At the end of the 2003 Construction Season, 500 households have applied for latrines. However, ProNet could only meet 400 because of limited funding. This number is equal to the latrines constructed during the six-year period between 1995 and 2001. For the 2005/6 construction season 650 households have applied to participate in the latrine programme in three Districts.

Another dimension discovered from this innovation was that there was between 90 and 95% latrine coverage in the piloted communities. This met the project strategy of concentrating facilities in a few communities rather than spreading 'thinly' in more communities.

Data from debt recovery indicate that 10 of the 18 communities have made 100% payment as at August 2004. The payment of the remaining 8 communities' averages 65%. A total amount of Twelve Million Cedis (US$1200) has been generated from this innovation.

Poor households identified by the communities were exempted from the payment of commitment fee. For the 400 latrines constructed during the period under review 12 (3%) households were exempted from paying the fees.

Poverty and Water Action in Rural Nepal

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Water is a basic need and a human right. Rural water and sanitation action has many direct and indirect ways of moving towards the Millennium Development Goals. Internationally it is well established that improving water security and sanitation for poor people helps eradicate poverty and support sustainable development. However, the poorest groups can be ignored by development programmes since their voices are not heard and they have a lower (political) status in community development. Lesser education and awareness together with sometimes discriminatory caste/ethnic traditions further hamper full participation in local action.

The Rural Water Supply and Sanitation Support Programme (RWSSSP) Phase III was a joint effort of the Governments of Nepal and Finland. Phase III operated in eight districts of Western Nepal in 1999-2004, completing nearly 900 water and/or sanitation schemes. This paper outlines the findings from the various interactions with the Water and Sanitation Users Committees (UC) about how a water and sanitation programme can directly address poverty. The aim was to sharpen the poverty focus and to find practical new approaches and working modalities.

Water supply is a high priority in rural Nepali villages. Due to hardship, willingness to pay both in cash and in kind is high especially in the Hill Areas. Yet, the ability to pay or contribute is another matter and can be a problem in poor areas. Not everyone can contribute equally although many programmes expect the same or similar input or participation from all as participation creates a sense of ownership and, thus, a foundation for future sustainability. Also, meaningful participation of the poorest of the poor is a challenge for many reasons.

The UCs were of the opinion that a pro-poor water and sanitation programme should aim at full service coverage within a village. This would bring all interest groups together to work out the best local solutions. The UCs reported they have done the following to address the needs of the poor in their communities:

- Manage a revolving fund charging minimal or zero interest for private water supply and/or sanitation related initiatives.
- Encourage the poor to join income generation activities and link these with the relevant organisations for such activities (other than water and sanitation programmes).
- Encourage and advise disadvantaged groups about ways of increasing their saving and proper utilisation of the fund.
- Subsidise the poor within a community. Some UCs have constructed latrines for the poor up to the plinth level, leaving only the superstructure for the households to erect. Some UCs gave priority to the poor in recruiting paid labour during scheme implementation. Some UCs accepted more in kind contributions from the poor while cash was expected from the others.
- Initiate awareness activities on health and sanitation education, followed by latrine construction.

The UCs recommended the following for a water and sanitation programme:

- Pay attention to the landless families, marginal areas and illegal settlements. This is also a legal problem as facilities should not be constructed for illegal settlements that can be removed at any time. Yet, for humanitarian reasons water and sanitation are essential. Marginal areas on hill tops have the most severe water problems. The full coverage approach would automatically include these areas in a planning process.
- The programme should provide more low-cost technology options, such as rainwater harvesting and improvement and protection of traditional water sources along with the more expensive ones such as gravity flow systems within a scheme. The UC should identify the needs and recommend action, aiming at full coverage.

- Upgrading and rehabilitation of the most affected existing facilities together with “the rehabilitation” of the UC as an institution. Management training for the UC, and UC Networking at district and national levels, would strengthen the UCs as local civil actors and support especially the more remote, poor and small UCs. Especially these were not always aware of their rights, responsibilities and roles as democratically elected users groups as stipulated in the Local Self-Governance Act of Nepal.

Based on consultations, the RWSSSP Phase III initiated poverty-focus schemes with modified contribution patterns and tailor-made human resource development activities. These were based on participatory well-being ranking and verified by community poverty profiles. The approach was received favourably. A series of UC Management training events were also carried out by specially educated trainers including some of the more educated UC members. Feed back on using experienced UC members as trainers of other UC members was highly positive.

At the policy level a dynamic poverty-sensitive approach to rural water and sanitation action should be developed. It would involve rethinking contributions and subsidies, technology options, training components and public awareness campaigns. Continuity and follow up over a longer period of time is needed. Linking with the income generating programmes for productive use of water and local activities to mitigate water-induced hazards with re-forestation, soil conservation and ecosystem protection are some themes for a poverty-sensitive rural water programme to translate into action. Inter-agency partnerships and coordination at the practical local level should be encouraged and stripped of bureaucratic difficulties.

The Millennium Development Goals Progress Report for Nepal in 2002 listed the goal for drinking water as the only one which can probably be achieved with a strong supportive environment. It should not be forgotten that rural water action can also address the goals of poverty reduction, food production, education and health, and environment through affirmative local water and sanitation action.

A community based water and sanitation solution for the slums in Dhaka City

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The issue: About 30% of the population of Bangladesh – some 45 million people – lives in urban areas, and a third of them live in squatters and slums with little or no access to clean water and sanitation. The government is committed to help this impoverished population with the help of a comprehensive poverty alleviation program, the broad goal of which is to improve the quality of life for the poor. This initiative is consistent with the millennium development goals of alleviating poverty through better education, health care, gender balance, partnership, and environmental sustainability. This last goal strives for halving the number of people without safe drinking water by 2015 compared to 1990.

In this backdrop, this paper presents a case study on a novel project on water supply, sanitation and hygiene education designed for the urban poor in Dhaka. The paper will describe the essential project components, present its major achievements and limitations, and suggest ways to make the delivery of project services more effective.

The Project: The project was initiated in 1996 by Water-Aid with the community-level support from a partner NGO – Dustha Shashthya Kendra (DSK). The scope of the project expanded steadily to include 150 slums in Dhaka and Chittagong by 2002. The services provided by the project included: legal water points, sanitation blocks, cluster latrines, household water-sealed pit latrines, hygiene education, drainage improvement, and solid waste management. Most of these services have been provided on cost-recovery basis through community management.

Water points constituted a legal connection to the main line of Dhaka Water Supply and Sewerage Authority (DWASA) along with an underground reservoir and space for bathing and laundry – designed to serve around 500 people. The sanitation blocks typically included up to 12 latrine stalls discharging into a septic tank, along with bathing facilities, also designed for 500 people. Hygiene education and other components were designed to raise awareness on health and benefit the environment.

Achievements and limitations: The project enabled 98% of the beneficiaries to have access to supply water compared to 77% of the non-beneficiaries who had access to water – this is a significant 27% improvement. The gain was more for the 'very poor' group – about 38%. In addition to the apparent health benefits, easier access to clean water freed up time for women and children, and allowed them to pursue other economic activities. In order to provide legitimate access, Water-Aid and DSK had to overcome a major institutional constraint – convince DWASA to allow 'legal' water connections to the slums dwellers, who are tenants and not owners of land. This was no doubt a major break through and a pioneering effort on part of DSK – a model that was adopted by other NGOs later on. A two-tier management model was developed comprising of a management committee and an advisory committee. The former was made of nine women whose primary responsibilities included: collecting water fees, maintenance, and payment of water bills/loan. The advisory committee was made up of five men whose job was to negotiate with local leaders and provide security to the water point.

In general, most slum communities were able to pay for the water bills, but some were unable to recover the capital cost within the payback period. Some 'very poor' members of the community were unable to pay their share regularly. They were allowed subsistence water, but this made them use unsafe water sources such as nearby ditch, canal or river. Moreover, some water points might have been under-utilized due to the presence of cheaper alternatives, such as free municipal stand-pipes or illegal connections that cost less.

The sanitation blocks had positive impact in lowering the high-risk defecation practices (using open hang, drains, water bodies and open spaces); however the success rate was modest. The three key constraints identified for limited success were: high cost, lack of awareness, and space. Attempts were made to recover some cost by allowing non-participants to use the facility for a small fee. It has been estimated that at least a 6-year interest free payback period is needed for recovering the cost of sanitation blocks.

Hygiene education was introduced to mobilize the community to participate in the program. Both house-to-house and community level campaigns were carried out. Messages conveyed to the participants were simple: keeping clean, washing hands after defecation, covering food, using sandals, using safe water, and using sanitary latrines. Households were encouraged to use garbage bins and keep the drains flowing.

The project had a strong capacity building component – members of the management and advisory committees were trained on organizational and management skills. It was noted that due to the inability to pay, the 'poorest of the poor' were often excluded from the committees. The project attempted to promote a sense of ownership, but the slums dwellers did not own the land and their landlords' support was crucial in setting up and operating the facilities.

Remarks: The project has been a great success given the difficulties it faced in introducing the idea of community based water points and sanitation blocks. It has had demonstration impacts in influencing the non-beneficiaries to organize similar programs. By allowing to take charge of the management and financial responsibilities, the project has instilled a sense of 'citizenship' among the otherwise marginalized slum populations. However, the poorest of the poor still seem to have been left out due to their inability to share the cost. They may be allowed to contribute 'in kind' rather than 'in cash' and this may allow them to participate fully in the program.

Cost Recovery and Affordability Challenges for Small Urban Water Supply Schemes: A case study of Rakai town, Uganda

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Presentation of topic and analysis of issue:
At the Johannesburg summit of nations in 1992, all 192 United Nations member states pledged themselves to the attainment of a set of development goals by the year 2015. Known as the UN Millennium Development Goals, they include the goal of ensuring environmental sustainability. This goal is to be partially met through reducing by half the proportion of people without sustainable access to safe drinking water.

For its part the Government of Uganda has established policies and strategies to increase safe water coverage in urban centres to 100% by the year 2015. The coverage currently stands at about 54%. However, a study commissioned by the Directorate of Water Development revealed the alarming fact that safe water usage is below 30%. The major cause of this low usage was identified as the unaffordability of the water. Thus, resources invested in providing access to safe drinking water are not delivering dividends. The water supply systems are under-utilized and hence unsustainable.

Currently, the management of over 20 small urban centre water supply schemes in Uganda has been privatized. In each case, the ownership of the infrastructure is vested in the local water authorities namely, district councils, town councils and sub-county councils. The process of privatization involves clustering three to six towns, depending on proximity, to ensure management operations are economically viable. The private operators are selected to manage the clustered towns through competitive tendering processes for locally registered firms. For smaller scale schemes that may not be clustered with others, local operators with lower overheads are employed by the water authorities as an interim measure. Such operators have also been used for sub-systems that are fed from a larger system in a nearby big town, as is the case for some suburbs of Kampala City.

This paper presents results of a study on the challenges facing the development and management of small urban water supply systems in Uganda, with particular reference to the case of the management structures and tariff spectra developed in Rakai Town. The Government of Uganda included provision of water supply among the five major pillars of its poverty eradication programme. The study methodology consisted of three phases, including a survey of literature and related official documents, interviewing stakeholders and then communicating with stakeholders. This process enabled us to establish with them the critical constraints to water supply development. The study revealed the current Rakai town water supply system to be unsustainable as it stands. A combination of carefully considered tariffs, subsidies, and clustering are discussed, along with the effects they have had. A combination of the nature and effects of carefully considered tariffs, subsidies, and clustering are discussed.

Discussion of results/Findings:
The study shows that alternative approaches to operation and maintenance of water supply infrastructure need to be adopted to ensure the utilization and sustainability of existing infrastructure, and to provide capital for expansion. There is inadequate understanding among the community of the benefits of paying for safe water, and a part of the population continues to use water from unsafe sources. A proposed institutional framework for water management could not be implemented successfully due to the lack of adequate technical and managerial resources. There is a need for capacity building that targets the public and private sectors involved. The results of the study also indicate that a level of government participation is always necessary for sustainable water supply to small urban centres.

This study showed that in order to ensure sustainability of water supply systems in the small urban centre of Rakai town, emphasis should be put on maximising water consumption by the population. This will be achieved by making the cost of water affordable. While lowering costs may appear to negatively affect cost recovery efforts, it attracts more consumers to use the system. In the long run this increased demand will result in the fixed costs being fully recovered. With more people utilising the safe water as a result of lower tariffs, the health and improved sanitation benefits will also be realised.

Building dignity, not toilets

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By reinventing and reinforcing the concept of community, Gram Vikas has set off a unique development process in villages of Orissa, located on the eastern cost of India, considered to be one of the poorest in the country. Termed RHEP (Rural Health and Environment Programme), it uses universally important needs of drinking water and sanitation as a common ground for villagers to come together to sow the seeds of "...a village republic." The fundamentals of the scheme require 100% participation from all villagers with clearly defined stakes and mechanisms for institutional and financial sustainability. The experience demonstrates how something as basic as drinking water and sanitation is able to coalesce and bind divergent strands within communities and create new relationship dynamics between men-women, different sections of the communities, and trigger other strands of development.

In parallel livelihood promotion activities to improve the income and food security of the families. A range of skills is gained as a result of the programme including construction (masonry, stone-cutting, wire-bending, carpentry, plumbing and electrical fittings), forestry and fish-farming. Over 500 masons, including 93 women were trained in 2000 – 2001.

Villagers are encouraged to develop common lands and wastelands with tree plantations, thereby providing timber, fuel, fodder and fruit. Training in business skills of management and marketing are also provided by Gram Vikas.

Gram Vikas will only work in a village once each and every family, irrespective of status, agrees to be part of the programme. This is rooted in the premise that sanitation can only be dealt with properly when every household adopts safe sanitation practices and in the belief that poor people can and will pay for products and services they believe will improve their quality of life. The villagers came together not only to raise the necessary funds for the project but also for joint decision making, initially in respect of the water supply, but eventually for all other decisions to be taken in the community.

In each village the entire community is brought together to facilitate the formation of a village committee to build a central water tank for the village. Water is pumped from a safe source and stored in the overhead tank and supplied to every family through an underground pipe system. Toilets and bathing rooms with running water are provided on an individual basis with twin leach pits per toilet. . The planting of banana trees adjacent to these leach pits ensures that not only is there little need to ever empty them, but also that a plentiful supply of bananas is available. The communities are also supported in developing community infrastructure such as roads, drains and grain banks.

A critical factor for project sustainability is the institution of a corpus fund in each village at the start of the intervention. All families contribute an average of Rs 1,000 to the fund, which is used only for extension of the same facilities to new families as the village grows, ensuring 100% coverage at all times. Since contribution to the fund is mandatory, the richer families subsidize poorer families or part support is extended from the community fund. Setting up the corpus fund has led to enhanced village unity as all families are shareholders in the fund and have an equal stake in decision-making. The corpus fund gives a sense of financial security to the villagers and has been used as collateral in some villages to raise loans from banks.

The total spent from 1992 – 2001 on providing toilets, bathing rooms, water tanks, water supply systems, compost tanks, community halls and drainage is $1m. 66 per cent of this cost was met by Gram Vikas, 32 per cent by households and 2 per cent by the government. The maintenance and running costs are met by the villagers themselves and these costs are approximately $12.5 per household per year, covering electricity bills, repairs and maintenance of pumps and the salary of the pump operator.

Women have taken the lead in ensuring that the programme is completed on time and that the project continues after Gram Vikas withdraws. It is the women in the community who benefit most from the improved water supply since they no longer need to spend hours a day fetching and carrying water and can also bathe in clean water in the privacy of their own home, rather than having to use the polluted village pond. There has been a notable reduction in the incidence of skin disease and gynaecological problems since the heavily polluted village ponds are no longer used for bathing. No longer used as communal bathing places, the clean ponds are now used for pisci-culture, bringing a much welcome additional source of income and protein to the village. An indicator of the success of the programme is that private water supply and sanitation are now featured on the marriage lists of young village women.

RHEP aims to create an enabling environment in the villages in which it works for the community to become politically assertive. It encourages each individual to be involved in the decision-making process and helps village committees to register themselves as legal entities and to keep proper accounting records. The legal status enables villagers to play a pro-active role in securing development funds that are available as part of government programmes.

A range of construction materials are used, primarily stone or locally made bricks. Local masons have been trained to use innovative masonry bonds which are 30 per cent more resource efficient than conventional brick masonry. Filler slab roofs save on concrete by substituting locally available cheap filler material. The vertical shaft brick kiln has been developed for local use and is 30 per cent more effective than the commonly found brick kilns and 50 per cent more effective than the local clamps. Over 30 jobs have been created in the brick kilns established to date.

Gram Vikas' reaches out to over 154 villages (~12,000 families) through RHEP, and is continuously expanding in clusters through people driven processes. Initially it took two or three years to convince villagers of the value of joining the programme, but the acknowledged success of the programme means that many villages are now pressing for it to be implemented. Gram Vikas aims to have reached 100,000 families in the rural areas of Orissa by 2020. It recognises that achieving a critical mass is crucial if the government, private and non-governmental organisations are to react to a community's demands and they are seeking to cluster new villages around existing ones in order to increase the impact.

Gram Vikas is now partnering the government in implementation of the rural drinking water supply programme across Orissa, and demonstrating its approach to total sanitation and habitat development at a wider platform. Its holistic and sustainable approach to development and efforts to realise Mahatma Gandhi's vision of sustainable "village republics", continues to be increasingly recognised throughout India.

Selecting Appropriate Wastewater Treatment Technologies For Achieving Millennium Development Goals In Urban Settings.

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According to the World Health Organization, at least 1.1 billion people lack access to safe water and 2.4 billion lack access to basic sanitation. These deficiencies are linked directly to the deaths of almost 4,000 children each day. Goal 7 of the United Nations' Millennium Development Goals (MDGs)--Ensure Environmental Sustainability-- includes a specific target for water and sanitation: to halve by 2015 the proportion of people without access to safe drinking water and basic sanitation.

The world has experienced unprecedented urban growth in recent decades. In the year 2000, almost half of the world's population lived in urban areas. It is expected that this number will increase to 60 percent by 2030, and that most urban growth will occur in less developed countries. This means that efforts towards meeting MDGs in developing nations must address not only small-scale rural solutions but also basic sanitation in urban settings. In comparison with wastewater collection coverage, wastewater treatment coverage in urban areas of developing countries is generally much lower and, in many cases, non-existent. Therefore the challenge remains in defining for them treatment schemes based on situation-appropriate technologies that are suitable for the harsh realities they face.

Low implementation costs, proven technology, ease of operation, and flexibility of upgrade in subsequent stages are all desired features of appropriate wastewater treatment technologies that would address the sanitation challenges unfortunately still present in many of the urban centers of the developing world. Lagoon-based treatment solutions, although generally cost-effective in relatively small urban applications, are not considered feasible for larger applications due to their inherent large space requirements. More compact conventional mechanical technologies commonly adopted in developed countries, such as activated sludge, are expensive to build and operate, and they require high levels of expertise to run and maintain. So mechanical-based wastewater treatment solutions that are simpler and less expensive to build and operate are still required for medium to large urban settings in developing countries and/or in the absence of large available areas. Two examples of such technologies are chemically enhanced primary treatment (CEPT) and upflow anaerobic sludge blanket reactors (UASB).

CEPT

Physical-chemical treatment of wastewater, which originated in Europe in the 18th century, was widely relied upon in the late-19th and early-20th centuries as part of sanitation schemes for urban centers in Europe and in North America. The high cost of handling and disposing the large amounts of sludge produced and the advent of stricter effluent requirements resulted in abandonment of this process in favor of systems that relied upon a biological treatment step. In recent years however, chemically enhanced primary treatment, a variation of the early process that relies upon considerably lower dosages of chemicals, has found applicability in large-scale treatment solutions. Treatment plants in cities like Hong Kong, Rio de Janeiro, Mexico City, and Bogotá have either adopted or are in the process of incorporating CEPT technology.

CEPT is suitable for applications in which minimizing construction and operations and maintenance (O&M) costs is essential. This process is applicable for situations in which high removals of organic matter are not required (e.g., Ocean discharges) or, with the incorporation of disinfection, where public health protection is considered a higher priority than environmental protection (e.g., effluent reuse for irrigation). An interesting characteristic of this process is that its initial implementation doesn't preclude achieving higher treatment levels by later incorporating a biological treatment step.

UASB Reactors

Upflow Anaerobic Sludge Blanket technology is increasingly considered for municipal wastewater treatment applications in warm-weather locations because of its low cost and ease of operation. Although this technology cannot by itself produce effluent of the quality of a conventional secondary process such as activated sludge, it can still achieve significant organic matter removal rates (e.g., 60 to 75 percent

BOD_5 removals) at a fraction of the construction and O&M costs. Experience to date in Latin America has shown that an UASB-based plant is simpler, less reliant on mechanical components. and can easily achieve double the organic matter removal rates of conventional primary treatment. In addition, the UASB process generates substantially lower quantities of sludge, therefore reducing the associated sludge disposal costs. It's important to recognize, however, that the anaerobic nature of the process carries a high potential for H_2S generation (thus odor and corrosion problems) for municipal UASB applications with significant sulfate contents. The challenge is to couple UASB technology with a cost-effective subsequent disinfection step to protect public health or a polishing step for those applications requiring secondary and/or tertiary treatment levels.

This presentation will address the challenges associated with providing wastewater treatment solutions in medium to large urban areas were essentially none currently exist and will focus on two particular technologies deemed appropriate for these applications in developing countries. Discussion will include key features of these technologies, their basis for design, performance characteristics, typical costs, and specific examples where they have been implemented.

Recycling of Grey Water in Cyprus

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Presentation of the project/topic and analysis of the issue:
Only the estimated 0.1% or less of the world's water supports the world's population and this is unequally distributed around the world. In arid or semi-arid regions of the world like Cyprus, the need for a satisfactory water supply poses a constant problem because of low or uneven distribution of precipitation and high evapotranspiration.

Throughout its long history Cyprus has always been confronted with the problem of water shortage. Droughts are a very usual phenomenon and many times in the past Cyprus came close to desertion as a result. Cyprus has no rivers with perennial flow while rainfall is highly variable and droughts occur frequently. For the period 1960 to 1996, a lot of large and medium size water projects using conventional sources (dams, main conveyors, etc), were constructed for both irrigation and drinking water supply. Each of these projects built for the solution of the water problem of Cyprus was bigger than the previous. At the same time the problem not only does it not get better but it grows larger each year. In order for this situation to improve, as from 1997 onwards, the Government of Cyprus has decided in parallel with new projects using non-conventional sources (desalination, etc), the implementation of water conservation measures at household level.

Conservation of drinking water has been initiated as a practical means of assisting water demand management where, for instance, capital expenditure on water resource development (new dams, main conveyors, water treatment, etc) might be reduced or deferred. "Water saved is exactly the same as water supplied" and "One person's reduction in water use makes water available for someone else to use".

Potable water used in households and industry is normally taken directly from the drinking water system and discharged into a central sewerage system or into an onsite wastewater system, like a septic tank/absorption pit. Water suitable for potable use is therefore taken from the supply system and used for other purposes. It is quite obvious that water of this quality is not needed from many domestic and industrial applications. In Cyprus over 50% of the demand for water could be met by water of a lower grade quality. To meet these non-potable water demands with an appropriate quality of water the cheapest solution is the decentralized recycling of at least a suitable part of the discharge water i.e grey water for reuse for garden irrigation/watering and toilet flushing of the same household.

In Cyprus lightly polluted or Grey Water from baths, showers, hand or wash basins and washing machines is kept separate from heavily polluted or Black Water from WC's and kitchens. As a result it is relatively easy to intercept each type of waste water at household level for subsequent treatment and reuse. This reuse is novel in Cyprus.

Presentation of the results/findings:
After five years (1985 – 1991) research and two years (1997-1998) experimental work on a pilot scale the Government of Cyprus decided to subsidize, as from the beginning of 1999, the installation of a Grey Water Treatment Plant (GWTP). The cost of such a treatment plant, fully automatic, for a household with a production of 1 cubic meter per day is €1400 and the Government of Cyprus, through the Water Development Department gives €350 as a subsidy. As from 2003, this subsidy was doubled reaching €700 and now covers half the cost of the GWTP. This decision was taken, because drinking water saved is approximately 4 times cheaper than the same amount of drinking water supplied to the same town, from new projects.

With this scheme there is a conservation of drinking water from 35% to 40% of the per capita water consumption. This means that the conservation of drinking water from every two persons covers the needs of the third person. With this practical measure there is at the moment a saving of 2 million cubic meters per year of drinking water.

The quality of the treated effluent is suitable for garden irrigation and for toilet flushing. Cyprus does not have National Standards for the reuse of the treated grey water effluent. Cyprus follows the strictest of the standards for the reuse of treated sewage effluent. These strict standards cover the irrigation of all cultivations except for vegetables that are eaten raw. These strict standards state that the Biochemical Oxygen Demand (BOD5) should not be more than 10 mg/L, the Suspended Solids (SS) not more than 10 mg/L, the Faecal Coliforms/100ml not more than 5 and free from Intestinal worms/l.. The treaded effluent from the GWTP has less than the above numbers. In addition the turbidity is less than 5 NTU which is within the Drinking Water Standards. . Conclusions and Recommendations The water resources of the Island of Cyprus are limited, and they are almost fully developed. Water conservation and reuse remain a top priority in Cyprus.

With the recycling of Grey Water, there is substantial economy on drinking water in residential areas.

The quality of the recycled water is suitable for irrigation purposes and for toilet flushing.

The cost for installing and operating the grey water treatment plant is quite low compared to other methods of treating waste water, such as the biological treatment

Appropriate Technologies for Wastewater Treatment and Reuse in the Rural Areas of the Middle East – Case Study of Successful Regional Cooperation

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Water scarcity and contamination of surface and ground water are major regional Middle East problems. Middle East is the driest region in the world with only 1% of the world's freshwater resources. Water resources are also insufficient to meet rising demands due to dramatic increases in population and water consumption. The scarceness of both groundwater and surface water resources in the Middle East crosses geo-political borders; contamination of water resources especially by untreated sewage therefore causes shared problems for all countries involved. In order to catalyze the introduction and the implementation of appropriate and sustainable wastewater treatment solutions and to realize the benefits of reuse in rural areas, a collaborative project of Palestinian, Israeli and Egyptian organizations was undertaken. For five years now, the partner teams have been investigating appropriate, low-cost, efficient, safe and replicable wastewater treatment and reuse for sustainable agriculture.

At the heart of the project is the Sakhnin demonstration plant focusing on wastewater treatment and the irrigation pilot site in El-Sadat city, Egypt. Both pilot plants have been functioning successfully and innovatively during the last 5 years. Other major parts of the project include: establishment of full-scale wastewater treatment and irrigation systems in Beny-Zaid, a small village in the West Bank (Palestine); Training program for municipalities and farmers on wastewater reuse; Establishment of regional resource centers in Palestine, Israel and Egypt for knowledge exchange, providing information, and educational programs on wastewater issues.

The objective of this regional project is to establish low-cost, efficient, and replicable wastewater treatment and reuse systems in rural areas of the Middle East. The goal for the design and operation of the Sakhnin pilot plant is to implement a replicable, comprehensive model for appropriate technology for wastewater treatment and reuse in sustainable agriculture in rural areas in the Middle East. Based on land availability, population size, climatic conditions and socioeconomic considerations, the appropriate technology should be an extensive, reliable, simple, low-cost and low impact system.

The experimental pilot plant system in Sakhnin consists of up flow anaerobic sludge blanket (UASB) reactor, passively aerated vertical bed (PAVB), Intermittent Sand Filter (ISF), constructed wetland (CWL) and reservoir. In general the pilot plant was designed for maximum flexibility to allow for different wastewater treatment schemes.

The site in Egypt is located outside Sadat City adjacent to the City's 30,000-m3/day wastewater treatment facility. The systems essentially use natural treatment processes for polishing stabilization pond effluents and further treating that effluent with a constructed wetland. The reuse pilot site at Sadat City is divided into four equal quadrants. Each quadrant is planted in a variety of seven different species of non-food crops. Two diagonally opposing quadrants are irrigated with "wetland" water, one quarter with "polishing pond" effluent, and the last one with "fresh" water from a local groundwater supply.

The results indicate that the combination of extensive and semi intensive treatment systems is an efficient way for treatment and reuse of wastewater in rural areas. Specifically, it was found that the up flow anaerobic sludge blanket (UASB) bioreactor system could be a good alternative for anaerobic ponds, significantly reducing the required area with better performance. The effluent of the UASB can be fed directly to either an intermittent sand filter (ISF), or PAVB and horizontal constructed wetlands. Subsequently, and based on the pilot study at Sakhnin, the semi-full system at Beny Zaid, West Bank, was designed and built.

This study shows that this model can be an appropriate solution for treating wastewater for local reuse in rural areas under the climatic conditions characterizing the Middle East. The combination of the different treatment units ensures year round stable effluent quality in a semi arid climate typical to the Middle East.

Harvesting Human Urine in Tepoztlán, Mexico: Cultural, logistical and institutional challenges for closing the nutrient loop to urban agriculture

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The diverse benefits of urine-diverting (UD) toilets have by now been clearly demonstrated, as have the potential of using urine as a fertilizer. Nevertheless, in spite of the clear advantages of closed loop ecological sanitation (ecosan) approaches, the dearth of effective, affordable, and user friendly urine harvesting (UH) methods continues to be a major bottleneck for demonstrating that UD ecosan can be a viable sanitation alternative in urban settings. As anyone with direct UD toilet experience knows, the volumes of dried faeces are relatively small and can be dealt with at intervals of several months at a time, whereas urine is a constant flow -- and, unless it is disposed of non-ecologically in an on-site soak pit, the management of significant volumes of urine represents a major logistical, financial and cultural challenge.

Throughout 2004, the TepozEco Project, with financial support from the Swiss National Centre of Competence in Research-- North/South (NCCR-PAMS), EcoSanRes and UNDP, has given special attention to developing and testing UH strategies for "recovering and recycling valuable nutrients to stimulate local agricultural production and self-reliance."

Urine harvesting activities have included:

- Collection at public events, institutional settings and households,
- Design and testing of odourless urinals for both men and women,
- Construction and management of portable urinals for large scale public gatherings,
- Micro-enterprise development to provide mobile UH services events at public festivals and private celebrations (parties, weddings, etc.),
- Installation of permanent urinals in parking lots, sports facilities and restaurants,
- Hygienic measures and guidelines,
- Legislative framework and constraints,
- Education and promotion, and
- Coordination with public and private sector.

Processing and application strategies have included:

- Direct application on cash crops (nopal cactus, avocado, tomato, corn, etc.),
- Fermented urine for intensive orinoponic gardens,
- Application on compost at household, neighbourhood and municipal levels, and
- Trial applications of urine on the main soccer field.

In addition to reviewing the simple collection, transportation, storage and application techniques, the presentation will discuss the valuable lessons have been generated through the experience. Among the preliminary conclusions:

1. Results are particularly promising for urine harvesting in public and institutional settings, which offer greater volumes per collection point, than do domestic toilets. Nevertheless, a major hurdle has been the lack of public waterless urinals that are odourless, low-cost and offer easy access for emptying. The design and promotion of public and institutional urinals has become a major creative and logistical challenge of the program. TepozEco has been working closely with Mexico's principle supplier of public waterless urinals to design smaller, lower cost units (with an improved odour trap from in South Africa), for public, institutional, as well as household users. .

2. The local context in Tepoztlán does not offer the infrastructure or institutional capacity for establishing and sustaining a large-scale household urine collection system. For the time being, it seems that domestic urine will be best disposed of on-site (e.g. added to household compost, orinoponics, mixed with greywater; and direct application to trees, lawns and gardens.) -- and, possibly, transported short distances to neighbourhood eco-station composting facilities.

3. It is estimated that the medium term UH potential from public facilities within the municipality (including schools, public facilities, festivals, etc.) would be around 100,000 litres per year, sufficient to fertilize approximately 10 hectares with urine alone. Therefore, in order to fertilize large-scale agricultural plantations, it will be advisable to combine urine with other fertilizing techniques (such as application of manure, compost and other organic fertilizers). In other words, promote urine application together with sustainable, organic agricultural practices.

4. The UH strategy goes beyond simply closing the nutrient loop. The water saving potential, particularly in a town such as Tepoztlán with growing volume of tourism, is significant.

5. The UH project has contributed to awareness raising in terms of water conservation, as well as the potential benefits of urine as a fertilizer. By "demystifying" urine, the project has helped to achieve greater cultural awareness and acceptance of ecosan alternatives in general.

6. Long term sustainability of any UH system will depend upon the ability to create favourable conditions for primary stakeholders –i.e. private/social entrepreneurs, public service providers, local government, and/or farmers —to assume responsibility in the functioning of the system.

7. Involvement with public urinals inevitably raises associated issues, which eventually will also have to be addressed. For example, the installation of mobile urinals for men has generated a demand for urinals for women. Finally, it is difficult to focus exclusively on urinals without resolving the other part of the equation, i.e. adequate public toilets that provide efficient, hygienic and ecological disposal of faeces as well. Whereas the TepozEco project has begun to investigate options for eco-public toilets, (such as the Clivus Multrum), for the moment this seems to go beyond both the mandate and capacity of the program.

Applying appropriate technologies and participatory approaches to water management: lessons from the field

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While the principles of integrated water management are universal, improving water resources management requires a variety of approaches, tailored to the specific conditions of the local environment. In developing countries, limited resources and centralized government institutions create a special set of challenges. This paper presents examples of institutional and technical solutions drawn from the implementation of water projects funded by USAID in three countries: Morocco, Egypt and South Africa. In Morocco, the Water Resources Sustainability project (1996-2003) implemented technical and institutional solutions to integrated water management in the urban, agricultural and industrial sectors. The project addressed issues related to water management in a scarce water environment through three pilot activities: a wastewater treatment and reuse plant in southern Morocco; a chromium recycling plant to reduce water pollution in Fes; and a soil erosion control project in northern Morocco to curb the silting of an important reservoir. These projects used a combination of appropriate technologies, community participation, and institutional partnerships to improve water resources management. The Drarga wastewater treatment plant has been operational since 2001 with a treatment capacity of 1,000 m3 per day. The plant uses a re-circulating sand filtration system with constructed wetlands. The wastewater treatment plant includes cost-recovery mechanisms that make it financially self-sustaining. In Fes, the chromium recycling plant has been operational since 2003 and is reducing the contamination of the Sebou river, one of the most important in Morocco. In the Rif mountains of northern Morocco, the project has reduced soil loss by over 20% to protect the silting of the Nakhla dam. All these projects were implemented using a combination of technological inputs and participatory approaches to ensure sustainability. In Egypt, the Secondary Cities project (1995-2004) worked with municipalities of medium sized cities to improve water and wastewater management through both institutional means and technological improvements. The project facilitated collaboration between four different ministries to undertake a wastewater reuse scheme on 10,000 feddans of reclaimed desert land for a newly constructed stabilization-pond treatment facility in Luxor. The reuse scheme took advantage of drip irrigation to get maximum use of the water resources.

In South Africa, the ongoing Bushbuckridge project (2000-2005) is working with local authorities and service providers to eliminate exposure to water-borne diseases and improve the supply of clean water in an area that experienced discriminatory resource allocation during the Apartheid era. The Bohlabela district municipality and its 163 communities suffer from a badly-damaged infrastructure with broken pipes, faulty meters, and less than 5-percent cost recovery. Through a combination of training in management, cost-recovery, operations, customer service, and maintenance the Bushbuckridge Water Board Service Area has greatly improved the access to clean and safe water services to the municipality's one million residents.

Discussion of Results/Findings:
The paper explores the common lessons learned, success stories and best practices from three distinct water management projects that applied appropriate technologies and institutional strengthening tools. The methodologies used to improve water and wastewater management in different contexts and the best practices developed will be useful to implementers of water programs at the drainage basin scale, and in growing cities where expanding populations, poor water management, and increased pollution are threatening water resources.

In particular, the paper highlights tools and methods that can make water and wastewater projects sustainable in developing countries, where institutional issues, financial constraints, and technical capacity pose unique challenges.

Arsenic-safe aquifer as sustainable source of drinking water supply: A case study from Matlab thana in Southeast Bangladesh

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Introduction
The presence of naturally occurring (geogenic) arsenic has been known to be present in concentrations above the safe drinking water limit of World Health Organisation (WHO; 10 g/L) in the groundwater of the Bengal Delta Plain (BDP), Bangladesh. The elevated concentrations of arsenic are mostly found in the Holocene aquifers and are mobilized through the reductive dissolution of ferric oxide and hydroxides in reaction with organic matter after consumption of more favoured electron acceptors. As the installation of tube wells is easy in these unconfined sediments, the wells give water in excess and are safe from microbiological contaminants most of the population (98 %) are dependent on groundwater as their source of drinking water. This has resulted in the exposure of nearly one fourth of the population (35 million people) to high levels of arsenic. The supply of arsenic safe drinking water is thus a core issue to meet within the framework of the UN millennium goal for sustainable development.

A number of safe-drinking water options such as household filters, pond sand filters etc. has been tested and implemented in high-risk areas. The results have not been very encouraging, as the different options have not been widely accepted by the people. Instead, two new approaches have emerged from people's own initiative: i) switching to known/presumed safe tube wells in the vicinity or ii) reinstallation to an altered depth.

In Matlab thana Bangladesh Rural Advancement Committee (BARC) and the International Centre for Diarrhoeal Disease Research, Bangladesh (ICDDR,B) runs an extensive surveillance program concerning arsenic enrichment in tube wells, health clinic and demographic surveillance system. More than 82% of the tube wells in Matlab thana have arsenic levels above the drinking water. During a visit in Matlab thana, it was found that some of the local drillers prefer to install tube wells to a deeper depth than before (60 m compared to 30 m as before) since the water at this depth contains less dissolved iron. High levels of iron make the water taste bad and can thus be identified by the drillers. The sediments at this depth had also been found to have another colour, reddish and yellowish instead of the overlying black. The objective of this study was to find weather it is possible to identify and target the presumed oxidised and safe aquifers for the installation of tube wells based on the indigenous knowledge of the local drillers. As the use of tube wells, as source for potable water is widely accepted, cheap and robust, this could be a viable option for safe drinking water.
Presentation of the results/findings

The interviews and the work done together with the drillers showed that the presumed oxidised zone could be identified, both by the interviews and by the drillings that were done. In all drillings, a thick layer of black sediments overly a zone were the sediments are brownish, olive and yellowish in colour. The thickness of the black sediments varied between 40 50 m and the lithology showed great heterogeneity. Beside texture, the drillers used four distinct colours black, white, off-white and red to describe the sediments in Matlab. The lack of iron and the presence of red, white or off-white (i.e. not black) sediments were the most important parameter for the drillers when they defined good water.

The groundwater was generally reducing with low concentrations of SO42- and NO3- but with high concentrations of Fetot and Mntot. The groundwater had high HCO3- concentrations (60 500 mg/L), was of Na-Cl-HCO3 or Ca-Mg-HCO3 type (or a mix of them) and neutral or slightly acid (pH = 6 7). The arsenic concentrations varied between 0 and 355 µg/L. The groundwater samples were classified in four groups with respect to the colour of the sediments from where they were extracted (black, white, off-white and red). Basic statistics were done on each group and each group were presented in a box-diagram per analysed parameter. It was found that the four different groups represented a very distinct scale of groundwater composition with respect to the redox conditions. The water extracted from black sediments was the most reduced, followed by white, off-white and red that was less reduced.

The reddish/yellowish colour and the low less content of iron in groundwater from these depths suggested a more oxidised condition and in this zone it was presumed that iron would present as coatings on the sediment as oxy-hydroxides (rust), which would give the reddish/yellowish colour of the sediments. These ferric oxides and hydroxides could possible be able to adsorb arsenic and thus groundwater from this zone will be arsenic free.

Conclusions and Recommendations
On the basis of this study we can conclude that: i) arsenic is mobilised from grey sediments under more reducing environments; ii) it is possible to estimate the relative risk of aquifers/sediments in terms of As mobilization if the characteristics of the sediments are known, and iii) it is possible to target safe aquifers by combining the indigenous knowledge and technique of the drillers along with modern geological and hydrogeochemical expertise.

Finally, as we promote a simple technique based on the knowledge of the local drillers, the water- and sediment system and the processes that govern the mobilisation of arsenic need to be better understood as a possible option for sustainable groundwater development.

Faecal Coliform Removal in WSP Effluents by a Coupled Dynamic Roughing Filters and Subsurface Horizontal Flow Constructed Wetland in Tanzania.

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The rapid urbanisation and increase in population in Tanzania with concomitant escalating demand for food production will increase demand for alternative water resources. Consequently reclamation and reuse of treated wastewaters for agriculture has received much attention in Tanzania. The presence of faecal coliform in wastewater presents a potential health risk to occupational workers directly exposed to wastewater, to consumers as a result of uncontrolled application of wastewater in agriculture and to the public from environmental contamination. Diseases are usually transmitted via contaminated food or water often as a result of inadequate sanitation and water supply facilities or disposal of insufficiently treated wastewater. For disposal or reuse of wastewater in land application schemes, the removal of beneficial plant nutrients such as nitrogen and phosphorus is not desired but the removal of faecal coliform is the principal health related treatment objective for sewage treatment systems in Tanzania thus reducing morbidity rate.

The use of coupled Dynamic Roughing Filters (DyRF) and Horizontal Subsurface Flow Constructed Wetlands (HSSFCW) as a cheaper and yet effective and appropriate alternative method for treating domestic wastewater in tropical environments like Tanzania was investigated. This study was intended to introduce an alternative approach of improving further the Waste Stabilisation Pond (WSP) effluent by coupling them to DyRF and HSSFCW in order to upgrade WSP effluents in Tanzania. The specific objective of the study was to determine the optimum design and operational variables (filtration rate, gravel size, and a filter material thickness) of DyRF ahead of HSSFCW and to present design recommendations for a coupled DyRF and HSSFCW wastewater treatment system for the removal of Fecal Coliform (FC). Advantages of HSSFCW are that; HSSFCW are generally reliable systems with no need for anthropogenic energy sources or chemical requirements, a minimum of operational requirements. HSSFCW can be easily decentralized and scaled down to small sizes. Low cost in terms of investment, operation and maintenance especially in the developing countries. HSSFCW makes use of simple technology and the available skills for construction, operation and maintenance, with a possible re – use of the end products. HSSFCW also be easily adapted to the climate, they also introduce another beneficial aspect of nutrient re – cycling

This study was a further attempt by the University of Dar es Salaam, to test the suitability of this type of gravel filters that were well researched at UDSM in the past to polish WSP effluents prior to use for irrigating. The need for this study partly emanated from the observed persistent illegal use of the effluent from the University WSP for various small-scale irrigation applications. This can endanger the health of both the farmers and the end users of the irrigated crops.

Design and operational variables of DyRF were optimised in order to achieve maximum efficiency of the purification process (or minimum, FC). A pilot of DyRF and HSSFCW was constructed at the outlet of the WSP at the University of Dar es Salaam, Tanzania. The study was carried out in a 2.2 m × 0.7 m × 0.7 m deep DyRF as a first stage, using three different fractions of gravel ranging from 8mm to 32mm, from the top to the bottom respectively. In the second stage, a HSSFCW planted by Phragmite Mauritiunus with 0.6-m wide, 1.75-m long and 0.6 - m deep was used.

The optimised design and operational variables yielding a very high purification efficiency of DyRF were filtration rate of 2 - 3m/h, gravel size of 8 – 25mm, and a filter material thickness of 0.7m. Under these optimised variables in DyRF, HSSFCW gave the FC mean removal rate of 99.99 % with the recording of mean effluent FC concentrations of 790 FC/100ml suggesting that effluents guidelines of 1x10^3 FC/100ml would generally be met for restricted irrigation without endangering the health of both farmers and the end users of the irrigated crops.

Based on results obtained from this study, it can be concluded that the use of coupled DyRF and HSSFCW as alternative approach of upgrading WSP effluents has produced safe water that will be direct input to irrigation for expanded grain production, reliable water for subsistence agriculture, reduced urban hunger due to cheaper food prices and that the health people are better able to absorb the nutrients in food that those suffering from water – related diseases, particularly worms. These improved indicators will thus reach the Millennium Development Goals.

Meeting the MGD on Sanitation in Asia: Learning from the Japanese Experiences

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Targets on sanitation, set by the Millennium Development Goals, are the most challenging, as 675 million people in Asia will need access to sanitation till 2015 to increase the coverage of sanitation from current 78 per cent to 89 per cent. The bigger challenge is for wastewater treatment, as water pollution, is becoming severe and seriously damaging fresh water resources, which are vital to meet the MGD targets on water supply. Most of the cities do not have proper sewerage system and wastewater treatment facilities, as in China the wastewater treatment only covers 16 per cent of the generated wastewater (Song 1997). The sanitation and wastewater targets are usually difficult to meet due to its low priority and low willingness to pay by the community in comparison with the water supply. Therefore, relying on financing these facilities mainly through consumer fees would be inadvisable. Japanese experiences may provide some good learning for the Asian counties, where decentralization is being rapidly pushed, to improve their sanitation and wastewater treatment coverage.

The decentralization is aimed to empower local governments with political, administrative, and fiscal decision-making. Japan has a successful history of local governments' empowerment. The citizens' campaigns in 1960s for pollution control further strengthened local governments role to provide environmental services including sanitation and wastewater treatment. The sewage system improvements started from 1960s, when only 5 per cent of total Japanese population was receiving this service. The first Five Year Plan for Improving Sewage Systems was enacted in 1960 to increase the coverage from 5 per cent to 20 per cent at a total expenditure of 296.3 billion. At the conclusion of 8th five-year plan, costing 23,700 billion yen, the coverage reached at 62 per cent in 2000.

As per World Development Report and State of Environment Report of 1999/2000, the sewerage connection in Japan is 58 per cent (major cities have achieved 100 per cent coverage), while in China and South Korea the coverage is 25.8 per cent and 39 per cent respectively. The other Asian countries are far behind in municipal sewage system. The comparative success of Japan lies with its appropriate level of decentralization and the relationship between national government and local governments. National governments are continuously supporting local governments through various national subsidies. The national government identifies the regions with serious pollution problems and asks the local governments to prepare Pollution Control Programs including sewage systems. In 1995, the 34 designated regions spent a total of 3.6 trillion yen (US$300 billion). For municipal sewage system, the designated regions get 50 per cent of national subsidy, while the ordinary region gets 40 per cent subsidy. For final treatment facilities in the public sewage system, the designated region gets 50 per cent, while the ordinary region gets about 33 per cent of national government subsidy.

The subsidies are essential source of financing these services, as the operation and maintenance cost is also high. Even in Japan, the user charges only cover 39.4 per cent of O&M costs (Nihon Gesuido Kyokai 2001). The policies on national and local subsidies are vital to set and meet the targets on sanitation and wastewater treatment. These policies should be in line with the aims of the decentralization. As in Japan, to further improve the fiscal decentralization, Trinty Reforms are being introduced, which will cut the national subsidies and provide avenues for the local governments to generate the revenues, which are being lost in-terms of national subsidies. This will further improve the local governance as the local governments will have to decide for the best use of their revenues and will try to improve the coverage and efficiency of the local services including municipal sewage systems. In many of the Asian countries, the decentralization is so far focused on the de-concentration or giving away the responsibility of managing public services without fiscal decentralization and policies on the financial support. This is creating the burden for the local governments due to their limited capacity. Hence Japanese roadmap for decentralization and national subsidies may provide a guidance for these countries.

Applying Water Resources Management Techniques

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Africa, home to about 13 percent of the world, remains the greatest challenge in accelerating water services coverage. In 2000, approximately 36 percent of the population did not have access to a safe water supply and about 40 percent did not have access to sanitary facilities.
Lack of water resources worldwide poses a threat to global security as well as the lives of poor and vulnerable. We need to value water security as something that is in the interests of every body and therefore a global public good.

The financing in the water sector should focus on the goal of sustainable development and thus the focus should be on projects initiated by local communities rather than large-scale multi-million dollar initiatives.

In Uganda, the national water policy promotes an integrated approach to manage the water resources in ways that are sustainable and beneficial to the people. One of the key policy is sustainable provision of clean safe water within easy reach and good hygienic sanitation practices and facilities, based on management directives of responsibility and owernership by the users, with in decentralized governance.

The water statute, 1995, provide for the use, protection and management of water resources and supply, to provide for the institution of water and sewerage authorities and to facilitate the devolution of water supply and sewerage undertakings.

The national water policy objective is to increase water and sanitation coverage in the rural areas through;
- The provision of appropriate water and sanitation to government institutions and public places in small towns and rural growth centres.
- As well as improvement of hygiene behavior of the community, through hygiene education and promotion.

In rural areas, the basic service level is 20 to25 litres of water per capita per day from a protected source, within 1500 metres. In built up areas and peri-urban zones the water service level is still 20 to25 litres per day, but within a maximum walking distance of 200 metres. Each water source should not serve more than 300 people. A demand driven negotiation approach should be used; the level of service chosen will depend on;
- Walking distance.
- Number of users.
- Access to alternative water source.
- Affordability and acceptability.

If users choose a level above the basic level, they are required to meet the added cost of construction. In choosing a water supply system, the following should be considered:
1) Choose well known and tested technologies and hardware.
2) Locally made or locally available hard ware should be used. The Uganda National Bureau of Standards recommends the following hand pumps:

(a) For deep wells (deeper than 20 m):
- U2 hand pump.
- U3 hand pump.

(b) For shallow wells (less than 20 m deep)
- U3 light-handle pump.
- TARA direct- action pump
- NIRA AF 85.

3) Low-cost technologies should be selected offering good possibilities for Community participation in decision making and implementation.

4) For rural and sparsely populated rural growth centres, preference should be given to point sources, such as protected springs, hand pumps and gravity flow schemes.

5) Motor or engine-driven pumps should only be used for water supply in rural growth centres where there is regular power, trained operation and maintenance staff assured.

A community water supply scheme should satisfy the following requirements:

- Acceptable water quality.
- Sufficient water quality.
- Convenience.
- Reliability.
- Affordability in construction, operation and maintenance.

Local Community responsive and participatory initiatives to meet the Millennium Development Goals on water & sanitation

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Katosi Women Fishing & Development Ass.

Katosi, a rural village located along the shores of L.Victoria on Katosi landing site, is one of the leading fishing bays in the region. With a population of over 20,000 people, Katosi faces all problems characteristic to an over populated fisher community outstanding of which are poor water, Hygiene and Sanitation facilities.

A baseline survey carried out by KWFDA revealed that the area was faced with poor excreta management for 60% of the population had no access to safe latrines while 30% completely had no latrines. Poor hygienic practices existed, water borne and sanitation-related diseases were rampant, and majority population depended on contaminated waters of L.Victoria for Domestic use.

After careful analysis of the situation, alternative solutions to suit grassroots local needs and sustainably solve water and sanitation problems at Katosi landing site were identified. It is thus along this point that KWFDA intervened to sensitize, educate and equip women and community with knowledge and skill on good hygienic practices, supporting households acquire safe latrines, Rainwater harvesting tanks, construct and protect wells. The progressive success of this intervention as revealed by less occurrence of poor water & sanitation related diseases has paramountly been made possible through identifying and initiating the most effective solutions coupled with approaches to meet local needs.

Community responsiveness characterized by capturing and ensuring favorable community attitudes is the initial and most significant factor enabling the success of this intervention. This good response attained after KWFDA effectively sensitized the community on the comprehensive and broad goals of the water and sanitation project on their general livelihoods created a sense of ownership of the project. This enhanced the effectiveness of actual intervention alternatives as coupled solutions to solve water and sanitation problems.

Direct local community Participation through assisting in the construction processes and formation of water user committees to aid proper sustainability, operation and maintenance of wells and other facilities constructed has contributed to sustainability of solutions to water and sanitation problems at katosi.
Cost sharing favored by good community responsiveness enabled KWFDA work in partnership with the local population to alleviate their problems sustainably. Under this well designed scheme and procedure, members commit themselves to paying back half the costs on the total cost facilities like rain water harvesting tanks, latrines and each household contributes a maintenance fee for protected and constructed wells in their area.

A revolving loan created as a result of pooling repayments has not only enabled sustainability of the project but has enabled KWFDA reach out to a bigger number of people thus progressively reducing the number of people without access to safe water and sanitation facilities.
Favored by good community response and participation in the project, KWFDA has so far successfully supported 18 of her members acquire rainwater harvesting tanks, 9 acquired safe latrines, protected 8 ordinary springs, constructed 4 shallow wells and carried out 5 sensitization trainings to members and community in hygiene and sanitation.

KWFDA intervention is progressively reducing water borne and sanitation related diseases such as diarrhea, cholera, malaria and typhoid which have reduced by 39% hence infant and maternal mortality rates have reduced. Actual behavioral change involving adoption of better hygiene practices like hand washing, safe water chain have been realized and the community through an internal evaluation confessed positive improvement of their general livelihoods.

Thus, to solve water and sanitation problems effectively, there is need to carefully analyze the local situation. This analysis is characterized by identification of the most effective alternative solutions particular to a community and indispensably couple them with community cost sharing, positive

community response, local participation and sustainability as initiatives in effectively solving water sanitation problems. In this way we can reach the Millenium Development Goals on water and sanitation.
This poster will represent the success story of KWFDA 's tailor-made initiative that has reduced poverty and improved livelihoods of atleast 2180 households. Increased access to safe water and sanitation facilities for 920 people, reduced infant and maternal mortality rates resulting from related diseases by 14%. This gives hope towards supplementing global efforts to effectively achieve the Millenium development goals on water and sanitation by 2015.

Cost Optimization in Small Towns Water Supply Project Implementation and Management

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Common global thinking on small towns is that water supply systems in small towns are typically too complex to be well managed by community groups, but too complex to financially viable for professional water utilities. There is some debate over the definition of small towns. In March 200, global e-conference on small town water supply define it as " Settlements that are sufficiently large and dense to benefit from the economies of scale offered by piped water supply systems, but too small and dispersed to be efficiently managed by a conventional urban water utility. Small towns usually have populations between 5,000 and 50,000, but can be larger or smaller".

In Sri Lanka small town is defined as a town having population between 2,000 and 6,000. It is estimated that over 300 towns in Sri Lanka fall in to above category. Historically small town water supply schemes were designed and constructed by the National Water Supply and Drainage Board (NWSDB). The Operation and maintenance (O&M) was carried out either by NWSDB or the Local Authority (LA) in the area. During 1992 -1998 period the Community Water Supply and Sanitation Project –I (CWSSP -I) implemented 12 small town water supply projects on pilot basis. Under the community centered approach adopted by the project, beneficiary communities were actively involved for water supply project planning and construction and also given the opportunity to decide O&M agency. The Community Based Organization (CBO) established to implement the project undertook O&M responsibilities in 8 small towns under this arrangement. With the success of CWSSP, community centered approach was adopted to 47 small town projects implemented under Asian Development Bank assisted Third Water Supply and Sanitation (sector) Project (TWSSP) during 1998 -2004 period.

A comprehensive assessment was carried out in year 2004, by the Second Community Water Supply and Sanitation Project (2nd CWSSP) on performance of different small town water supply scheme (STWS) management models. The main objective of the assessment is to develop an appropriate model for small town water supply project implementation and scheme management to the country. The main findings of the assessment are; (i) NWSDB is a large and technically competent agency, but its efficiency and effectiveness are especially constrained by its inability, to set a realistic water supply tariff system due to government restrictions (ii) LAs comprise an elected executive council and appointed administrative and technical staff. There is significant variation in the competence and effectiveness of LAs, and while some are competent and effective, most lack competent staff and resources. As a locally elected organization, the LA is potentially in a strong position to represent the people's service requirements. However, the perception of need to satisfy voters and hence to ensure re-election the elected members of the LA commonly tends to manifest itself not through the provision of good services, but through minimizing water tariff. Consequently, like the central government, there is a general reluctance by LAs to impose adequate municipal water tariffs and effective collection of the tariff. (iii) CBOs manage STWS schemes quite successfully, especially where the LA had been supportive. CBOs vary in size, structure and technical and administrative competence, and significant capacity building and strengthening is needed after they are formed. CBOs are in an ideal position to represent and reasonably reflect the needs and wishes of their communities. It is significant that STWS study has shown that, compared to NWSDB and LAs, CBOs are most effective in setting tariffs that cover O&M costs and collection of tariff effectively. Therefore, the assessment recommends CBO managed model is the most appropriate for Sri Lanka.

With the findings of the assessment, community based small towns project delivery mechanism has been improved. Under the proposed mechanism Small Town Water Council (STWC) with representation with the beneficiary community, other user groups such as institutions, business entities and industries will be established. The project will provide capital cost contributions up to a maximum of 80 % of the total cost with a maximum cost ceiling per household and other user entities. As the user groups have to contribute a minimum of 20 % of the capital cost, the STWC will be focusing on optimizing capital cost expenditure. Further, as the water supply construction is to be carried out by the STWC, construction cost will be reduced by at least 25 % which counts for profit and overhead component of contractor otherwise employed for construction. It has been estimated that this capital cost optimization by the user groups can reduce the overall capital cost expenditure by more than 50 % compared to the conventional project implementation methods practiced earlier by the NWSDB.

The community based project implementation and scheme management approach tested in Sri Lanka has instrumental in the substantial reduction of the construction cost and the scheme sustainability has been enhanced significantly. The proposed small towns project delivery mechanism developed based on the past experience will enhance this delivery mechanism further. The experience is that the community based project implementation and scheme management approach will be highly effective in achieving MDGs, as the country is attempting to utilize limited funds available for the RWSS Sector in the most effective manner.

The Use of Natural Plant Coagulants in Removal of Bacteria, Bacteriophage and Clay Particles from Turbid Waters

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Use of indigenous plant-derived materials as natural plant coagulants have an important role to play in provision of potable water to rural communities in the developing countries. The use of such plant materials while only recently discovered in the west, has been known for centuries in other parts of the world. Their use as primary coagulants and coagulant aids are studied with particular reference to Moringa oleifera and Vicia faba seeds. Moringa oleifera seeds are one of the most effective and widespread natural plant coagulants and therefore were selected in this study for drinking – water treatment. The coagulating activity of Moringa seeds has been ascribed to polypeptides. Vicia faba is also used in Africa as a natural plant coagulant and was used in this study for comparison.

Investigations have been made into the use of Moringa oleifera and Vicia faba as primary coagulant for removal of clay particles and fecal indicator bacteria. These tests were carried out using artificial water and kaolin as model suspensions to represent a wide range of natural turbid waters which occur in developing countries.

A study of electrophoretic mobility showed that Moringa seed acts as a cationic polyelectrolyte and the Vicia faba acts as an anionic one.

Bacteria and bacteriophage removal of 1-3 log units (90-99.0%) was obtained within the first 1-2 hours of coagulation with Moringa seeds. However, bacterial cells were not inactivated but were simply concentrated in the coagulated sediment. The Vicia faba as an anionic polyelectrolyte was found to be less efficient in removal of bacteria cells.

It was found that the results of coagulation of E.coli, bacteriophage and kaolin could be satisfactorily expressed by the Langmuir adsorption equation. The results illustrate similarities in the behavior of the bacteria, bacteriophage and clay particles.

The coagulation efficiency of both Moringa and Vicia were found to be affected by certain physico – chemical factors, namely, concentration of suspended solids, divalent cationic metal ion, and organic matter. The relative importance of these factors was evaluated.

Moringa suspensions were found to be quite effective as a coagulant aid in conjunction with commercial alum in coagulation of E.coli and bacteriophage. This effect was particularly marked for highly turbid waters (NTU>1000). Vicia suspensions were not effective as coagulant aids in removal of bacterial cells beyond the levels obtained with unaided alum.

Tailoring Water and Sanitation Solution to Eradicate of Extreme Poverty in Sri Lankan Circumstances.

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Water recourses and adequate water supplies are essential preconditions to the achievement of UN Millennium Development Goals target to halve, by 2015, the proportion of people without sustainable access to safe drinking water and basic sanitation. Sound water management practices will be a necessary component of effort to achieve these targets. 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 Water Supply and Sanitation Collaborative Council. The results are devastating. More than 2.2 million people die each year from diseases associated with poor water sanitary conditions. 6000 children die every day from disease that can be prevented by improved water and sanitation, hence it so crucial for human well being and development.

Today, we are wasting much water or used inefficiently. Demand is growing faster than the supply can be replenished by nature. We have to find the water required in rapidly growing cities, industries etc. While in most regions there is enough water to meet every ones needs, and have to be properly managed and used. We must also be organized and harmonized with other arrangements in society such as land policies, programs to achieve essential development objectives.

Despite poor economic growth, Sri Lanka has achieved considerable progress. according to the UNDP Human Deve. Report 2003, "Sri Lanka is said to have performed well within the South Asian Region with regard to eradication of extreme poverty." President of Sri Lanka emphasized the importance of the MDG and pointed out how they addressed the essential dimensions of poverty and their effects on people's lives. "We have to search for practical tools that could help us along the path by formulating effective regional action plans, customizing and tailored to the national circumstances considering the program and should implement them within limited time frame. Thereby we would successfully alleviate much of the poverty which is the scourge of our Nation."

This report describes the processes and procedures that the Ministries and Agencies adopted, in association with stakeholders to overcome various requirements of the rapid increasing population. And also it discussed the prioritized investment plans and how they initiative fundamental structural Reforms, Ordinance and newly introduced alternative systems, solutions and discussed critical hard and soft components for sustainable solutions to give the poor a better deal.

The coping mechanism in achieving the MDGs was obtaining the necessary human intervention by integration, coordination and communication between and among the executive agencies and the stakeholders. They also encouraged small people to participate actively in civic works in their local areas, i.e. construction of storage tanks like such "hard path " approach. Through creative reforms, sanctions like, Rainwater Harvesting Project and such "soft approach" developed to caring, people concerned integrated development activities. This is guidance for state authorities to improve their project interventions to eliminate the water and sanitation problems, to reach MDGs.

Food production has a fundamental roll in reducing poverty in Sri Lanka. On the demand side, the agriculture sector used 96 % of the total water withdrawals in 1991. (ESCAP). Water for agriculture will be an alarming issue in near future and as a remedy; the Authority has linked Rain-fed and Irrigated Agriculture under one Ministry to gain the food security. At the same time productivity losses under natural hazards, floods and prolonged droughts, and water pollution were tried to harmonize with the stakeholder participation and with the help of donor agencies.

Although Sri Lanka has been quite impressive in achieving most national targets at aggregate level, for example, 82% and 92% country's 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 decades old conflict. It was a delicate task to identify regional disparities and make special task programs with best combination of hard and soft solutions, like "10000 Tank Restoration Project," and "Samurdi," These are active community involvement in rural infrastructure development projects by empowering the poor and strengthening governance.

To coordinate the formulation of national policies and its implementations we established an apex body known as National Council for Economic Development In order to mobilize resources and trigger action the relevant ministries are developing a process involving academia, researchers and civil society organizations, to expedite the project activities, including launching campaigns and awareness.

Though Sri Lanka's income levels compare very favorably with the rest of South Asia, there is nevertheless a population of about 6 % still living below the poverty line. A permanent solution to the ethnic conflict as a result of the ongoing peace process could however help significantly reduce this incidence of poverty by diverting valuable financial resources otherwise spent on the war to important development activities especially targeting the poorer sections of the population. All it requires is the political will to make it work.

Demand Responsive Approach for Rural Water Supply Project: A Case Study Experiences

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Lack of accessibility to safe drinking water is one of the primary constraints affecting the rural livelihoods, especially in the dry zone of Sri Lanka. Adequacy, timeliness, reliability and quality of water were the major issues affecting the rural people in relation to safe drinking water supply. Water fetching from available water sources was one of the routine essential household activity which caused significant trade-off to household works, labour availability, income earning opportunities, child welfare and sanitary and health conditions of the rural peoples. The situation affected the poor more than rich in the community.

Government of Sri Lanka (GOSL) has set a goal to reach the target of "safe water for all citizens" by 2025. However, it has been estimated from the rural water projects implemented in various parts of the country that, about 3-5% of the potential beneficiaries are dropout from rural water supply projects mainly due to poverty or marginalization (NWSDB, 2003). Lack of necessary financial allocation for O& M of the already implemented water supply schemes is another challenge faced by the government.

Demand Responsive Approach (DRA) has been used as a primary tool by the GOSL to implement rural water supply projects in order to achieve capital cost recovery and ensure the sustainability of the project, while targeting poor segments of the community more effectively than traditional top down approaches. However, past disagreeable experiences on uncompleted participatory projects implemented in the various parts of rural areas, at the expense of large number of beneficiary labour time and materials pose a biggest challenge for DRA implementers in soliciting beneficiary participation and their contribution.

The major objective of this paper is to discuss and share the experiences of the approach successfully adopted in Sri Lanka to mobilize peoples to implement and manage the rural water supply project using DRA as a tool. The paper also discussed the approach adopted by DRA in targeting the entire community and soliciting the beneficiary participation as well as empowerment. The findings are based on a case study conducted in a village located in the North Central dry zone of Sri Lanka.

The main stakeholders of the DRA process are Community Based Organization (CBO) created for the water supply project, Partner Organization (local level NGO involved in community mobilization and project implementation), government agency responsible for water supply and the beneficiaries. The active involvement and contribution of entire beneficiaries in the DRA approach have resulted in sense of ownership and they have realized the necessary of sustainable operation and maintenance (O&M) of the system. Cost recovery policy adopted in rural water supply schemes has two components, namely partial capital cost recovery and full recovery of O&M cost. Partial capital cost recovery was achieved by mobilzation of fixed amount of labour by each household for the project implementation and a lump sum cash payment. A tariff structure was formulated by the CBO with participation of all members and other stakeholders considering approximate monthly electricity cost, cost of water treatment, payment of salaries for care taker, approximate monthly cost for any emergency repairs and depreciation of water pump.

The level of impact of the cost recovery policy on monthly household income varies among different wealth groups. The lump sum payment for capital cost recovery represents 9-96% of household monthly income within the community. The impact is very high for low wealth group (25-96% of monthly income) compared to high wealth group (<20% of monthly income). Monthly tariff payment at the moment is with in the payable limit for poor group as well, since it is less than 5% of monthly income. However, trade off experience from capital cost recovery policy is much higher, especially for poorest group. Low wealth group had to sacrifice or postponed number of planned activities due to capital cost payment. The had reduce food expenditure, use small saving kept for emergency needs (droughts), postponed house repairs and work for additional labour hours. The important aspects of the tariff policy are that, no water connection so far has been cut off due to non-payment of tariff including low wealth group and request for new water connection has been increasing.

DRA approach under taken in the case study area of Sri Lanka indicates the effectiveness and efficiency of the approach in addressing sustainability and reaching the majority of the community. The step undertaken in reaching the community and convincing the people and the mobilization process is a success story. The project has enormously improved the household water security, women and child welfare, household income level, land value in the village and the community capacity in undertaking community development activities. However, the findings clearly highlights that, DRA is inherently biased towards cost recovery, therefore tends to marginalize the poorest of the poor among the communities. The rural water supply projects needs to formulate specific strategies to target the poorest segments in the rural areas to ensure that they receive their basic right of adequate safe water.

A single lump sum payment represents a major burden for poorer households and it is important to devise mechanisms to ensure this does not prohibit these households from benefiting. Another major problem with DRA implemented in Sri Lanka is latecomers are penalized, as the subsidy is only available for a short period of time. The challenge of institutionalizing DRA has yet to be addressed effectively. Important questions surround is how to build capacity and ensure sufficient flexibility in institutional arrangements to enable an effective response to changing pattern of demand in the longer term.

A single planning framework applicable to urban water management around the world: an International Demand Management Framework

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Presentation of the project/topic and analysis of the issues: Global population expansion in the coming decades will occur mostly in the developing world's urban areas. Such expansion will undoubtedly result in increasing demand on already pressured or non-existent water and sanitation services. This paper presents an emerging international framework combining hard and soft solutions for planning and managing urban water systems applicable to different scales and climatic situations in all urban regions. This flexible process aims to transfer a proven integrated methodology applied in Australia, North America and some parts of Europe (Howe and White 2003) to other regions, particularly in the developing world and emerging economies. It is now being developed into a comprehensive set of guidelines, the International Demand Management Framework (IDMF). The IDMF will enable urban water supply agencies and water resource managers to focus on service needs rather than supply-side options, improve asset management and planning, reduce capital and operating costs of providing water and sanitation services and make more informed decisions based on the economic, social and environmental benefits of water service options from a whole of society perspective. Given the anticipated high costs of achieving the Millennium Development Goals (MDGs), these issues will become increasingly important in the developing country context.

The concept of water demand management has many different connotations in terms of its definition and role in sustainable water management. In this paper, it is presented as a complete planning framework applicable to any climatic and economic region by: forecasting water demand using end-use analysis (EUA), analysing options using least cost planning (LCP) and evaluating implemented programs. Improved accuracy of demand forecasting is essential for water service providers to design water systems in an efficient, cost-effective and sustainable way. One of the key methods used in the IDMF is EUA and the development of region-specific end use models (EUM). EUA disaggregates water demand into 'services' and 'end uses' and is one of the few integrated and cost-effective approaches to forecasting water demand that takes into account regional-differences such as climate, housing type, efficiency of appliance stock and water-use behaviour. After developing an EUM, demand- and supply-side options can be developed that address local drivers and meet the expressed service demand. Such options that include both hard and soft solutions can then be analysed, assessed, and compared on the basis of levelised unit cost of meeting demand, rather than providing supply, and, incorporate water savings as well as costs and benefits (LCP). Where possible, 'whole of society' costs and benefits (avoided and deferred capital and operating costs) should be addressed, rather than focusing on utility costs only (Fane and White 2003). Finally, financial analyses from utility and other perspectives can determine how best to roll out programs and allocate costs and benefits amongst stakeholders. In addition, the use of innovative methods for public participation (Carson and Gelber 2002) allows water service providers to determine goals and objectives from the perspective of citizens, including 'willingness to pay' and 'willingness to accept' considerations. There is currently no consistent and widely applicable set of guidelines on undertaking EUA for demand forecasting and developing demand management options. Development of the IDMF guidelines will allow a consistent international methodology and terminology, effective knowledge transfer of the latest research and skills and capacity building to developing countries.

Presentation of results/findings: This paper will demonstrate the successful application of the IDMF in Australia, US, and Europe, and further demonstrate it's potential application in other regions, including developing and emerging economies. The development of the IDMF will be informed through existing literature, extensive consultation with international experts (Working Group) and potential users (Reference Group) and case-studies from developing and emerging economies. To ensure the IDMF reflects an international perspective, it is being managed as Task Force 7 under the International Water Association (IWA) Specialist Group – 'Efficient Operation and Management'.

Conclusions and Recommendations: Given the significant increased demand for water and sanitation services expected in urban areas in developing countries and emerging economies in the coming decades, a flexible, integrated and cost-effective process for providing such services will be instrumental to achieving the MDGs. Water demand management still holds enormous potential. It provides 'new' water services at a lower cost to society compared to new freshwater supplies or reuse options. Further, this water service is provided at a lower resource use intensity i.e. it saves materials and energy required for treatment, distribution, use and collection (Mitchell et al, 2004). Today there are numerous proven examples of the application of demand management. However there is still potential to improve the process in existing regions and extend it to new areas, particularly in the developing world. For these reasons, demand management using EUA and LCP is the focus of a new comprehensive set of guidelines, the IDMF, which is being developed iteratively through extensive consultation with experts and potential users.

1. EUA involves the disaggregation of water demand into customer sectors and further into individual end uses (e.g. toilets, showers); 2. LCP is a process whereby, for example, a water service provider determines a range of options that at lowest cost provide their customers with the 'services' they require rather than the water itself.

Rainwater harvesting and ecological sanitation-made for each other in India.

Mr. Vishwanath Srikantaiah, India
Rainwater Club

The bigger challenge in India is providing sanitation rather than water supply in reaching the Millenium Development Goal. Choices have to be made of the type and technologies to be used in tune with the cultural practices prevalent, the social taboos involved and the technical best fix available in terms of sustainability, cost and resource recovery.

While rainwater harvesting is gaining ground for satisfying water requirements from household levels to agricultural requirements its use in the sanitation sector would be crucial. Conventional systems of sanitation which end up polluting water bodies or underground sources cannot be seen to be the answer. They would start impacting the very water supply crucial to the sanitation use - the 'fouling of the nest' syndrome.

Marrying rooftop rainwater collection and storage for anal cleansing and adopting source seperating eco-toilets would be the key to ensuring water availability for sanitation. One of the key reasons why goverment and non-government sanitation systems have failed is because of the non-availability of drinking water. In such a situation to expect households to use water for flushing toilets would be asking too much. Many toilets though built are never used for the purpose for which they were intended.

By using a urine seperating squatting pan system of sanitation water requirement for flushing would be eliminated. This would also be in tune with the social system of India i.e squatting. Water requirement would only be for anal cleaning since Indians are predominantly washers not wipers. By using a 'tippy tap' only 40 ml of water can be delivered for anal cleaning. Another 40 ml of water would be required for washing of hands with soap. 80 ml per use would translate to 400 ml for a family of 5. In a year this would mean 146 litres of water only would be required for anal cleaning. The anal cleaning water could either be collected with the urine component or even seperately if the pan system is correctly designed. It could even go to the faeces chamber if enough dry saw dust or coconut fibre powder is used.

Collecting roof top rainwater in a small 150 litre drum from the rooftop of the toilet of 1.20 square metres would be enough for the water requirement of the toilet. Assuming even a 300 mm of rain and a collection efficiency of 0.80 of the rainwater falling on the rooftop. The rainwater collection would translate to 288 litres of water .This is more than the requirement of 146 litres and in fact provides extra for other hygiene requirements.

Ecological sanitation and rainwater harvesting go hand in hand and result in a self contained toilet in the true sense of the term. It is the rich and the urbanites who have to set an example by adopting the system, managing their own waste and converting it as a resource. Social and caste taboos can only then be broken by this demonstration effect.

While Gandhiji used to clean his own toilet, the time has come for cities and villages to switch to ecological sanitation and rainwater harvesting for a sustainable solution to the problem of human waste tp live up to his ideals.

Such a system has been put to use on the first floor in a house in Bangalore and has made it to the newspapers. Communities and councillors have been visiting to see for themselves how the system works and the general reactio has been positive.More such examples need to be put in place for a movement to begin.The next step is to work with women self help groups in the production of the source seperating squatting pan, the tippy tap and the rainwater collection system. This should become an entrepreneurship with income generating possibilities. Women would also be the best advertisers and marketeers for this product since water and sanitation continues to be in the womens domain in India.

Conclusion: Ecological saniataion and rainwater harvesting are the way forward to achieve the millenium development goals in India in a sustainable fashion. More work needs to be done to propagate and set examples.That it works has been conclusively established.

First eco-san-toilet in Ukraine: cooperation for sustainable rural development

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MAMA86

According to official statistic dates 28% of rural population of Ukraine is connected to water supply and 9% - to canalization. But in a reality the situation is worse. The main infrastructures' problems are ageing, bad conditions, interruption of water supply and canalization work, water looses and wastewaters leakages.
The access to safe drinking water and adequate sanitation is an actual and critical rural development problem. Traditionally the people in rural areas and small towns used ground water wells for drinking purposes and pit latrines for sanitation. More than 11 mlns use wells in Ukraine now. Today the common problem of the wells water is contamination, which is usually related to nitrates, pathogens, oil products and pesticides. The main sources of nitrates and pathogens contamination are the pit latrines used by individual households, schools and other public institutions in the rural areas.
Lack of proper water supply and sanitation facilities is the common problem for rural schools. Now in Ukraine 2 mlns schoolchildren are studying at 14 000 rural schools. In Poltava rayon there are 30 schools among them 12 schools use conventional toilets, 5 schools have toilet and pit latrines and 13 schools use only pit latrines.

Ukraine's climate is temperately continental with long and cold winters (the mean winter temperature is 21oF (-6oC).Usually pit latrines are located 50-100 m fare from school and have not heating. Cold, dirty and old pit latrines are the problems for the children, which are out of attention of adults.
In 2004 in the framework of the project "Cooperation for sustainable rural development: water supply, eco-sanitation and organic agriculture" funded by MATRA program of the Ministry of Foreign Affairs of the Netherlands the eco-sanitation (eco-san) pilot was implemented in the village Gozhuly of Poltava rayon, Ukraine.

This pilot was implemented by NGOs: "MAMA-86" and Women in Europe for a Common Future (WECF) in cooperation with experts from the Hamburg Technical University, Department of Industrial and Municipal Wastewater management.

The project is aimed on improvement the school sanitation facilities and access to safe drinking water by implementing eco-san toilet model developed by WECF and "Medium & Sanitas" in Garla Mare village, Romania in 2003 and finding the solutions on safe drinking water provision.
In Gozhuly the school is connected to the water supply and canalization. Because of frequent water supply interruption the schoolchildren used pit latrine, which was in emergency conditions.
Other problem of the water supply is low drinking water quality related to the natural high fluoride content and secondary contamination caused by bad water supply network conditions. As a result of the high fluoride content in the water the majority of the school children has the dental fluorosis.

Results /findings
In May 2004 the first seminars on eco-sanitation was organized for Gozhuly dwellers, authorities of oblast and rayon levels. During the discussions of the local problems the lack of sanitation facilities at school was dedicated as a priority for pilot project. It was decided to undertake the independent analysis of the wells and tap water quality with focus on testing the nitrates and fluoride contaminations. The analyses were made in Ukraine and Germany during June-July 2004. The results were showing that water from the central system (i.e. from the 200 m deep aquifer) contains too much fluoride more then in 7 times higher state standard. In the same time many wells have a too high content of nitrates (mostly between 100-250 mg NO3/l).

Clean water for school children.
There is a huge problem with teeth affected by a too high fluoride content of the water. 70% of schoolchildren (128 out of 184 children, including Kindergarten) are affected by dental fluorosis (Bentvelsen 2004). The information on fluoride and water treatment is gathering. But as a short term solution the school started to use water for drinking purposes from clean well.

School eco-san toilet

During August –October 2004 the eco-toilet was built in the school.
It is a “dry-diverting toilet” with separate collection and storing of the urine from the faecal with future dry composting of faeces and using of compost and the urine as organic fertilizers. Eco-sanitation provides the nutrient recycling, water saving and ground waters protection against infiltration of excrements from pit latrines or septic tanks.
The Gozhuly school eco-san toilet consists of 3 double vault urine diverting toilets, 3 waterless urinals and 2 urine tanks (2 m3 each). Each toilet equipped with plastic squatting-pans made in Chine, two easily accessible composting-chambers (vaults) with a sealed floor. One chamber is in use for approx. 1 year, after that it rests for one year while the other chamber is used. This facility is used by 165 pupils (6 – 18 years old) and 30 staff members.

In total the cost of the toilet building with VAT (20%) is 61 000 hrv (nearly 9 000 Euro). This toilet was build with the entrance directly from the school, heating installation, changing the classroom design and building the additional corridor. The model was adapted to the Ukrainian building norms. Now the instruction on eco-san toilet using and maintenance is developing based on current legal framework.
In October-November the training on eco-toilet using and keeping were made for the children and school staff. The instructions were put on the toilets doors.

From the 2 November the toilet is in operation. MAMA-86 is monitoring the operational expenses, water, hygienic materials and reagents usage. At the end of the school year 2005 the data will be analyzed from economical, technical and social points of views.

After 3 month eco-toilet operation it is clear that children are using toilet correctly. 3 double vault urine diverting toilets are working well (no smell, easy to use and to maintain). There was a smell of ammonium in the urinals room. The problem was solved with help of Hamburg University expert.
There is a good result on water saving, water is used only for washing hands and cleaning the squatting-pans and the toilet rooms. In average 25 litres per day are used by school for sanitation purpose now.
The monitoring of maintenance costs is running. The data analysis is planning for the end of the project.

Results and recommendations

Teachers and pupils accepted the new toilet very well. It was shown, that with proper education even 6-year-old children understand the principle of diverting toilets. Eco-san toilet in Gozhuly already kept attention of the rayon and oblast administrations. The school sanitation problem is recognized as a second priority after safe water provision for the rural schools in oblast. The oblast authority is seeing the eco-san toilet as possible, affordable, appropriate and effective solution for improving the schoolchildren access to proper sanitation.

To promote the ecosan the cost-benefit analysis and legal framework developing are needed.

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Public and private urinals in an Ecosan project – a rapid way to sensitise the population

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Pilot projects on ecological sanitation are currently run in seven West African countries by the Centre for low cost water supply and sanitation (Crepa), having its headquarters in Ouagadougou and national offices in ten francophone countries in the region.

Crepa-Côte d'Ivoire is doing tests in the village Petit Badien, about 80 km from Abidjan on the coast. The population of Petit Badien is having its income mainly from agriculture and fishing. Cassava, which is the main alimentary base in many tropical countries, is experiencing a declining productivity in Côte d'Ivoire due to the population growth and industrial competition which necessitate shorter fallow periods leading to impoverishment of the soil.

The urgent need for low cost fertiliser, made the Crepa research team start by focusing on the collect of urine. In collaboration with the population it was decided to build two units of public urinals, which were constructed in August 2003 by local masons and contribution from the villagers. The urinals were found difficult to use by women, which led to the installation of urinals in 14 private households. The home urinal consists of a jerry can equipped with a funnel in the opening and a light bulb in the funnel to minimise bad smell and nitrogen loss. The women found this type convenient to use. Later eight ecosan toilets were constructed in the preparatory school of Petit Badien.

The specific urine production established were 0,7 litres/person/day. The total daily production was 75 litres distributed on: public urinals: 8 l/d, household urinals: 47 l/d and Ecosan toilets: 20 l/d. A transport system with wheelbarrow was established, that collects the jerry cans twice a week and empties them in an elevated plastic container of 1 m3, mounted on a wooden pedestal at the agricultural site in the village, where application of urine on the field can be made drop by drop by gravity.

The use of urine as fertiliser on yams has augmented the yield by 120 %. The yield of cassava has augmented by 37 % for the ameliorated variety (olékanga) and 18 % for the local variety (s/préfet), to be compared with the chemical fertiliser which rendered an augmentation of 41 and 10 % respectively. It is concluded that urine after two seasons of cultivation well can compete with chemical fertiliser considering the yield of tubers under the conditions present in Petit Badien.

Concerning the possible contamination of urine by faecal matter, a comparative study of urine from urinals, pedestal seats and squatting slabs has been made. It is shown that the urine from urinals runs the least risk, zero of contamination from faecal coli forms and anaerobic sulphite reducers, while having the highest content of nitrogen, measured as Kjeldal-N.

The sociological follow-up has been made at three stages: before the introduction of the Ecosan concept to the population (T0), after the installation of the urine collection system (T1) and after the harvest of cassava (T2). The population, which by the beginning of the project was unaware of the fertilising properties of human urine, has after 15 months of implementation and testing come to 65 % awareness. The acceptability is raised from 30 % at T0 to 75 % at T2. The great interest in participating in the construction of toilets and agricultural activities and the reactions from the population confirm the high level of sensitisation.

Conclusion: The installation of public and private urinals in a society where the need for fertiliser is important, has had several positive effects:

- a widespread understanding for the Ecosan concept with a large number of persons sensitised in relation to the economic and physical effort from the project management,
- a hygienically safer fertilising product with a higher concentration of nitrogen compared to squatting and pedestal toilets,
- a rapid increase of agricultural yield, creating a spontaneous interest for Ecosan which might lead to private initiatives.

Workshop 5:

Strategies to Increase Resource Use Efficiency in Industrial and Agricultural Sectors

Valuing a Critical Resource: Innovative Water Approaches taken by Industry

By Jan Dell, P.E., Vice President, Industrial Client Group, CH2M HILL

Progressive companies have begun to think "beyond the factory fence line" to develop innovative strategies to increase resource use efficiency. Strategies include evaluating the full implications and costs of clean water scarcity risks for their businesses, for their employees, in their supply chains, for their consumer markets and for their communities. Some companies have begun to design products to minimize the need for water in production and also in end use.

This presentation will address two innovative approaches which leading-edge companies are taking to address this critical resource issue: Value Chain Assessments and Beyond the Factory Fence Line Assessments. Case studies of specific company programs will be presented.

Beyond the well-recognized threats to society and the planet, global scarcity of clean water and other water-related risks are multi-billion dollar threats to to businesses and their investors. The threats take two general forms: the inability to manufacture products and the impacts on consumer markets. In the past few years, numerous multinational corporations or their suppliers have lost their license-to-operate or have had to restrict production growth because of the competition for scarce water resources especially with local communities. Consumer markets have been negatively impacted by health issues associated with the lack of access to clean water and by the inability to use products which require clean water.

Value Chain Assessment Approach

The benefits of an assessment of the intensity of water needs in a companies' value chain from raw material and agricultural production through transport, manufacturing, retail and consumer use reside in understanding the areas of significant water use and discharge impact. This information enables business managers to develop optimal approaches for minimizing the intensity of water use, mitigating potential water-related risks and capitalizing on cost-saving opportunities in their operations. The life cycle analysis of water uses and discharges in a company's value chain enables prioritization of opportunities and risks and creates an informed basis for future programs and actions.

Innovative Supply Chain Programs

Value Chain Assessments by some consumer product companies have established that their water-related impacts are outside of their owned operations in their massive supply chains – often in developing countries. Progressive companies like Nike and Gap (Banana Republic, Old Navy) view environmental performance as a shared responsibility between themselves and their suppliers. They have adopted global water quality guidelines for suppliers that help protect human health and water quality around the world. The benefits of these programs to the companies extend beyond strengthening their supply chains to providing valuable brand protection.

"Beyond the Factory Fence Line" Approach

An assessment "beyond the factory fence line" of industrial facilities is valuable because external changes can result in steep increases in water costs, production delays, limits on production, or strong community opposition to company activities. Identifying potential water quality and water use impacts and considering the impacts in relation to the external environment provides valuable information for creating novel and sustainable solutions to reduce or eliminate water uses or impacts. Beyond avoiding the risk of production interruptions, beneficial outcomes of this approach include:

- ✓ Identification of partnerships with local communities, water authorities, NGOs, and other organizations that could be initiated to address specific water challenges.
- ✓ Identification of water-related projects that could support local communities by improving water quality for drinking and sanitation, for use in agriculture, local industry or recreation.
- ✓ Identification of potential community investment/philanthropic activities that could be directed to address water challenges.

Producing more food with less water: Finding synergies when faced with trade-offs

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The water productivity challenge
Some 80 % of human water requirements, or some four tons of freshwater per human per day (a meat based diet), are needed to produce food, a figure which rises above 90 % in poor developing countries where sanitation, drinking water supply and industrial water use is low. Recent research indicates that consumptive freshwater use may have to triple in sub-Saharan Africa and double in Asia over the coming 50 years in order to eradicate malnourishment and feed growing populations (Falkenmark and Rockström, 2004).

The water for food challenge is so large that without water productivity gains, the estimated additional consumption of freshwater in agriculture in 2050, will amount to 5,600 km^3/year, which is three times higher current consumptive use in global irrigation. Even after expansion and water productivity improvements in irrigated agriculture, 4,800 km^3/year of freshwater remains to be tapped for food production (before considering water productivity gains). The main source of food will thus have to originate from primarily productivity increase in rainfed farming.

The Millennium Development Goals (MDG) of halving the number poor and hungry by 2015 forms a formidable freshwater challenge. Of the world's 900 million malnourished, almost the totality live in developing countries. Population growth, despite the deceleration caused mainly by the HIV-AIDs pandemic, is estimated to continue with approximately 80 million people per year, slowing down below 60 million per year beyond 2025 to reach a global population of 8.9 billion in 2050 (up from present 6.1 billion). Ninety-five percent of this growth occurs in developing countries, where the purchasing power is extremely low and where a large portion of the populations make their living from smallholder agriculture. Absolute poverty is to a large extent confined to rural areas (hosting 70 % of those living on less than 1 USD/day). Moreover, there is an environmental dimension of the MDG challenge, as the majority of high priority countries (hosting the largest proportion of poor people), are also countries hosted in semi-arid climates.

In summary thus, the MDG challenge is largely a challenge of providing sustainable livelihood options for savannah societies.

There is a growing realization of the importance of environmental water flows, not only for aquatic ecosystem services (King …) but also to sustain terrestrial services (Rockström et al., 1999). Over 15 % of river basins in the world are facing hydrological closure due to human extraction of water. Large increases in freshwater use in agriculture is thus a risky future, as trade-offs with other water dependent ecosystems, and direct human water use may be necessary.

A critical first step in analyzing upstream-downstream and sector trade-offs, is to assess the possibilities of improving the water productivity of the world's largest direct water consuming sector, namely agriculture. This paper focuses particularly on the hot-spot in terms of water and livelihoods – namely smallholder rainfed farming systems in water scarcity prone savannah agro-ecosystems.

Understanding the dynamics of consumptive water use
In this paper, the perspective is of the smallholder farmer, who is concerned with maximising the amount of yield (kg/ha) at a production system scale (here we simplify the analysis by only considering volume/weight of produce rather than value of produce, something we return to in the discussion section of this paper). As shown by Gregory (1988), for management efforts in water scarce rainfed farming systems, rainfall *WP* (WP_R) may be the most useful tool to measure improvement of a system. Here, the full water balance forms part of the *WP* definition, and each reduction of flow "losses" as deep percolation (D), surface runoff ($Roff$) and soil evaporation (E) in favour of productive green water flow as crop transpiration (T) will improve WP_R. However, while WP_R may be improved at the farmer scale, *WP* may be reduced at the watershed and basin scale, if local reductions in blue (runoff) water flows result in less water for downstream use.

The only scale-independent *WP* improvement – in biophysical terms – is to reduce the amount of consumptive water use, i.e., green water flow, per unit yield output (Falkenmark and Rockström, 2004). This can be achieved by improving evapotranspiration *WP* (WP_{ET}) either through vapour shift, where non-productive soil evaporation is shifted in favour of productive crop transpiration through improved shading of the soil surface, or by increasing the proportion of productive crop transpiration to total green water flow (illustrated in Fig. 1a) (Rockstrom, 2003). The other alternative is to improve transpirational water productivity (WP_T), i.e., increase the ratio of crop output per unit productive crop transpiration, as illustrated in Fig 1b for a cropping system shifting from WP_T = 700 m^3/t to WP_T = 300 m^3/t. Empirical research shows that, while WP_{ET} is highly dynamic and relatively easy to improve through management (Ritchie, 1983), WP_T is conservative and difficult to improve (Sinclair et al., 1983). The linear relationship between yield and *T*-flow as well as *ET*-flow is well documented following the general relationships shown in Fig. 1.

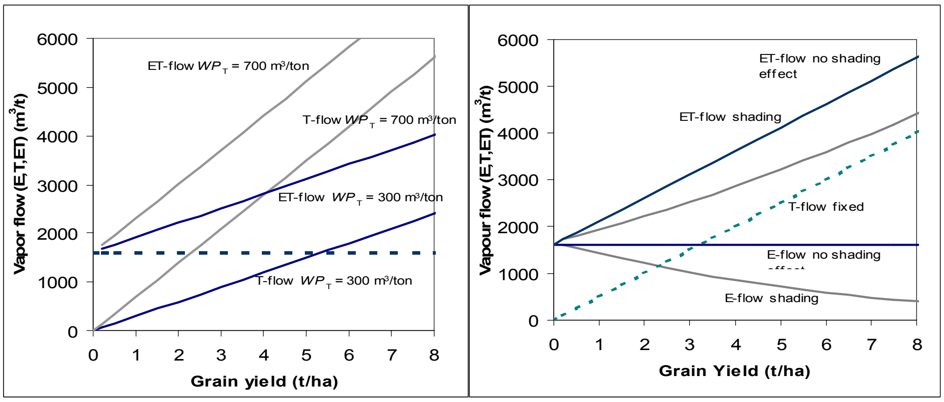

Figure 2. General understanding of the relationship between grain yield and consumptive water flows as crop transpiration (T), evaporation (E) and total green water flow (evapotranspiration, ET). Fig. 2a shows the effect on ET flow of a shift in WP_T (keeping E flow constant with increased yield). Fig. 2b shows the effect on ET flow of vapour shift, where E-flow is reduced with increased yield, while WP_T is constant.

Options for upgrading and water productivity improvements

Water management strategies are integral to improvement agricultural productivity, and can be distinguished by (1) strategies to enhance plant water uptake capacity and (2) plant water availability (Table 1).

Table 1. Avenues to upgrade rainfed agriculture through integrated soil and water management.

Strategy for Upgrading	Management	Methodology	Target parameter
Plant water uptake capacity	Soil management	Tillage	Root length and density
		Crop rotation Mulching and Manures (green and brown) (Inorganic) Fertiliser	Crop development
	Crop management	Crop choice Intercropping/crop rotation Timing of operations Pest management	
Plant water availability	Soil management	Tillage	Soil infiltrability
		Weed management	Less unproductive competition
		Soil and water conservation	
		Crop rotation Mulching/Organic manures	Water holding capacity
	Water management	Water harvesting	Dry spell mitigation

As seen from Table 1, there is a wide spectrum of integrated soil and water management options that contribute to improve the two water determinants of crop growth. A key challenge in savanna agro-ecosystems is to deal with spatial and temporal variability of rainfall, which generates frequent dry spells, water logging, and droughts. Water harvesting systems, both in-situ and external systems for supplemental irrigation, are key to address dry spell mitigation.

Impacts of water harvesting systems and integrated water and soil management systems on water productivity are shown in Figure 2. Here, the dynamic relation between consumptive water use and yield is clearly shown, which originate from the combined effect of vapour shift (evaporation to transpiration redirection) and particularly of an improved ratio between T and total ET flow (which can originate in absolute terms from reduction of other blue water flows (surface runoff, deep percolation).

Relative water productivity improvements are very substantial, particularly in the lower yield range (from 0.5 – 2 t/ha), which is the yield range of focus in the target MDG countries. This is interesting, as it opens large opportunities to improve yields, while consuming relatively smaller volumes of water. For example, the doubling of yields from 1 t/ha (the average grain yield in large parts of sub-Saharan Africa to 2 t/ha, can improve water productivity from approximately 3,000 m^3/t to 1,800 m^3/t, resulting (for a 1 ha farm) in a shift from a cumulative water consumption of 3,000 m^3 to a total consumption of 3,600 m^3, i.e. a 600 m^3 increased compared to the normally assumed doubling of consumptive water use to 6,000 m^3.

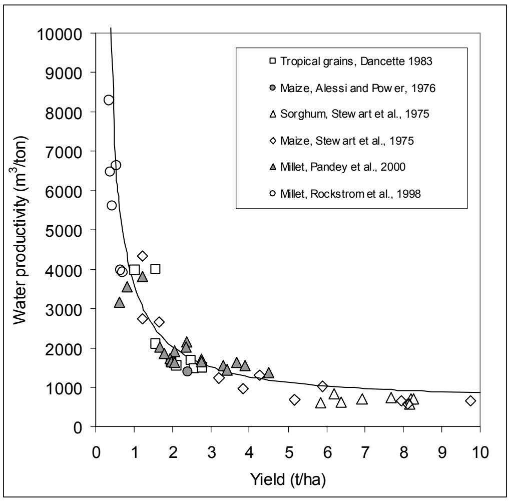

Figure 3. Green water productivity, WP_{ET}, as a function of grain yield for tropical C4 grains (adapted from Rockström, 2003).

Implications for water resource planning

For global savannah agro-ecosystems as whole, Falkenmark and Rockström (2004) estimated that at least 1,500 km^3/yr could be "saved" through water productivity improvements in smallholder farming systems, i.e., a reduction from the required 4,800 km^3/yr in 2050 (after deduction for irrigated agriculture) to 3,300 km^3/yr. This is a very significant contribution, almost equivalent to the current global consumptive use in irrigation (1,800 km^3/yr). However, despite this reduction in food pressure on freshwater, a gigantic challenge remains (3,300 km^3/yr) which certainly will require horizontal expansion, and thus trade-offs with other terrestrial and aquatic water dependent ecosystems.

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Participatory Decision Making Model for Regional Hydro-System Nadela in Serbia: Case Study

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Regional hydro system Nadela is one of the most important constituents of the Danube-Tisza-Danube hydro system, located in eastern part of Vojvodina Province in Serbia. It is used for irrigation, drainage, industrial water supply, collecting the used waters, fishing and some outdoor recreation activities. Management of the system is characterised by present conflict interests of different parties: government, local authorities in municipalities, responsible water management companies, ecologists, public bodies etc. The conflicts are presently sharpened because of the lack of funding, improper legislation or absence of precise water policies, low efficiency in collecting water taxes, difficulties in motivating societal delegates to participate in management, etc.

This paper presents main results of a case study application of the Analytic hierarchy process (AHP) in participatory decision making, undertaken to improve the management of the Nadela hydro system. Overall goal has been set to establish proper participative decision making model and then to identify the best management strategy for the system, assuming that existing problems should be solved step-by-step, in presence of both obstruction and support of different parties and interest groups.

Introductory meetings were managed to brief participants in decision making process on the main problems in system management, on the solving methodology and on the final intent of the case study. First step was to identify various interest groups and other parties that will act as subjects of the decision making process, and to articulate their preferences. Then, participants were motivated to come to the consensus about common action: to identify strategy that will ensure well balanced system use and satisfaction of prescribed system purposes and users expectations, but also that will respect defined system capacity and wider interests of a society. Finally, most important decision making issues were elaborated and decision elements identified, while keeping in mind that AHP generally requires that the problem to be solved must not be large regarding its 'hierarchization' and number of decision elements.

The number of levels (4) and decision elements (13) of the AHP hierarchy has been defined by consensus of participants involved: (a) at the top of the hierarchy the goal is set as a 'benefit for all'; (b) next level consists of 3 criteria (economy, social aspect, ecology); (c) 5 decision elements are defined at the third level as system purposes (irrigation, drainage, used waters, industrial water supply, and other purposes); (d) at the bottom of the hierarchy are 4 management strategies – decision alternatives, defined by responsible (authorized) water management company. Evaluation is performed by 8 participants, divided into 5 decision groups. The AHP is used to calculate the weights of alternative strategies for each participant; that is, method is used on the individual basis. These weights are then aggregated within each of 5 groups. At the final stage of a process, best strategy is identified by aggregating the alternatives' weights assuming different importance of the decision groups.

Although there were some problems to motivate participants to take active role in the process, cooperation was fruitful and process ended with success. Developed decision model based on AHP appears to be acceptable framework for multicriteria modeling of water management problems. Its practical use to support participatory decision process in part of managing waters in Vojvodina Province was successful which recommends this model for further use. Authors believe that the model offers new opportunities in sustainable regional water management in general, at least in situations similar to those analyzed here.

Increasing Land and Water Resources Use Efficiency through Nutrient Amendments and Supplementary Irrigation-A Case of Manyame river basin in Zimbabwe

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1.0 Introduction
Small holder farmers in the Manyame catchment try their best to improve their livelihoods through crop production. Unfortunately most of their effort goes to waste each year because of inefficient use of land and water resources. The predicament facing the farmers is caused by lack of commercial fertilizer due to unavailability in the shops or price increases which had put the commodity out of reach from most communal smallholder farmers

2.0 Methodology
The study was designed as a two factor experimental design consisting of 10m x 10m randomized blocks with three (3) repetitions to ensure statistical validity. The major factor being assessed was nutrients. The nutrient factor was being assessed on four (4) four levels of treatments consisting of the following: plot 1 was the control where maize was planted and allowed to grow without any crop nutrients applied. plot 2 compounds D was applied as basal fertilizer treatment and ammonium nitrate as top dressing at 4 weeks, both fertilizers were applied at the rate of 6g per crop. plot 3 was the experimental plot in which urine was applied at the rate of 100 ml per crop as the basal treatment and 100 ml as the top dressing treatment, this was applied at 4weeks old and when the crop was at knee level as usually the practice in the area. Plot 4 was the second experimental plot where feacal matter (humanure) was applied as basal fertilizer at the rate of 80 g per planting station. In the same plot 4 urine (ecofert) was applied at the rate of 100 ml per plant. Crop yields were weighed to determine the yield and expressed as production per hacter of land Rainfall was measured using a conical field rain gauge and used to compute the water use efficiency and supplementary irrigation was applied during dry spell periods which was two weeks during the season in question..

3.0 Results
3.1 Maize yield(land productivity)
Maize from different 10m x 10m plots was harvested shelled, dried and weighed using an electronic weighing machine. The data was computed and expressed in Kilograms per hectare terms. Below is a graph showing the yield in kg/ha from different treatments

Figure 3.1 Average grain yields/ha harvested from the four treatments
3.5 Water productivity
Figure 3.5 below shows the different water use efficiencies in m3/ton in the figure/graphs that follow
1 is control
2 is commercial fertilizer
3 is ecofert
4 is the humanure + ecofert

Figure 3.5 Water productivity from different treatment sites
Water use efficiency ranged from 2000 - 2300 m3/ton for a non fertilized crop in the control plot (1). WUEet for crops fertilized with chemical fertilizers compound D and Ammonium Nitrate (2) and ecofert (3) alone ranged between 1650 m3 /ton– 1700 m3/ton. The highest water productivity or efficiencies were found on plot (4) the crops fertilized by a combination of humanure and ecofert with WUEet of about 1300 m3/ton from different treatments. The study suggest that humanure plus ecofert has highest water and land resources use efficiency followed by ecofert (urine) only, followed by commercial fertilizer. Cultivating without any nutrient is an inefficient use of scarce water resources.
Figure 3.6 Water balance in a control plot
The total water supplied to the humanure plot was calculated and an average worked out Using available data , percentage of water used by the crop as evapo-transpiration (ET) and the one being lost as drainage (D) was calculated. Figure 3.6 and 3.7 below was an attempt to show the water balance in the control experimental plot.

Figure 3.6 Water balance humanure + ecofert (urine) plots

The above diagrams show the different water partitioning of supplementary irrigation (SI) + rainfall (P) at the experimental field level. Figure A shows water partitioning on a field where the farmer is not applying any form of nutrient amendment. On such the study seems to indicate 65% of the total water supplied is used for

productive evapo-transpiration (ET) while 35% is lost as underground drainage (D) and also to contribute to underground water recharge.
The second Figure 3.7 shows a scenario where a farm chooses to embark on a humanure + ecofert maize production strategy. The study reveals that 76% of the total amount of water supplied to a field is taken up by plants as total evapo-transpiration (ET) 11% above the water uptake in field where no nutrients have been used.
Figure 3.7 water balance on ecofert + humanure strategy

Consequently a relatively low flow 24% is lost as drainage D. Whilst they is much gain to the farmer in terms of productive (ET) and corresponding grain yield, they is loss to the underground water recharge.

Conclusions
Taking into cognizance all the research limitations and sample sizes it can safely be concluded that. Humanure + ecofert (urine) improve the water productivity by above 10% in rain-fed maize production ensuring more crop per drop of water.

Recommendations
The reuse of humanure and ecofert should be considered as an alternative source of crop nutrients and adopted into policy by government and local authorities in Zimbabwe.

Assessing physical efficiency of small reservoir irrigation systems through integrative watershed modelling

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The Volta Basin covers 400,000 km2 of the West-African savanna zone. Ghana lies downstream and contains 42% of the basin. Most of the upstream part of the basin lies in Burkina Faso (43% of total), and the remaining 15% lies in Mali, Côte d'Ivoire, Togo, and Benin. Average rainfall is 1000 mm per year of which around 9% or 36 km3 becomes available as runoff. The rainfall pattern is characterised by a great spatial and temporal variation.

The basin population is largely rural and poor, with per capita incomes below Sub-Saharan African standards. Agriculture is the primary economic activity in the basin and the major water user following hydropower. Given the extremely unreliable rainfall, irrigation development is seen as an obvious strategy to increase agricultural production. As the annual population growth rate is 2.5%, country reports predict that water demand for agricultural irrigation in the basin will increase considerably in the near future. By 2020, the demand for water in Ghana is expected to rise by almost 500 % over levels in 2000 and over 300% for the basin as a whole.

In general, irrigation development in the basin is mainly linked to the construction of small reservoirs. These small reservoirs are formed by constructing dams across intermittent streams, which cause water to become impounded. Small reservoirs are attractive

first of all, because they can be managed at a local level and second, because they often have additional uses such as for drinking water supply, domestic purposes, fisheries and livestock. Although there is no comprehensive record of the numbers of small reservoirs, there are local inventories. For example, there are 160 reservoirs in the Upper East Region of Ghana, roughly, 1400 reservoirs in Burkina Faso and 250 in Northern Cote d'Ivoire; the majority of which are in the Volta Basin.

Although the construction and use of small reservoirs, especially in the Northern part of the basin is widespread, thus far, little or no consideration has been given to the analysis of the physical efficiency of these systems. Since most of these reservoirs are along tributary streams, they are hydrologically linked and are also very responsive to precipitation events in the drainage basin. Reservoirs can on the one hand, cause increased groundwater recharge but on the other hand can also cause higher evaporative losses.

In this study, reservoirs are analysed at a watershed scale where climate and land use influences as well as upstream and down stream effects are examined. This is possible by the application of a distributed physical watershed model such as WaSim-ETH. In this approach, climate, land use and soil information is integrated to simulate hydrological processes such as rainfall, infiltration, runoff, groundwater recharge and evapotranspiration. Therefore, changes in upstream land use or variability in climate can be simulated and direct effects on reservoir volume can be quantified. The physical consequences of constructing more reservoirs as well as irrigation systems at a watershed level can also be examined.

Potential use of groundwater for irrigation as an alternative to water use from reservoir systems is a very important issue for irrigation management in the basin. Annual groundwater production through boreholes, hand dug wells, and piped systems have increased substantially over past decades. However, despite the rapid development, groundwater production is still less than 5 % of average annual groundwater recharge in most of the basin. Therefore, in the face of rainfall variability and water scarcity, groundwater irrigation is a very desirable alternative. The integrated model system WaSim-ETH also provides the option of modelling groundwater recharge and flow. Therefore, the use of pumped groundwater verses surface water from the reservoirs will be evaluated.

This study is a sub-project within the GLOWA Volta Project, financed by the German Government. The central objective of the GLOWA Volta project is the analysis of the physical and socio-economic determinants of the hydrological cycle, and based on this the development of a scientifically sound decision support system for the assessment, sustainable use and development of water resources in the Volta Basin. Integration of climatic, ecological and socio-economic factors and correlations with respect to the hydrologic cycle is the main scientific challenge. This study is being carried out in collaboration with the Water for Food, Challenge Program's Small Reservoirs Project.

Water Efficiency - A Sustainable Way Forward for Oman

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This paper provides details of a water efficiency and sustainable water management strategy (including allocation planning) undertaken for Salalah, the second largest city in the Sultanate of Oman.

In the arid climate of Salalah, both the urban and agricultural sectors rely on a freshwater aquifer and a limited number of freshwater springs as the primary freshwater resource. This finite resource has been suffering from over abstraction. As a result saline intrusion is now a significant issue causing agricultural land to become so saline that crop yield is reducing and in some cases the farms are being abandoned. With the urban population and tourism expected to double over the next 15 years, this issue will only continue to grow and cause further tension between the urban and agricultural sectors. Current net water demand (NWD) in the agricultural sector is approximately 61 million cubic meters per annum (Mm3/a). Water demand in the urban sector is currently only 21.5 Mm3/a but is expected to rise significantly to 42 Mm3/a by 2020 under the reference case or business as usual demand scenario.

This Study: reviewed the reference case demand for both the urban and agricultural sectors over a 15 year demand horizon; considered the current level of water efficiency for both sectors; developed a suite of options including water efficiency/demand management, source substitution and supply (hard and soft solutions); identified the costs and benefits of the options developed using the principles of least cost planning/integrated resource planning (LCP/IRP) ; and identified the most economic, environmental and socially appropriate suite of options to provide water services to the growing city and associated agricultural sector yet within the sustainable yield of the aquifer. This suite of options was then compared against the high cost desalination plant option currently being investigated by the water supply department of the city. A supply curve was developed showing the cumulative costs and volume of water saved or supplied for each option considered. The supply curve shows that a suite of demand management options in the agricultural and urban sectors are more cost effective (i.e. have lower unit costs) and should be implemented first, prior to the majority of the supply options. These demand management options for both the urban and agricultural sectors include a range of measures (structural and behavioural modifications) and instruments (economic, educational and regulatory). When additional benefits from implementing demand management options are also taken into considerations (i.e. lower energy usage, lower greenhouse gas emissions, higher crop yields) demand management options become even more attractive.

LCP/IRP is a process that enables demand management and supply options to be considered on an equal basis, and in a transparent way. In the majority of cases, as is the case in Salalah, demand management options generally have the lowest unit cost and highest social and environmental benefits and should be implemented before large scale supply options. This process therefore enables stakeholders to make informed decisions on which options in terms of economic, social and environmental benefits are best for their specific region.

A ground water model was also used and developed in the Study to test the effects of the suite of options designed, and subsequently two scenarios were chosen and compared with the reference case. Scenario 1 involved a suite of urban and agricultural demand management options being implemented (including moving towards appropriate best practice technical equipment and management practices in agriculture), along with removing a single large grass farm of low crop value that consumes 7 Mm3/a. This scenario saves or supplies 36 Mm3/a for a present value cost of 22 M Omani Rials (approximately 44 M EUROS). Scenario 2 included all these options, plus removing half of the remaining low crop value large grass farms, plus extending an existing wastewater injection system, providing a total volume of water saved or supplied of 47 Mm3/a at a total present value cost of 46 M Omani Rials (approximately 92 M EUROS). It was found that even with Scenario 2, comprising the most intensive suite of options considered, saline intrusion is still likely to occur at the coastal front causing further loss of irrigated land in that area.

With the LCP/IRP options modelling and groundwater modelling a clear picture of the effects of the supply and demand management options has been possible providing details not only of the economic, social and environmental impacts but also the spatial and temporal effects on the finite groundwater resource under constraint. Using the results of the modelling a 'Sustainable Water Management Strategy' has been developed discussing the issues associated with the level of investment required, water allocation, metering and pricing etc. The combination of: options modelling, LCP/IRP analysis and groundwater modelling to test the effects of the options has resulted in a powerful tool that can be refined in the future as more data becomes available. The Strategy developed is the first step in a sustainable way forward for Oman.

This paper will be of interest to: water resource managers dealing with a finite resource and the tensions between urban and agricultural sectors; water service providers developing and costing options for both urban and agricultural sectors; and those interested in the application of groundwater modelling and LCP/IRP as decision making tools.

BMP strategies to increase water sustainability in commodity supply chains.

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Presentation of the topic

Agriculture is the largest industry on the planet. It employs more than one billion people and generates more than one trillion dollars' worth of goods annually. From a freshwater perspective, agriculture is by far the largest user and polluter, withdrawing about 70% of the planet's developed freshwater resources —more than three times more than industry (20%) and dwarfing municipal uses (10%); in developing countries water extraction for farming is often more than 90%. Farming is also the leading cause of pollution in the most of the countries that measure its impact.

Encouraging more productive uses of water and reducing pollution from farming in river basins has therefore the potential to increase the sustainability of water use, especially in those regions that are faced with growing scarcity.

This paper will consider strategies relevant to farmers and buyers/investors – near the start and the end of agricultural supply chains – that are being developed and tested to increase the productivity of water, and other critical inputs. Examples relating to cotton and sugar will be used to illustrate the strategies.

Analysis of issue

The main environmental concerns about agriculture relate to the impacts that it has in terms of occupying and converting natural habitats to farmland, soil erosion and degradation, water use and pollution, air pollution, and loss of biodiversity. These impacts also have social impacts since, for example, water used or polluted by farming is unavailable for other community uses.

At farm level a variety of crops may be grown in rotation or consecutively. Nevertheless, it is useful to take a commodity approach at the international level, since it is the supply chains for these products that link the consumption of food and fibre products back through their supply chains to farmers.

At present, much of the information about where and how a commodity is produced is divorced from the end product that are offered to consumers. Except in the few cases of crops with a vertically integrated chain e.g. for organic production, this makes it difficult for benefits and incentives of applying better management practice (BMPs) reduce these impacts to be communicated along the supply chain from buyer to producer and vice-versa.

WWF and the IFC (World Bank Group) are collaborating in a process to encourage the use of BMPs in commodity production as a strategy for reducing the major social and environmental impacts of their production and processing.

Presentation of results

IFC-WWF commissioned research in 2004 to consider the commodities for which a BMP approach, that would lead to reduced impacts and lower farm costs. The study considered 10 commodities then narrowed the scope down to 4 priorities: cotton, sugar, oil palm and soy. IFC and WWF are now working on all 4 of these commodities with consortia of progressive businesses and investors to identify examples of BMP application from which global or regional, result oriented performance criteria can be set-up. Two examples of BMP development for cotton and sugar are described below.

In Pakistan's Indus River Basin, field tests have been undertaken over the past few years to assess the combined benefits of applying Integrated Pest Management (IPM) and Bed and Furrow Irrigation practices in cotton, one of the most important commodities for the Pakistan economy. This has enabled savings of about 40% in terms of applied water and reduced pesticide applications from 12 or more per crop season to about 2-3. Overall crop yields were unaffected or even improved under these BMPs.

In Kwa Zulu Natal, in the south-east of South Africa sugar cane is the dominant cash crop for large scale and small farmers alike. Although the sugar crop is mostly rainfed, the impact of this near mono-culture has large impacts on water availability for downstream communities and ecosystems. On farms in the Midlands, BMPs are being developed and tested to reduce runoff and erosion, through better farm planning and use of trash cane blankets. Again these BMPs appear to offer advantages in terms of yield with reduced inputs.

Conclusions/Recommendations

The work described in this paper is still on-going. However from the research carried-out at international level and at farm level there are already conclusions and recommendations emerging that should be considered in all cases where agriculture is a major land and water user in a river basins.

The initial conclusions are:

- There is a demonstrated 'win-win' situation for farmers that are able to maintain or improve yields – for cotton and sugar at least - through applying BMPs which entail using less water and chemicals per hectare;
- BMPs to improve the efficiency and productivity of water use in farming will vary across regions – what is relevant for South Asia will be very different to that in Brazil or Australia;
- Responsible retailers and investors are becoming increasingly interested and active in developing ways of using BMP "screens" to reduce risks associated with their supply chains or investments;
- If it is possible to scale-up these BMPs and to put in place supporting water allocation policies, then a 'win-win-win' scenario is possible, including conservation of freshwater ecosystems.

The main recommendations are:

- For multinational food and fibre companies to engage in processes that aim to identify the ways to reduce the main environmental and social impacts of supply chains, through the application of BMPs
- For Governments, their local agencies and local NGOs to provide financial and technical support to farmers to understand the opportunities of applying BMPs
- For Governments at national and river basins level to confirm water rights and put in place water allocation policies and practices that enable water saved through BMPs to be used for other priority activities, including maintaining ecosystem functions.

Participatory GIS for planning efficient water resource management towards improved agricultural productivity in canal command areas

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Real time GPS is known as Differential Global Positioning System (DGPS). It plays an important role in collecting timely, reliable, unambiguous geo-referenced spatial data of large area in a cost effective manner. Main component of back held DGPS are antenna/receiver, solar panel, and battery unit with charger, system unit and handheld computer. Receiver unit receives the signal from the satellite and sends it to the system unit, which in turn, passes it onto the handheld through communication port. Data is recorded in the hand held computer, which is downloaded to laptop/desktop computer for further processing. DGPS, integrated with Laser range finder with compass and handheld computer constitutes a total survey station where, control points are geo referenced on the basis DGPS signals, plots are surveyed through LASER range finder, information are passed to hand held computer and maps are formed in situ using the appropriate software. RDBMS are used for collecting ancillary information regarding the attributes of plots and integrated in a GIS environment with plots for making thematic maps and village cadastral maps.

Geo-PRA is an important tool for getting overview of socio-economic condition as well as natural resources in respect of a particular village and recording the information in geo-referenced maps in a very short period of time.Concerted efforts were made for mapping natural resources using geo-informatics through participatory approach for increasing agricultural production towards livelihood improvement in 16 villages of RP channel 5 distributary command under Patna main canal in Bihar and fourteen villages of Ranipur distributary command under Gandak canal system of eastern Uttar Pradesh. At first different target groups including community building organistions, land owners, and poor, marginal farmers and landless people of civil societies were identified and brought in a common forum called outlet management groups in the canal command area through intense paricipatory process for addressing water managemnt issues comprehensively. Differential Global Positioning System (DGPS) was integrated with LASER range finder and Pocket PC or Huskey for producing large scale (cadastral) plot maps using Pocket GIS software in the field . Basic attributes like village, land type, soil, outlets of the distributary and drainage directions were recorded on palm IIIxe hand held computer using Satellite Form software. Plot maps and attribute data were then integrated in a GIS environment to produce base map. Hard copy of those cadastral maps were used by village volunteers themselves for recording ancillary information like date of transplanting of paddy, source of irrigation, crops, tube wells, methods of irrigation, crops, methods of irrigation, accessibility of irrigation etc. on payment basis. Incorporating direct observation data to the base maps different water related thematic maps lake date of transplanting of rice, source of irrigations, use of tubewell irrigation inconjunction of surface irrigation for different purposes in different cropping seasons and outlet commandwise water availaability to different agricultural plots after different irrigation cycles from the distributary were developed.

The raw inventory data were made available to use by water management groups, agronomists, social scientists, farmers and self help groups for taking management decision with suitable interventions. On the basis of temporal and spatial monitoring of plots in kharif season; date of transplanting of rice in different outlet commands, area coverage under kharif crops mainly rice in each command were estimated from attribute data of thematic maps. Those data were used as input of water balance model to generate different scenarios of canal water management options including that of determination of water deficit areas, extent of surplus flows etc.as affected by changes in canal management decisions. Scenarios of water availability are generated for controlled and uncontrolled situations at the outlet levels of the distributaroy which facilititates outlet management groups for taking suitable water management related interventions. On the basis of the information generated in the thematic maps dialogues have been initiated with stakeholders regarding use of thematic maps and future management strategies in respect of soil, water and crops towards increased productivity and improvement of livelihood.

Rainwater harvesting for industries Case study in Bangalore,South India

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Industrial demand for water is one of the fastest growing sectors in the Asian economies especially that of China and India. Though still a relatively smaller component of the total water consumption as compared to agricultural demand, industrial demand for water already is reaching ceilings. Supply has become a begin constraint for industrial location and growth even for the software sector and the traditional non-water intensive industries.In addition to reduce ,reuse and recycle the 4th R - rainwater harvesting has also to be included in the sustainable water supply armoury.

While rainwater harvesting has been now accepted as a good practice for agriculture and domestic use its potential for fulfilling industrial demand also is significant. With typical large areas and roofs conventional design has treated rainwater as a waste to be drained away from site. With a proper understanding of its volume,value and quality appropriate design strategies can be put in place to reap benefits from rainwater availability. Designing will require key understanding of rainfall variability,peak flows, hydro-geology,evaporation and stratified requirements of water in terms of quality.

While catchment management will play a key part in ensuring runoff and collection, designing shall need to focus on the components of rainwater harvesting namely catchment ,conveyance and storage.Appropriate designing will also need to be of rooftops,paved surfaces and unpaved surfaces.

Key understanding is emerging for example in rooftop coatings, in the proper segregation of polluted areas of catchment, the correct selection of landscape and the proper understanding of aquifers, their storage capacity, the infiltration rates of soil and the enormous significance of evaporation losses in the tropical countries.

Case studies of implementation are revealing learnings in terms of a code of procedure to be evolved for rainwater harvesting,design parameters for rooftop water,planning at the design stage itself and the cost benefits. Typical cost benefit ratios are in the range of 2 to 3 years with self sufficiency in water requirement through rainwater harvesting by some industries while others have reached a 30% satiation of demand in an average year of rain.

In the case of a printer manufacturing unit, the phased entry of rainwater harvesting began with a small rain barrel storing 1000 litres. Quantity and quality measures convinced management to invest in more rain barrels, a sump tank for storage, recharge ponds, contour trenches and contour bunds and ultimately the planting of 4000 trees on site spread over 5 Hectares. The unit is now self sufficient for its water requirement through both collection and recharge of water. Realising its sustainability a scheme has been evolved to take rainwater harvesting to individual homes of employees where the company offers a 50% subsidy for the rainwater harvesting at each employees house. A water literacy programme was started by the company, quiz held and all employees motivated to conserve and use water efficiently. A water resource centre for educatinn school children, training women from slums and rural areas and training plumbers has been started snowballing into a water conservation and rainwater harvesting movement in Bangalore.

Another company realized its dependency on groundwater when borewells started failing to yield water. It has converted its entire campus of 40 Hectares as a mini watershed for water harvesting. Two lakes have been created which store all raiwnater incident on campus and this rainwater is used to immediately recharge deep borewells. After monitoring groundwater movements appropriate recharge and drawal wells have been identified so as to use the aquifers judiciously for the units benefit.

Industries in Bangalore pay the highest tariff for water in India at nearly 1.50 dollars per kilo-litre. Saving rainwater not only makes for sustainability of water use but also makes economic sense in terms of the money saved on water bills. The government of the state has come forward now to make rainwater harvesting mandatory for all industries in Bangalore.

Effectiveness of cleaner production on water resources contamination control

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Tanneries in the municipality of El Cerrito are traditional industries, small and medium enterprises (SMEs), with economic importance for the region due to their intensive use of labor and exporting potential. At the same time, they are characterized by a low productivity, raw material of low quality, technological obsolescence and high negative impacts to the environment. Great part of this contamination comes from the uncontrolled use of resources and raw materials in productive processes. This entails to industrial effluents without treatment with high levels of BOD, QOD, total suspended solids with chromium and sulfide in high concentrations, among others. These effluents contaminate the Cerrito River, affecting the population health and the quality of the water that is used downstream for agricultural activities like sugar cane irrigation. There is also contamination by industrial and dangerous solid wastes like cuts of semi-processed and finished leather with high content of chromium and other substances, which sometimes are disposed into the water bodies or on the ground where leachate infiltrates, affecting groundwater near to the surface.

On the other hand, the environmental authority of the region, CVC, will initiate the construction of the wastewater treatment plant of the municipality, to which the tanneries will be connected, once these industries implement CP actions. It is expected that the tanneries will not affect the biological system that has been considered for the treatment plant (biological ponds). In order to help the tanneries to improve their environmental performance, CVC supported the Regional Center for Cleaner Production (RCCP) in the project "Cleaner Production in the tanneries of El Cerrito", to propose and implement actions of CP in the processes and COLCIENCIAS, the national institution of science and technology, funded a project between the Center for Leather Productivity (CPD), RCCP, University of Valle and the leather chain. Both projects have been developed in light of principles and methods based on participatory action research that assure that the problems are analyzed by the involved actors and solutions are a consensus result. The actors have adapted the methodology and participated in the spaces of agreement where the entrepreneurs have played a central role. This methodology has allowed to create a confidence base that has made possible the participation of the totality of the tanneries of El Cerrito (21 companies) in the CP projects, which had not been possible in previous interventions. In addition, the ice between the CVC and the entrepreneurs was broken and new agreements were reached around the environmental normativity. According to this, the entrepreneurs committed themselves to fulfill specific CP aspects of short, medium and long term that were analyzed in the consensus spaces.

The solutions implemented in the first project (short term) showed the reduction of water consumption in the processes as well as reductions in BOD and TSS, mainly. It was observed a reduction of 47% in BOD5 and 64% in SST. BOD and TSS reductions are due to sludge recovery by the pre-treatment systems that complemented the CP actions. At collective level, this recovery was estimated in 14,000 kg/week, approximately. Also, at individual level, the short term implementations reduced the amount of chromium in sludge as a result of CP actions. The processes were improved by the separation of the effluent lines allowing handling in an independent way the effluents with chromium, with sulfides and those that only contained organic matter. This gave the opportunity to reuse or take some advantage of sludge without chromium.

In conclusion, these projects have demonstrated that based in a participatory process, CP actions can be introduced with very positive results for the environment, the private sector and the region in general. At present, the environmental authority (CVC), the entrepreneurs, the CRPML and the other actors are developing the CP project funded by COLCIENCIAS that will give continuity to the first one. This project has as final objective to increase the competitiveness of these SMEs through the environmental improvement, considering that in the next years, Colombia will be facing strong competitors due to the Free Trade Agreement.

The reuse of water in Mediterranean stressed industrial districts : the experience of the textile district of Prato,Tuscany Region, Italy

Mr. Giorgio Cesari, Italy
APAT

The EU Directive 2000/60/CE, the so-called Water Framework Directive, establishes a common frame for the water policy in the European Union. Within its basic principles, the full cost recovery of water uses and the sustainable use of renewable resources, represent the main goals of water policy. In most Mediterranean countries the exploitation index of renewable water resources is too high and hence the water re-use seems the most suitable technical response. In Italy, legislative and economical tools have been enforced to incite the reuse of industrial and treated waste water. The textile Prato district achievements represent a good example of the application of these tools and is considered particularly important since it involves approximately 350 small-medium size enterprises (SMEs).

The general objective of the Prato district plan, agreed between the Ministry of Environment and the Tuscany Region is to improve the recharge balance of the groundwater by reducing the abstraction of water by an amount of 7 million m3/y covered by recycled water making available 1/3 of the potable water needed for human consumption and to partly integrate the flow of the Bisenzio river specially during the summer low flow regime. Available volume of recycled water will grow up to 10 million m3/y (50% of the potable water needed by Prato's population) when ozone and aquatic plant treatment systems will be in place.
The plan is based on a combination of hard and soft approaches. The hard component include: an industrial plan fed with 100 l/sec of the treated urban wastewater from the Bagnacavallo treatment plan, a dual water pipe (civil and industrial) with the industrial section of 32 km, water reservoir and a mixing section for the Bisenzio river water restoration.

Costs of recycled water exceed those of naturally extracted water and legal acts were needed to support the water reuse by introducing an economic incentive (a low tariff on industrial water supply) to promote water reuse in industrial productions (Ministry of Environment decree 2003 no. 185 and related regional level regulation, from the Tuscany Region, as included in the Regional Water Protection Plan).
Similarly, Italian legislation supports other civil and irrigational reuse of water.

A wider diffusion of results of similar projects in the EU Mediterranean countries is recommended to encourage cross-comparisons of the institutional approaches and economic tools utilized to favour the dissemination of lessons learned, also to the advantage of the neighbouring countries of the Adriatic and North Africa.

Water Use Efficiency in Industrial Sector, Myth or Reality: Experience of a Textile Cluster in South India

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In recent years due to the high population growth and expansion of economic activities the demand for water from different sectors has increased considerably. The total water required for India during the year 2050 is estimated to be 1540 km3/year, which is significantly more than the current estimate of utilizable water resource potential (1122 km3/year). Compared to agriculture (84% of total share) water used in the industrial and domestic sectors (2.5% and 4.5%) is negligible. However, the future demand in the non-agriculture sectors will increase on account of rapid urbanization and industrialization. The projected industrial requirement for 2050 is 193 km3/year (which is even more than the domestic, 102 km3/year). Industrial water extraction is increasingly contested and sometimes leads to inter-sectoral water conflicts. Upstream diversion affects the riparian rights of downstream farmers. Similarly, over extraction of ground water leads in depletion of the water table. When industries discharge their untreated/partially treated effluents, pollution problems arise. Like the scientific irrigation practices (sprinkler and drip) water-conserving technologies are available in the industrial sector also. To some extent large units can adopt these kinds of technologies as well as recycling methods. But the majority of the small-scale industries may not be aware of conservation, and affordability may also a challenge. In this context the experience of a small-scale textile cluster in Tiruppur, South India provides useful insights.

Tiruppur is a major cotton knitwear centre, having 9000 small-scale units, and is located on the banks of Noyyal river in Tamilnadu state. The employment potential (more than 200,000) and foreign exchange earnings (around US $ 1000 million/year) are the positive aspects of the industry. In the Tiruppur textile cluster around 700 bleaching and dyeing (processing) units are functioning. These units together use 86 million litres per day (mld) of water for processing 500 tonnes of cloth. For textile processing water is a necessary input. One of the major reasons behind the growth of the textile industry in Tiruppur area was the availability of good quality water, which is more suitable (hardness less than 75 ppm) for processing. In earlier years, industries extracted their required water from the Noyyal river or from open wells. But, from the early 1990's due to textile pollution the units were compelled to transport major share of required water from the peripheral villages through tankers. At present industries are paying US $ 8.5 to 12.8 for one tanker (12,000 litres water). But the continuous exploitation led to depletion of groundwater in the villages, which seriously affected the rural activities and livelihood. The annual loss in agriculture is around US $ 25,000. On many occasions villagers protested against the water market and a number of violent incidents were reported. Now a mega water supply scheme, which is targeted to pump around 185 mld of water (100 mld for industry) from River Cauvery is progressing. This is the first kind of public-private water supply project in Asia with a total investment of US $ 218 million. Through this scheme industry needs to pay US $ 0.96/m3.

Corresponding with industrial growth the volume of water requirement has also increased in Tiruppur from 4.4 mld (1980), 11.4 mld (1985), 40.8 mld (1990) 101.8 mld (1995) to 86 mld (2000). But the average water requirement per kg of cloth processed has declined substantially over the period from 226.5 litres (1980), 175.9 litres (1985), 155.8 litres (1990), 152.7 litres (1995) to 144.8 litres (2000). Lack of fresh water in Noyyal river or industrial wells due to pollution, costs of water transportation and technology transformation (hand processing to winch or soft flow) have contributed to this change. The water requirement per kg of cloth processed for small units, which depend only on winches, is 175 litres. However it is lower (120 litres) in bigger units, which use on soft flow machines. Studies has shown that the material to liquor ratio in the soft flow machines (1:5 to 1:10) is less than the conventional winch (1:15 to 1:25). Through the use of soft flow machines, both water and chemical requirements can be reduced by 50%. Moreover, the volume of effluents and pollution load also is reduced considerably. But soft flow machines are ten times costlier than winches, and are not easily affordable by the large number of small units.

At present, even though industries are paying for water (US $ 0.89/m3), they are not taking any initiatives to reuse their effluents. After the pressure from the Tamilnadu Pollution Control Board (TNPCB), the units constructed effluent treatment plants at a fixed cost of US $ 10 million. Besides US $ 6.7 million had been incurred as annual operating cost. Unfortunately the treatment plants are not designed for reducing the TDS, particularly the chloride and sulphate. Industry can meet the TDS standard and re-use the water through the installation of Reverse Osmosis (R.O) plants. But this requires an additional capital investment of US $ 8.9 million and an annual operating cost of US $ 6.7 million. Through R.O, industry can save 80% of fresh water requirement or around US $ 20 million/year. Besides, the environmental impact of pollution can also be minimised considerably. But financing the huge investment is a big challenge.

When industries extract water from river they are paying a 'water charge' (US $ 0.004/m3 or US $ 0.01/m3) to Public Works Department. The Water Board's tariff for industrial supply is US $ 0.22/m3. All industries also need to pay a water cess to the TNPCB based on the purpose of water use and it varies from US $ 0.002/m3 to US $ 0.006/m3. Generally, water charges and water cess is high for industries when compared to other users. But it is doubtful to what extent they serve as a disincentive for water use. Industries consider water as one of the input factors and hence they are willing to pay much more. The existing water charges and water cess are not a burden for them. In Tiruppur, some processing units switched over to soft flow primarily for achieving the processing quality, which is a prerequisite for the export business, but not to conserve water. It is important to generate awareness, especially among the smaller units, regarding the need and options of efficient water management practices. Simultaneously, the concerned Industrial Departments need to promote the R&D efforts and develop cost effective water conserving and recycling technologies. Government can arrange adequate financial support (interest free loans, subsidies etc.) towards implementation. Besides, the water charges and water cess need to be revised considerably, if they are to act as economic incentive for conservation. Effluent taxes can also be levied on polluting units to encourage recycling and hence promote water conservation.

Water and Natural Resource Management: Experiences of the Traditional Water Wisdom

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India is facing severe water crisis in many parts of the country, in spite of being one of the well-endowed nations in South Asian region with respect to freshwater availability. The socio-ecological complexities arising from ever-increasing human pressure on water resources makes it difficult to implement easy technological solutions to water related problems. Over-extraction with falling water tables in northern plains, or seawater intrusion along shorelines, causing salinity of coastal agricultural lands, have caused tremendous human suffering. The recent Tsunami tragedy has further degraded the fragile hydro-ecological balance in coastal areas. The clearing of coastal mangroves and cultivation of prawn fisheries have destroyed the natural defence shields of coastal areas leaving them susceptible to disasters like Tsunami. The good vegetation cover with its extensive root system in the sub-soil acts as a sponge, improving the water retention capacity of the soil, releasing it gradually for plant growth during the dry season – a function which is critical under monsoonal climate The destruction of natural vegetation cover due to human activities has lead to land degradation, impacting the water balance in many areas in the country. The destruction of the natural buffering mechanisms against environmental uncertainties, evolved over long periods in different ecological zones of the country and their drastic alteration to new systems could lead to unpredictable ecological consequences.

Under such a situation, country's rich heritage of water harvesting systems, offers a solution to water conservation issues specially in the case of decentralized water harvesting systems, managed by the people. These technologies need to be analyzed and considered for adaptation in a decentralized manner, with community participation. In an ecological sense, such small-scale initiatives could be advantageous as they are people and environment friendly without any adverse impact/s at the ecosystem/landscape level. However, any disadvantage of these technologies , if at all, will be small and localized.

The present paper reports a case study of a decentralized water harvesting strategy, in a cluster of villages in north India in the economically backward eastern Uttar Pradesh . The main problem of the region was the availability of water during the dry season, outside the monsoon period. Rapid appraisal of rural communities, along a transect in the region consistently showed that people perceived water as the key resource. Even potable water was a problem, in the summers due to drying of wells and hand pumps. During consultation with communities through participatory rural appraisal, the revival of the traditional small-scale water harvesting technologies came up as the priority starting point. Some of these technologies were being applied in one or the other form by small and marginal farmers of the area. To improve water table a menu of simple technologies e.g. , building check dams, developing water sheds, desilting ponds and wells, clearing the inlets and outlets to the ponds and water bodies and recharging the wells were experimented. The activities provided work to the communities in the lean season of the year and resulted in increase in storage capacity of water bodies and created additional irrigation potential of the land in the region and enhanced agricultural productivity.

The structures thus created were low cost decentralized solution to water related problems which triggered a series of benefits, water availability throughout the year, restoration of grass cover on denuded landscape, adequate biomass for timber, fuel wood and fodder, and contribution to redeveloping traditional agro ecosystems, in additions of drinking water in some locations. This also enabled to local fishing communities in some villages starting fish culture thus providing sustainable livelihood opportunity for them. The greatest advantage was of the application of locally available traditional knowledge and technology, which people were able to relate to a value system, which was familiar to them. This was used as a strategy to reduce pressure on forest resources of the villages around Kaimur wildlife sanctuary in Mirzapur and Sonebhdra districts of the region in ecodevlopment programme initiated with the local Forest Department. This also formed basis for traditional natural resource development, since the economy of this region was based on traditional technologies centred around the use of natural resources. Thus water acted as trigger for effective rehabilitation/management of natural resources by communities. Reviving the natural resource base has also implication for the health of the rural people living close to nature and natural resources.

The experience of the initiative suggests the dynamics of people's participation centred around water which can trigger socio-ecological processes, in terms of an improved quality of life of the village communities. This also provides an appropriate example to illustrate the statement of ecological wisdom, 'small is beautiful'.

Regenerative Aquaponics: Integrating Fish and Vegetable Production To Optimize Wastewater and Nutrient Recycling for Urban Food Production

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Analysis of the Issue:
Issues of urban wastewater and waste management are typically addressed by engineers alone, without collaboration involving ecological farmers where practical expertise in nutrient flow management is found. Municipalities often lack of structures and concepts for integrated waste-to-resource management. Urban landscapes designed for decorative purposes are a potential resource to treat stormwater, wastewater and organic matter. At the same time, urban farmers lack affordable water, fertilizer and land. Generally at least half of household wastewater is greywater, and at least half of the home nutrient flow is organic matter, especially foodscraps, that can be recovered on the household scale using on-site, integrated organic aquaponic biosystems.

Aquaponics is a bio-integrated system combining recirculation aquaculture with hydroponic vegetable production. Aquaponics is a closed system that reuses most of its water and prevents loss of absorption into the ground. Beneficial interactions in conventional aquaponics operations reduce inputs but typical systems require a high initial capital expense for equipment and large economies of scale to realize profits. These are prohibitively expensive for typical, low-income urban farmers. There is a critical need to increase self-sufficiency for resource-limited urban households suffering food insecurity and under-employment.

Results/Findings:
Organic aquaponics can recover underutilized greywater and organic nutrients safely and economically by harnessing earthworms (Eisenia fetida) and using duckweed (lemna). Vermiculture, rich in complex microbial communities, has a documented efficiency to reduce pathogens in biosolids . Compost systems irrigated with greywater and inoculated with red earthworms after initial thermophilic heating stage, produce a vermicompost product. Vermicompost provides basic nutrient requirements for vegetables irrigated with fish wastewater. Duckweed produces more protein per square meter than soybeans and can provide a complete nutrient source for fish such as Nile Tilapia (Oreochromis niloticus) while providing a nutrient sink that treats wastewater. Enhancing aquatic foodweb biodiversity using scavenger organisms such as snails, and biofilm surfaces on higher plant roots, and semi-exposed rocks increases the systems load capacity and resiliance.

Water-conserving organic aquaponics using vermicompost as a nutrient-rich media (combined with straw or vermiculite) can dramatically increase water and nutrient efficiency for affordable food and increased income in limited spaces. Adding seaweed, kelp or greensand, if available, to vermicompost enhances valuable trace minerals. Surface aquaponics, placing vegetable seedlings in floating-beds on aquaculture ponds, produce fish and vegetables at lower yields, but are a no-energy-demand, integrated production system.

Conclusions and Recommendations:
Regenerative ‘waste farming systems’ not only reduce the amount of waste to be disposed of but transform wastewater and organic waste into food that can feed a growing population while generating income. Organic aquaponics is an affordable innovation appropriate for developed and developing countries to recover greywater and nutrients for sustainable food production. Aquaponic systems require resourcefulness to adapt free, recycled materials (ie: plastic bottles for troughs) for affordable food production for diversified livelihoods in urban settings. Vertical systems can be designed to optimize use of small spaces, roofs or backyards; transforming urban walls into productive working landscapes that metabolize the waste-products of human ecologies.

Lack of whole-systems strategic planning, lack of pilot systems in urban settings and lack of extension for urban agriculture, vermicomposting and organic aquaponics currently limits dissemination. Schoolyard landscapes have untapped potential for extension training that can harness youthful energies into productive, entrepreneurial enterprises involving families and the local community. Demonstration systems, training and funding is needed to demonstrate concepts, skills and feasibility to potential urban farmers in coordination with waste management engineers and ecological landscape designers. Interdisciplinary research is needed to scale-up concepts to municipal-level wastewater and waste treatment, and to advance regenerative urban design potentials.

Thirty years of research and outreach to improve water and soil resources in rain-fed agricultural areas of the Pacific Northwest region of the USA.

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The Pacific Northwest region (Washington, Oregon, Idaho) contains two of the five most highly erosive areas in the USA. Over 70% of annual precipitation in this region, where 15% of the USA's cereal crops are grown, occurs during the cooler months of the year when soils are often exposed to erosive processes. The topography is rolling and farmed slopes approaching 40% are not uncommon. This has resulted in high rates of soil erosion and a long-term decline in soil quality, surface water quality, crop yields and reduced soil storage of precipitation. In many places topsoil losses due to erosion have exceeded 60 cm in the last 100 years.

To deal with this problem a USDA funded research program called “Solutions to Economic and Environmental Problems” (STEEP) was initiated in 1976 to conserve soil resources and develop profitable and sustainable production systems. The results produced from this program by over 100 scientists from universities and the USDA have been providing relevant research and technology transfer to growers in the Pacific Northwest for 30 years. A primary research focus of STEEP is to reduce water and wind erosion from cropland and develop practical and affordable means for farmers to increase cropping intensity and reduce or eliminate tillage. Over the last several years, research has focused on no-till or direct seeding in a diversified cropping system of various rotations and alternate crops that are most sustainable and profitable. Advances in this technology have reduced soil erosion, enhanced soil quality, and protected water quality.

An emphasis has been placed on integrating research, technology transfer and the use of federal programs to enhance soil and water quality and sustainable agriculture.

Successful implementation of the technology developed in this program can reduce erosion losses by more than 22 Mg/ha on over 900,000 highly erosive hectares. However, this region lags behind the rest of the USA in the adoption of technologies to reduce erosion including direct seeding. The quality of surface waters in the region has been substantially improved over this 30-year project period. Cleaner water would result in substantial benefits to water quality including salmon habitat.

In addition to STEEP the USDA national and state water quality programs have placed an emphasis on improving water quality in the regions agricultural areas through the emphasis of agricultural water conservation and management.

Conferences and trade shows feature STEEP research and education. These conferences highlight regional and international speakers, focus sessions, and grower and research panels on conservation tillage. Proceedings of the conferences and research results are disseminated through videotapes, numerous field days, PNW STEEP Extension Conservation Tillage Updates, journal publications and through the STEEP web site: http://pnwsteep.wsu.edu and list serve: pnw_directseed@lyris.cahe.wsu.edu.

The PNW STEEP program is currently managed through three committees. A 10-member Technical Coordinating Committee includes scientists from the three universities and USDA-ARS, and a representative from USDA-NRCS. A 7-member Industry Advisory Committee includes 2 growers from each state representing the grain producer associations (ID Grain Producers Assoc., OR Wheat Growers League, and WA Assoc. of Wheat Growers), conservation district associations (ID Assoc. of Soil Conservation Districts, OR Assoc. Conservation Districts, and WA Assoc. Conservation Districts), and one each from the USA Dry Pea and Lentil Council and the PNW Direct Seed Association. An 11-member Administrative Committee includes members from both research and extension at the 3 land grant universities (UI, OSU and WSU), and one each from the USDA-ARS and USDA-NRCS.

We will present a summary of the major advancements that have taken place in this region in the last 30 years. We will also present information about our most difficult challenges and our current strategies to realize improved water quality and enhanced water management.

Extension Service as a Tool to Increase Productivity of Irrigated Agriculture in Central Asia

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Presentation of the topic and analysis of the issue: To clearly formulate what kind of reforms are needed in water sector along with improvement of water and land productivity three years ago the special pilot project was initiated in Central Asian. As a pilot area for the project it was selected the most populated region – the Fergana Valley, which is an ancient oasis where the age of irrigated agriculture and civilization, similarly like in India, Egypt, China, and the Middle East, is estimated at several millennia. Among principal outputs of the project, it is necessary to underline the following:

1. Successful demonstration of the advanced practices of water use and agro-technical activities - almost all pilot farms during 2003 and 2004 increased crop yield and decreased water consumption compared with initially observed during 2002.
2. During Project activities farm productivity increased by 2 times on average. Water productivity increased in different pilots by 30-95%, crop production increased by 4-54%.
3. In monetary terms, the net profit per hectare for cotton increased: in Uzbek part of the valley on USD 150, in Tajik part on USD 500, and in Kyrgyz part – on USD 1000.

The achievement of those results raised principal question – how is could be possible to sustain and replicate them in large scale? During the project activities there were some specific issues emerged, which require additional studies and pilots expansion for other zones of Central Asia.

Discussion of the results and findings: The suggested way for further experience dissemination is creation of the extension service on the base of existed demonstration plots. Recently, we observe the situation when farmers to "save money" refuse from fertilizers and pesticides loosing yield, and they can not understand that they loose more than applied cost could be. The similarly, lack of information about innovations on advanced technologies caused unproductive water losses and etc. The actual problem is farmers' poverty and impossibility to pay properly for consulting services. From this view point, at first stage, it is necessary to be oriented to productivity growth acceptable for each farmer. During this time the costs of extension service should be covered with governmental support. State support is needed both for extension services providers and for farmers. In the perspective the share of farmers will increase accordingly to their economic growth.

Taking into account recent economic, social and political conditions of the Central Asian countries, at the first stage of agricultural and water sectors reform, the proposed extension services should cover the following principal directions with regard to actual farmers' interests:

- Information and legal support to farmers and their capacity building;
- Planning of agricultural activity to obtain maximum profit from unit area;
- Selection of crops profitable for given zones and certain period of time;
- Possibility to reduce costs of crop production;
- Possibility to achieve potential productivity (on the base of land passportisztion);
- Marketing (including procurement and services).

The principal activities should be oriented to farmers and their needs satisfaction. The extension service should to study farming conditions and give recommendations on new technologies, to select the best practices and demonstrate them to farmers for replication. It will establish links between science and practices. The logical frame of the activities includes a number of linked steps. First of all, in different typical zones of the region with assistance from local consultants the initial information about irrigated farming should be collected:

- Information about pilots – gross and irrigated area, crop pattern, irrigation and drainage infrastructure, soils, groundwater table, land salinity and other;
- Data on water supply for past years, specifically about irrigation application terms and numbers;
- Hydromodule (climatic-soil) zoning;
- Data on fertilizers application (norms and terms);
- Data on diseases and pests and terms of their appearance;

- Data on agro-technical measures;
- Data on main crops yield for past years;
- Data on crop production costs for past years;

The second step is assessment and analysis of obtained information with special attention to the following issues:

- Irrigation water efficiency and productivity;
- Agro-technical activity and diseases and pest combat;
- Soil fertility and soil conditions in general;
- Economic effectiveness of agricultural production.

Next step – as final output of the activities is dissemination of information and experience among farmers and their training in:

- Irrigation regimes according to hydromodule zoning;
- Existing water account methods and devices;
- Existing irrigation technologies within the specific farm conditions;
- Existing crop diseases and pests and how to combat;
- Elite seed materials;
- Extension service and its opportunities.

Conclusion and recommendations: Started economic reforms in Central Asian countries (including the agricultural sector as main water consumer) should be supported by state assistance, promoting each economic entity in both technical and technological issues. To solve such issues it is necessary to establish extension centers, which will put in practice new technologies and state-of-the-art methods. An extension center is an organization, which works for the sake of agricultural producers realistically evaluating their needs and the capabilities of water management bodies. Extension centers render professional consultations to:

- Farmers on improving irrigation water productivity;
- Water management agencies on matters of water planning and allocation;
- Water users on issues of interrelations with water authorities.

The Analysis of Yellow River Water Regulation During Emergent Drought Period in 2003

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Since March 1999, Yellow River Conservancy Commission (YRCC) began to implement unified regulation of Yellow River water resources, up to 2002, Yellow River Basin experienced continuous drought years, and in the spring of 2003, it encountered extreme drought period when the total runoff from the main runoff generating areas was 50% less than many years average runoff. At the same time, because of continuous drought years, the reservoirs release a large amount of water to the river, the water storage amount is small, especially the Longyangxia Reservoir, which is a many years regulation reservoir, the water storage level approach the dead level. So in the spring of 2003, Yellow River water regulation was the most difficult since unified regulation. And it was emergent drought regulation period.

According to Water Law, and with the permitting of State Department, the Ministry of Water Resources issued the Yellow River Water Regulation Scheme during Emergent Drought Period in 2003. By the correct leading of State Flood Preventing General Office and the Ministry of Water Resources, YRCC forecast scientifically, deploy carefully, regulate subtly, and issued "the rules of water regulation emergent situation treatment ".No drying up, domestic using water, industrial using water and agricultural using water during key periods are ensured. In this paper, the runoff, reservoirs regulation, main measures used and water regulation characteristic in emergent drought period (April to the first ten days of July in 2003) are analyzed. It can provide an experience to the afterwards years.

Results of the Demonstration Projects Implementation in Agriculture and Industry in the Neman River Basin

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Background
The EU TACIS funded project «Reducing Agricultural and Industrial River Pollution: Improving Surface Water Quality in the Neman River Basin, Grodno Oblast, Belarus» has as its principal objective development of improved surface water quality in the Neman River Basin, through improvements in water quality management (WQM).

Industrial pollution of water in Grodno oblast principally comprises galvanic wastes from the engineering sector and organic wastes from agriculture. The former contain unacceptably high concentrations of heavy metals and phenols. Waste disposal practices, including the long-term storage of hazardous wastes on industrial sites may also be a significant contributor to water pollution. Urban pollution is an important long-term contributor to river pollution particularly from inadequately treated sewage effluent. The problem occurs partly because obsolete technologies are in use and maintenance is difficult in the present economic climate and partly because industrial effluents overload systems or (in the case of intransigent organics) have a deleterious effect on the biological treatment process. Reduced industrial activity has probably contributed to a reduction in total pollutants reaching water bodies. However the combination of old technologies, untreated historic pollution and insufficient investment as a result of the economic crisis have meant that there has been little accompanying improvement in river water quality.

Industrial Demonstration Project
Industrial development within the mentioned TACIS project includes emphasis on:
- Cleaner production
- More effective resource use
- Waste pre-treatment
- Treatment solutions bypassing the Grodno Wastewater Treatment Works (WWTW)

Whilst these factors are central to the Demonstration Sub-Project at Grodnotorgmash they may be more generally applied to industry within the Oblast. Reagent refinement which already more than 20 years, did not provide a necessary degree of sewage treatment from salts of heavy metals, even in conditions of dosed out dump fulfilled and in part neutralized electrolits and solutions. The circuit of assignment of sour washing waters from galvanic branch and alkaline oil-containing from mechanical branch did not provide their mixture and partial mutual neutralization.

Design and procurement of the clean-up facility to treat the electroplating waste solutions at the GrodnoTorgMash factory have been completed. The clean-up facility upgrade on site included the site clearance and removal of the old pipework, delivery and installation of the clean-up equipment.
There are some of advantages after implementation of new technology:
- more than 99 % a degree of clearing;
- return on a reuse of 80 % of volume of the cleared water;
- galvanic sludge's received as a result of clearing drains have small volumes and are easily utilized;
- the quantity of used reagents is reduced in 2 … 3 time in comparison with the existing circuit of clearing.

Agriculture Demonstration Project
Main aim of the agriculture demonstration project is evaluation a practice of the production, treatment and storage of farm animal dung and urine which will totally contain the effluent and enable the material to be fully utilised as a fertiliser and plant nutrients for the improved growth of arable crops on a working farm, with no run off or escape of effluent to the adjacent substrates, waterways and environment.

This project activity was completed for the Niva collective farm (pig unit) of the Grodno Rayon.
The pig farming technology at the demonstration farm has been changed from the wasteful and polluting water flush system to the environmentally friendly and economically beneficial deep bedding system.
After conversion annual consumption of water reduced on 55% as well as electric power on 10 time less. It is evident from the above that the conversion in question will allow a considerable reduction of the consumption of water and electric power for heat as well as improving the living environment and performance of the pigs. It will also spread the window of opportunity for removing the manure from the buildings, as the environment rules, as applied to slurries and poultry manure spreading, do not include relatively dry strawy, or woodchip

type manures as would be produced from the deep littered pigs, Therefore these less potent dry manures can be spread in the autumn as well as spring, but they should not be spread on flood land or on snow covered land, or near rivers.

It is normal practice to stack this type of manure for a few months to allow it time to heat up and sterilise itself and compost and to some extent decompose or breakdown the lignins and celluloses in the straw and woodchips. The rotted manure is then spread on land and ploughed under before the frosts and snow of winter.
The increase in proportion of straw type manure will reduce the negative impacts on the environment, resulting from the pig farm operations. It will reduce the smell from the piggery and also greatly reduce the danger of excess slurry and dirty water flowing downhill and entering the river systems and aquifer.

Conclusions
Selected demonstration projects under EU Tacis Programme which are implemented in Grodno oblast, Belarus are shown examples of approaches for increase resource use efficiency in industrial and agricultural sectors and obtain some positive measurable benefits.

Impact Assessment of Industrial Wastewater Diaposal into Irrigation Drainage System (Case Study)

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General

As we enter the 21st century, we find ourselves at a critical point and with very little time — years, not generations — in which to undo environmental damage and bring water resources to the point at which they can maintain themselves naturally. We must now think in terms of sustainable development. This means developing and managing resources and the environment in such a way that they both maintain a strong economy and preserve a healthy environment today and in the years to come.

Conventional water resources in Egypt are very limited. Egypt relies on the Nile River as a major source for fresh water and in addition the small amount of scattered seasonal rainfall in the Mediterranean coastal strip. Groundwater fairly contributes to the total amount of available water resources. With the construction of new industrial cities, agricultural expansion and the daily increasing population conventional water resources in Egypt will not be enough to fulfill the country's needs in the near future. Therefore, non-conventional water resources management techniques are becoming vital to maintain the current levels of water consumption in the country. Among the available techniques, the most identified are the waste water treatment and the ground water use.

Water resources projects, notably irrigation projects, may be associated with adverse impacts on environmental conditions, which may eventually curtail its sustainability. This is especially true with respect to pollution of agricultural drains because they receive not only agricultural wastewater, but also, municipal and industrial wastewater which has a detrimental effect on water quality.

In Egypt, El Gharbia governorate is located in the middle of the delta. It extends from Damietta branch in the east to Rossetta branch in the west. It is bound on the north by Kafr El-Shiek governorate and on the south by El-Mounoufiya governorate. The main source of fresh water in the governorate is the Nile River. This single source is facing a threat of being unsuitable for household use due to the huge amount of pollutants being discharged daily in it. The drainage network consists of many drains that receive the excess water from agriculture, industry and municipal run-off and discharge it into main drains or directly into the Nile River.

In the governorate, Gharbia Main Drain system is located in Middle Nile Delta region. It is considered as one of the largest drainage systems in the Nile Delta. The drain receives industrial effluents, without any treatment, from different industries located in Tanta and El Mahala El Kobra and discharges 0.85 BCM annually to the sea. The drain was closed by a weir at the beginning of 1990 to prevent seawater intrusion and use the excess water for serving the horizontal expansion plan. Recognizing the fact that the drain serves as a main source of water for reclamation lands, and noting that both official and non-official reuse are found along the drain, Environmental Impact Assessment (EIA) has been conducted in order to identify any expected negative impacts of these effluents and suggest the necessary mitigation actions to alleviate them.

Field measurement for the study are water samples are collected and analyzed from the disposal point of the industrial factories and along the receiving drain to study the water quality parameters and be compared with the Egyptian environmental law.

Moreover, WASP model was calibrated and used as an integral part in the EIA process to simulate different scenarios and study the effect of varying the pollution loads. Predicted values showed that concentrations exceeded the legislative standards given in the National Law 48 of 1982. The simulations conducted indicated that primary treatment is ample to alleviate the detrimental effect of discharged effluents. The study recommended setting incentives to encourage industries to treat their effluents prior to discharge.

Objective

The main objective of this study is to assess the impacts of reusing drainage water as a non-conventional water resource. In addition, it promotes the rational utilization of the vital resources in order to sustain the projected economic growth and to avoid wastage in terms of time, resources and efforts relative to water supply development by verifying and ascertaining the reliability of existing and potential non-conventional water resources in the study area.

In addition, it aims to generate information on the quality of the water resources within the coverage area and to establish baseline information on the present conditions of the vital resource.

Scope of work

The current work was conducted to assess the quality in surface water. The study focuses on Gharbia Main Drain system, which is one of the major drains in the Nile Delta.

The methodology adopted are described as follows:

Step 1 Identification of the overall water resources system

Step 2 Analyzing the nature and impact of the problem

Step 3 Evaluation of different scenarios including the current situation in order to address the different impacts and figure out how effective they would affect the environment.

Step 4 Planning the action to be taken in order to mitigate the potential adverse effects of the project.

Quantification capability requirements for efficient decrease of combined agricultural, industrial and household water pollutant loads in a catchment

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Water carrying pollutants from various agricultural, industrial and household sources is continuously transported through the catchments (drainage/river basins, watersheds) that constitute the Earth's "rain barrels" and drain into groundwater, streams, lakes, rivers and coastal waters. Along its different pathways in this catchment-scale transport process, pollutant mass is also attenuated subject to both physical mass exchange (diffusion, accumulation in immobile water zones) and biogeochemical transformation processes (such as adsorption, degradation, chemical reactions). Even with considerable such attenuation occurring within catchments, however, the combined pollutant loading at the catchment outlet from different sources in the catchment may still be too large and unacceptably deteriorate downstream water quality for both human and ecosystem uses.

A central question for efficient integrated pollutant abatement at the various agricultural, industrial and household sources in a catchment is then: how much does the pollutant discharge at each source need to be abated, such that, after downstream pollutant attenuation, the resulting combined load decrease at the catchment outlet is achieved with both economic efficiency and as required for restoring downstream water quality and ecosystem status? By the example of coastal nitrogen loading from all main Southern Swedish catchments that drain into the Baltic Sea, we show that the answer to this central question and the achievement of economic efficiency in nitrogen load abatement depends considerably on the variability of pathways for pollutant transport from various sources to the catchment outlet.

For example, coastal eutrophication by excess nitrogen (N) loading from various agricultural, industrial and household sources remains a most important water quality problem, in spite of many years of remediation efforts, in the Baltic Sea and world wide. The typical situation for most catchments is, as described above for many pollutants in general, that the resulting N loading from a catchment's outlet into downstream coastal waters is considerably smaller than the total sum of N discharges at the various N sources within the catchment, due to N attenuation along the various pathways from source to coast. How much smaller the coastal loading is than the sum of source discharges constitutes a critical question for successful and efficient abatement of coastal N loading.

In general, efficient abatement of pollutant loading at a catchment's outlet, by decrease of pollutant discharges at the various sources within a catchment, is defined as the abatement solution that either minimizes the total costs for, or maximizes the total net benefits of reaching targeted/required pollutant reductions at the catchment outlet. For the example cases of N loading from main Southern Swedish catchments into the Baltic Sea, we show that efficient solutions of N abatement at sources within catchments depend considerably on quantification accuracy of N transport and attenuation from different sources to the coast. Specifically, efficient abatement of N loading from a catchment requires the differing transport-attenuation processes of N stemming from different point and distributed sources to be quantified and accounted for separately in economic decision models and water pollution charges.

For the example cases of Southern Sweden, minimum costs for optimal N abatement solutions differ with about a factor 1.5 to 3, depending on whether source-specific N attenuation is differentiated or not in economic optimization of N discharge abatement at various sources. Such source-specific differentiation is currently not commonly accounted for in catchment-scale N transport-attenuation and abatement optimization models. Our results highlight and emphasize the practical importance of relevant model development for coupled hydrological pollutant transport-attenuation and economic pollutant abatement optimization for efficient pollutant abatement on catchment scales.

Workshop 6:

Political and Social Negotiation Processes: Sustainability and the Politics of Water

Social processes strengthen the political negotiations for change. Low Cost Sanitation Program of the Orangi Pilot Project – Research and Training Institute(OPP-RTI). Karachi, Pakistan

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Orangi Pilot Project

Orangi Pilot Project (OPP) as an NGO began work in Orangi in 1980. Orangi situated in the periphery of Karachi is a low income/informal settlement with a population of one million. OPP's role has been to support community initiatives for development, mobilize local resources and build partnership between people and government. In the process also strengthening the government's capacity for delivery of infrastructure. With the success of its programs of low of cost sanitation, housing, education, health and credit for micro enterprise, in 1988 OPP was upgraded into three independent institutions, of which one is the OPP-RTI. The low cost sanitation program, which began with providing social and technical support to residents in Orangi to lay self help lane and secondary sewers, has now expanded all over the city, into 12 more cities and into a number of villages, influencing policy and reaching to more then 1.5 million people.

The model that has evolved and is being replicated is the component sharing model of development where people and government are partners. The latrine in the homes, the lane sewers and secondary sewers known as 'internal development are financed, managed and maintained by the people, while the trunk sewers and treatment plants known as external development remains the responsibility of the government Thru the program 1,42,272 houses have invested Rs. 180.4 million (US $ 3 million) in latrines in the homes, lane sewers and secondaries with government investing Rs.230 million (US $ 3.8 million) on trunk mains.

The component sharing model is being applied both by community and government to other sectors too, like water supply, education, health, security and solid waste management. Since 1994 the OPP partner NGOs/CBOs that started replication are now expanding work beyond their towns and cities. They are constantly negotiating project and policy changes in partnership with the people and government.

In 1992 the Karachi Metropolitan Corporation accepted the OPP model for its Asian Development Bank (ADB) financed sewerage project for a part of Orangi. In 1994 Sindh[•] Katchi Abadi Authority, the provincial govt. agency responsible for provision of land title and upgrading of Katchi Abadis (informal settlements) adopted the OPP approach as its policy, work continues. In 2003 the Punjab Katchi Abadi and Urban Improvement Directorate too accepted the model, replication in 21 towns is underway. OPP-RTI is now the Karachi City Government's team member for developing the cities main sewage disposal and drainage channels. The City govt. has lately allocated Rs. 2.15 billion (US $ 36 million) for the work.

In 1999 accepting the OPP-RTIs low cost alternative (also promoted by a number of NGOs/CBOs), an ADB loan of US $ 100 million for the Korangi sewerage project in Karachi was cancelled by the government so work could be undertaken with local resources. In the process evolved a city wide network of NGOs, CBOs and citizens advocating alternatives to the mega projects in Karachi, while promoting the use of local resources and the need to build on what exists. Mapping and documentation of existing infrastructure of sewerage and water supply for Katchi Abadis and now for all over the city and for other cities too, as part of the work, has provided an important tool for planning and advocacy.

There is now a coming together of many citizens groups NGOs and CBOs, demanding and negotiating public consultations and dialogue for all government plans, programs and projects. The groups aware of the relationship between debt, lack of democracy and the politics of development, are avocating participatory democracy in development.

The presentation will highlight the processes, results, lessons learnt and the steps forward.

[•] There are 4 provinces in Pakistan. Sindh and Punjab are two of the most populous provinces.

Women in the Water World

Ms. Tatiana Bogdanova, Belarus
Bellorussian Research Institute for
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Traditionally the role of women in the water sector in many countries was unrecognised. Women professionals are recognised as critical catalysts in dealing with yet conservative communities especially in the rural sector and it is agreed that an enabling environment should be created so that they should be more involved in participatory management of water resources, going beyond more cosmetic representation.

Since 1999 a number of national and international organisations have appeared. Women for water initiative was an initiative of the Netherlands Women Council at the Second World Water Forum in 2000 in The Hague. Women for water initiative is not a new organisation but partnership of organisations and networks. The members have their own programmes and at the same time there is a common purpose participation of women in implementation of water projects. Sometimes to take care of the broken links between bottoms-up and top-down process. Women in Europe for a Common Future (WECF), Business and Professional Women (BPW) Christian Women movement in the Netherlands, Mama-86 in Ukraine, Medium and Sanities in Romania and Net Water in Sri Lanka are the members of this initiative. Also there is close cooperation with Women's Environment and Development Organisation (WEDO) in New York.

Women in Europe for a Common Future is a network of organisations and individuals working for sustainable development, protection of human health and environment and poverty reduction. The international network consists of members and partners in Western and Eastern Europe, the Caucasus and Central Asia. WECF strengthens the participation of women in decision making at local, national and international level, builds knowledge and capacity through skill, shares, surveys and training programmes. WECF has five working groups. The Water group will monitor the development and implementation of the EU Water Initiative and organise the information, experience exchange on drinking water problems and the solutions (eco-sanitation, rain harvesting and other low cost technical solutions affordable for communities).

A. Access to water and land: human rights

Although the access to safe drinking water and other resources has been recognized as a human right, implementation of this right has failed so far, thereby negatively impacting women.

Create national frameworks (e.g. constitutional, legislative, regulatory) premised on access to water as a basic human right. National and local governments should assume responsibility for implementation. Governments should ensure women's access to and ownership of land, as agreed in the Johannesburg Plan of Implementation (JPOI). Constitutional and legal barriers that bar women from owning or inheriting land should be eliminated in order to ensure them adequate access to housing and water. Women's rights to land, water and other natural resources should be incorporated into the provisions of the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW). Particularly in situations of conflicts and war, women's safe access to water, housing and sanitation should be ensured.

B. Private Sector Involvement in the water and sanitation sector

Liberalization of water markets is pushing large parts of the population further into poverty and into using unsafe sources of drinking water. Women are badly affected. Policies favouring privatization of public services create a lack of accountability and transparency.

Governments should recognize the negative impacts of water privatization on the livelihoods of poor and indigenous women. Therefore, water must be identified by all governments, private sector and all other stakeholders as a public good and human right and not a commodity to be traded on the open market. Water management must be for social needs and environmental sustainability rather than for short-term profit.

WEDO is an international advocacy organization that seeks to increase the power of women worldwide as policymakers at all levels in governments, institutions and forums to achieve economic and social justice, a healthy and peaceful planet, and human rights for all. Women as the Voice for the Environment (WAVE), is the first women's environment assembly organized by WEDO and the United Nations Environment Programme (UNEP).

Women for Water is a bridges between principles and practice in the sphere of water management. The key task is the connection between all horizontal and vertical networks, sharing the experience.

- Women should be encouraged to enter water management industry at all levels so that they can contribute to and benefit from any additional resources within this sector
- Women's knowledge and experience of water management should be acknowledge as a global resource to be developed
- Women should be drawn into the process of consultation at all levels when policy is created, systems developed and mechanism designed.

In all parts of the world women are key water managers. And yet, their expertise, hydrological knowledge and intricate survival strategies are rarely considered. At present, their local techniques tend to be neglected because they are difficult to locate and even more difficult to comprehend in terms of modern development co-operation jargon. Also, since their techniques are usually small-scale initiatives, they are not amenable to institutional funding or integration in large-scale development initiatives.

The gap between theory and practice of consensus building in South Korea: the case of the Hantan river dam

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Since the 1990s, with the expansion of local autonomy and democratisation, environmental conflicts have rapidly grown. Large public projects such as dams, land reclamation considered to promote industrialization in the past are being challenged by environmentalists as well as communities. The conflicts are mainly related to the lack of procedural legitimacy and distrust in the government and new modes of citizen participation are appearing to complement the conventional decision-making. The Hantan River dam case is noteworthy in that it is the very first social experiment testing the well-designed conflict resolution framework with a neutral party mediator. It has achieved some success but the conflict is still unresolved revealing the gap between theory and practice.

This paper examines the essentials of the applied models of consensus building and the influencing factors to alternative dispute resolution in practice. Focusing on the political environment in which the parties and the mediator operated, it explores the Hantan River dam case in South Korea. On the basis of these findings it evaluates this social experiment in terms of both the process and outcome depends on the factors that influenced the product of consensus building in the Korean context.

Consensus building is a collaborative decision-making approach in which the stakeholders identify common ground and cooperate towards finding a mutually acceptable solution to a contentious issue (Environment Council, 1995). A neutral party is often invited to help the process because mediation offers a greater opportunity for constructive interaction among parties. The mediated negotiation approach is expected to deal with the complex multi-stakeholder nature of environmental issues, as the stakeholders are able to control the whole process of decision-making and its outcome. The principles of participation, representation, legitimacy and accountability should be met for effective consensus. However, there exist some counter-arguments that even the well-designed process may not lead to consensus outcome nor address deeply held value conflicts and that some fundamentalist discourse may be precluded from the process. The failures may be attributed to the problem of practice such as a bad mediator, strategic action of parties or time constraints, but it may result from the political and social context in which a conflict occurs.

The Hantan River dam issue has been contested for more than five years, beginning in 1999 when the plan was proposed as a flood control measure over the downstream Imjin River, a shared river with North Korea. Above all, mistrust in the government built up from past experience had culminated due to the inadequate consultation process. The Presidential Commission on Sustainable Development (hereafter PCSD), the advisory body, attempted to act as a mediator to resolve the intractable conflict, which was meant to create a model initiated by President Roh Moo-Hyun.

The whole process is comprised of three stages. In the pre-negotiation period (Feb-May 2004), the task force team identified the stakeholders with contending issues and proposed a negotiation procedure. It reframed the dam construction agenda as a flood control issue. Next stage was the negotiation period among four stakeholder groups mediated by PCSD sub-committee (Jun-Sept 2004). Failed to reach an agreement, the parties delegated the whole responsibility of decision to the sub-committee by mutual consent. Thus, the period of arbitration by the sub-committee followed. The sub-committee discussed the five alternatives proposed by the parties and announced its final proposal (2 Nov.). Revoking the existing

multi-purpose dam plan, a smaller-scale flood-control dam with two floodwater storage areas will be constructed under the new roundtable. The agreement, which is not legally binding, but was agreed upon the parties in writing, has not been implemented yet due to a repeat of the anti-dam protest.
The Hantan River dam case sheds a light on the application of a mediation design in societies where there is a short history of experience with deliberative democracy and formal conflict management mechanisms. Well-prepared process involving all the parties provided the roundtable where the contested issues could be deliberated with equal distribution of information and power. The mutual trust was built up in the course of negotiation and the reframed agenda led more constructive discussion than the dam-or-not alternative did. PCSD as a neutral mediator also contributed to consensus building by gaining trust and leading social learning process. Considering that similar conflicts were badly delayed, deliberation based on the "rules of the game" enabled the parties to realize the worth of collaboration.

Nevertheless, this social experiment must more effectively address the following problems in practice. The time constraint to reach consensus caused the parties to avoid making a decision themselves, rather transforming mediation into an arbitration process. The mission was imposed by the President, which decreased flexibility of the process. It also generated strategic action by some parties to get away from the burdens a dam construction alternative may bring about. PCSD also had some inherent limitations in fulfilling its role as a neutral mediator because of its organizational position. The betrayal of anti-dam local people shows that the value conflict is not well addressed in the process, but it may result from the lack of social penalty mechanism, formal or informal, for the betrayal. Arbitration process without enforcement power may not be workable to deal with strategic action in these societies. Despite some success of the experiment, the gap between theory and practice of consensus building exist due to the cultural and political context which surrounds the conflict management process.

Negotiation or Neglect?
Interface of Positive Discriminatory Policy and Professional Ideologies

Dr Pranita Bhushan Udas, Nepal

Presentation of the project/topic and analysis of the issue(s)

Gender concerns in irrigation association are important not only to address users' (male and female) water need, but also to gain access to other resources. The Users' organizations are often seen and become important alliance in larger political arena. Research studies in irrigation sector in Nepal reveals that women involvement in formal irrigation organization is negligible. The irrigation policy 1992 recognized the lower participation of women in users' organization. The policy provides guidelines to involve at least 20 percent of women users' in committees. The irrigation regulation 2000 made it mandatory to have at least two women users in nine member users' committee while getting registered in District Water Resources Committee to be eligible for government support. In contrast to these irrigation policy documents, revised Irrigation Policy 2003 provides guidelines to include women users in committee only "if available". Arguments put forward by irrigation professionals, who are mostly male irrigation engineers for this change is that in most of the systems executed by Department of Irrigation, it was hard to bring women in the committee and inactive women member in the committee leads to ineffective WUA than a committee without women. In this paper I present an analysis of irrigation policy changes in last fourteen years through a gender lens. I explore how the gender ideology influences the policy change?

Presentation of the results/findings

In field the implementation of the quota system shows mixed result. In an irrigation system in Central Nepal, a low caste illiterate widow took this opportunity to nominate her educated daughter in law to the local irrigation users committee, where as the dominant caste women (in the same meeting) refused their nomination from local leaders. The widow legitimizes her action by attaching value to have an access to information. She refers to her own troubles being uneducated widow to deal with government bureaucrats to transfer land ownership in the event of her husband's death. This case shows that positive discriminatory policy does provide space for those women who could not come forward in formal meetings due to social barrier, but has enthusiasm to participate.

Another case from the same irrigation system shows that a woman committee member who used to participate in all meetings in temporary absence of her husband is replaced by her husband once he came back. She took this replacement in positive sense and feels that she has a male in home to help in many things. It explains gender relation in household is at the end the decision of male and female family members. The question is if there would not have been quota system, would she be represented in the committee, which she believes is important to be in. Another irrigation system from Eastern Nepal reveals that the users' constitution which is a mandatory while getting registered is not followed strictly, however they have informal rules which makes water flow in farmers' field. President of the organization and few committee members are more involved in networking with outside agency (government and non government) to bring more resources in the village. For outside agency, the president in specific and committee in general is a bridge to approach the villagers.

In contrast to the above policy objectives, the revised irrigation policy of 2003 states that, 'women members can be included in the committee 'if available'. It also mentions to include socially disadvantaged and excluded caste group "if available". The shift raises the question that is the positive discriminatory policy for women are also a part of similar policy for caste group? It is possible that not all small irrigation system all caste group will be present and the 'if available' clause suits more. But in all irrigation system women will be there. The increasing urbanization and male migration leave most of the farm responsibility in women's arm. If show, the revision in irrigation policy and argument put forward by implementers that women as poor participant reflects their gender ideology to analyze gender problem in village. If a woman member in a committee is inactive, does it has something to do with quota system or an empowerment program is needed. The male irrigation bureaucrats who go to implement the irrigation program in village does influence female members in a village to come forward and talk if they are gender sensitized , even then the gender ideologies existing in the village 'discourage' women to talk to outside male members restricting their participation in the public domain.

Conclusions and Recommendations

Positive discriminatory policy has become political agenda in most cases though the approach is justified on rights based argument. Simple presence of women members in irrigation committee could only manipulates policy choices. Women activism in favor of positive discriminatory policy in most cases put a big "full stop" after its inclusion in policy documents, which ignore an essential empowerment activity for women to make use of their position. In village, members who could realize the importance of being in the committee only could manipulate space provided by others. The question in the context of Nepal is then, whether all the users have realized the importance of being in the formal committee when illiteracy dominates the rural areas. If not then more effort should be given for educating users and making both male and female aware about the formal committee. Otherwise, water users' committee in specific and organization in general remain as a screen for outsider to see the village. The gender problem in village and problems identified by professionals still show a large gap in actual implementation.

TOWARDS SUSTAINABLE EQUITABLE MANAGEMENT OF WATER IN NAIROBI CITY: Enhancing the participation of women in water management discourse

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Presentation of the topic and analysis of the issue:
WATER provision in the city of Nairobi is not proper and is causing women much suffering. Attempts by women to correct this aberration is hampered by the fact that women are outnumbered on water management committees. Many parts of the city remain on water-rationing for the 6th year in a row; which also disrupts electricity supply to residents. For so long, Kenyan women have watched haplessly as they are given inadequate water services but now they are beginning toe agitate for changes. This research examines the following issues: How are women represented in water management committees and other meetings that legislate on water consumption in this city? What are the factors determining the representation of women on water boards in the city? How can women's participation in water discourse at local and at international levels be enhanced?

Presentation of Findings:
This study finds that women suffer most because of biased distribution of water services to city residents especially to women maternity hospitals and women penitentiaries. This paper finds that women suffer most in Nairobi City because of gender disparity on decision-making committees. Though the current Kenyan Minister for Water Development is a woman, nearly all the staff of the ministry in the country are men. Water policies are therefore formulated by committees dominated mainly by men; which explains the biased decision-making in the distribution of water to women in the city in the city of Nairobi.

This paper finds that water provision to two major women facilities in the city: the Pumwani Maternity Hospital; the largest delivery hospital in East & Central Africa and also to Langata Women's prison; the largest such women's penitentiary in Kenya is insufficient. Denying water services to maternity hospitals endangers the lives of mothers and their infants. The author argues that women nurture children and there can not be true dialogue on water while a major section of the society is left out of vital discussions.

This paper finds that the provision of water to the residents of Nairobi is also used as a political weapon. Residents in areas presumed to be strongholds of political parties that are in opposition to the government are usually denied water. Areas such as Embakasi Estate and many others go for months without water; causing much suffering to the women; upon whom the duty of collecting water in this country traditionally falls. Many residents go for days or months without water thus jeopardizing the sanitation and health of women in hospitals and prisons. Insufficient water compels women to buy water from hawkers. This has led to the evolution of cartels that supply water to residents through mobile vehicles, motorcycles, bicycles and donkeys. But the purity of this mobile water is questionable and yet in most cases it is the only water available. This study finds that the increase in the cases of typhoid and other water-related diseases affecting women and children is due to the biased water services offered to the residents of Nairobi as a result of the low number of women on water management committees.

Conclusion
Policies should be enacted to ensure that there is a constant supply of clean adequate water to women prisons and hospitals at all times. But legislation for such timely decisions can only be enacted if the number of women on water management committees and departments is increased. Water that is not well-treated jeopardizes women's sanitation and health especially those in prisons and hospitals.

This study asserts that women should unite and demand for stronger political representation in the government. The state should support women by creating an enabling environment to make women feel confident enough to run for positions of responsibility on water management committees. Positions that become open in water departments should be widely publicized to reach all eligible women. International conferences should go a step further and set aside a minimum quota of positions specifically for women. These procedures will enhance women participation in discourse on water and contribute to the sustainable and equitable management of water in Kenya and in other nations.

Economic, political and environmental risks with bulk water supply BOTs

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a. Topic

Most research on the role of private sector participation (PSP) in water services has focussed on the various forms of concessions, lease, and management contracts for urban water distribution systems. Relatively little attention has been paid to the build-operate-transfer (BOT) contracts which have been used in many countries as a way of financing the construction of new bulk water supply, water treatment plants, and wastewater treatment plants.

The typical structure of these contracts is that a private company invests the money to build the reservoir or treatment plant, and then recoups the cost by operating the plant and selling the water under a long-term 20 to 30 year agreement with the water authority. Under these agreements, the water authorities promise to buy the water produced by the reservoir or plant at a price which is set to ensure the profit of the private company; and such agreements are normally guaranteed by national governments.

Case studies of a number of these contracts in various countries suggest that these BOTs have long-term economic implications for urban water distribution systems, create risks for public authorities guaranteeing such contracts, risk over-exploitation of water resources, and their negotiation can involve non-transparent political processes.

b. Results/findings

The economic impacts can be observed in a number of countries. In Malaysia, a series of bulk water BOTs have created financial pressures on water distributors whose end price to customers cannot always match the price they pay for the water. Elsewhere, the BOTs themselves have been terminated, though the terms of compensation remain the subject of dispute. In Vietnam, the Thu Duc treatment plant in Ho Chi Minh City was selling water at nearly twice the price charged to customers: the operator abandoned the contract in 2003 because of disputes over the interpretation of the contract. The bulk water supply contract of Shenyang Public Utility was also ended in 2002 because demand was lower than forecast and the public water authority could not afford to pay. A BOT contract in Bogota, Colombia, was terminated after the city council calculated that the project was charging 10 times too much, and that it was worth paying USD$80m to buy out the contract.

Extensive government guarantees can be observed which protect companies from a wider ange of risks. The Rio Chillon project in Peru includes government guarantees of purchase, as well as government guarantees of loans and bonds issued by the project. A Shanghai BOT was protected by a guaranteed rate of return, which was so central to the economics of the project that the operator terminated the contract after the Chinese government announced profit guarantees for private firms would no longer be enforceable.

Problems of political processes can be observed in the Izmit BOT in Turkey, where a government investigation into possible corruption; and Milan, where the process of developing contracts for wastewater treatment plants have led to a conviction for corruption.

The negotiation of the projects appear to be vulnerable to forecasts of demand which turn out to be exaggerated, and thus the schemes themselves may capture water resources unnecessarily. According to a report by the ADB, the Chengdu water supply BOT has led to the local government being forced to purchase 400,000 m3 per day which is unnecessary to their requirements. The Izmit project has captured water which is unaffordable to the municipalities for whom it was intended , and the operator has resorted to exporting water for industrial customers in other countries.

The dynamics observed with water supply BOTs can be compared with experiences with independent power stations (IPPs) in the electricity sector. IPPs share similar financial and political structure with the water supply BOTs: they involve investment in new electricity generation, underpinned by a long-term power purchase agreement (PPA) under which the distributor agrees to purchase the output for a period of 20 years or more – a promise which is invariably underpinned by government guarantees. Some of these agreement also created crises for the distributors, who found themselves obliged to purchase electricity at a price higher than they were selling it to customers, and at prices higher than they had to pay for alternatives. Examples include the Dabhol IPP in India, which became non-viable and is now the subject of billion-dollar claims for compensation, and the Indonesian PPPs agreed under the Suharto regime, which have created a costly burden for the county's electricity system.

c. Conclusions and recommendations

In conclusion, the evidence from these case studies suggest that there should be a re-appraisal of the economics of existing water supply BOTs, and lessons of this experience should be incorporated into future consideration of how best to finance and evaluate the need for water supply schemes. Attention should be drawn to recent advice from the IMF on the need for careful evaluation of BOT proposals against traditional forms of public procurement of construction and separate operating arrangements. Otherwise long-term economic liabilities may be accumulated which damage the ability of water utilities to function.

Conflicts of sustainable water access .The Dilemma between the social and economic values of water in Poor Countries. The case of Bolivia.

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Universidad Evangelica Boliviana

The high percentage of population that consent to water and sanitation in inadequate conditions is a deep and complex problem in Bolivia. In this context, the participation of private sector is considered a promising alternative. However former experiences were no succeeded. This paper is related to the failed participation of the international private sector in the provision of water services in La Paz-El Alto and Cochabamba concessions.

In order to extend the service to low income households, both systems were conceded to two international private companies.

Samapa in La Paz –El Alto was privatised in July 1997 on a 30-year concession to Aguas Illimani, a subsidiary of Lyonnaise des Eaux., Bolivian and Argentine investors. The main goal was extend the services to low income households and committed to achieve 100 % of coverage in La Paz and 95 % in the case of sewer. In the case of El Alto, install almost 72000 new connections and a coverage of 90 % of sewer system. These objectives should be completed until ends of 2001 in the case of the drinkable water and 2021 in the case of sewer. The contract also permits increasing tariffs each 5 years which also was indexed to dollar.

In September 1999, the municipal water service of Cochabamba was privatised. The concessionaire Aguas del Tunari, a multi-national corporation a subsidiary of International Water Limited. The relevant articles of this contract established: Grant water concessions to Aguas del Tunari, for a period of 40 years. The exclusive rights for provide the services, the possibility of tariff increment and dollar indexation.

However, these two concessions finished abruptly before their limit time. In both cases due to a strong popular pressure. In early April 2000 Aguas del Tunari left the city after a violent confrontation. In January 2005 after three day of civic blockades and strikes Aguas del Illimani also decided to abandonee the La Paz – El Alto concession.

The main demands, coincident in both cases, were no exaggerate increment of water bills and the necessity of investments in order to achieve the goals

Bolivia is a poor country with 58.6 % of poverty and 24.8 % in the threshold of the poverty. Both cities present the same pattern of poverty 66% in La Paz and 51% in Cochabamba. In this context the average monthly salary is around 85 $us (if we considered the unequal distribution of wealth, this became even worse) it is difficult to expect no reaction when water bills increased from 100 to 300 %, and represented, at least, an increment from 12 % to 35 % of the monthly salary, in extreme cases.

The two contracts are no clear about investments. For example, in the case of Cochabamba, investments were conditioned to obtain unconditional financial resources or financing not guaranteed by the patrimony of the shareholders

The solution of water services in Bolivia is a long-term process that requires an integral focus, based on the authentic participation of users, construction of common objectives and general population adherence to the water policy. I t is necessary investments for extending the services to low income inhabitants who are unable to pay high water prices. This requires a deep knowledge about the magnitude and characteristics of poverty that authorities and business sector usually ignore. However the Bolivian process neglected these principles and started, under international pressure, a short process, underestimating the complexity of the economic and social problems and how they interacted.

In both cases the marginal and poor social groups did not participate in the contract signed process and they leader the protests. These groups were composed by people with strong native influence product of migration from rural areas. For a part of this community water is perceived as a source of life that hardly could be reduced to monetary terms, since they perceive the value of water in different parameters.

International pressure goes with standardisation of norms, rules and participation of private sector. Private corporations (which main objective function is maximising their economic benefits as much as possible) and poor countries relationships are not always in equal conditions. The importance conceded to markets and the current week Bolivian economy, influences the unequal relationship that usually affects the control conditions established during negotiations that is visible in the lack of transparency of contracts. For example, the commercial confidentiality of the financial arrangements,(hidden in intellectual property) and also in the article that permit conditioned investments. In this condition fresh investments are no sure from the private sector. This is a great paradox, because the main reason of looking for private participation is the access to new capital.

For solving problems that reach the basic services is necessary integral poly that includes the main sectors in the country. It is not possible to expect a solidary policy in the water sector when the economic mark is ruled by neo liberalism. In 1985 Bolivia adopted, through the supreme decree DS 21060, a neo- liberal economy. This also influences the water sanitation law that establishes legal condition for private participation in water services, introduce the cost recovery concept in water tariffs and no allowed subsidies.

Bolivia was pressed for the incorporation of private sector in the provision of water services by the World Bank (which becomes later new partner of Aguas del Illimani). The Cochabamba concession was granted even though the water law had not yet been promulgated. In the case of Aguas del Illimani its concession was a previous year. This suggests that the process was no carefully organized.

Bureaucracy and Irrigation Reforms: Lessons from Andhra Pradesh, India

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Presentation of the project/topic and analysis of the issue(s)

Neo-liberal policies have a large impact on irrigation management in developing countries. There is a growing interest in the impact and performance of the Irrigation Management Transfer (IMT) policy models. The Mexican and Philippine irrigation reform models widely disseminated and viewed as successful examples of irrigation transfer policies. In line with them, Andhra Pradesh (A.P) is the first state in India to implement irrigation reform policy in 1997 enacted by a state legislation. Andhra Pradesh is a South Indian State based on agricultural economy with a population of 70 millions. The reforms in the state were started as part of the overall economic and institutional modernization program introduced by the then Chief Minister Mr.Chandrababu Naidu. The irrigation reforms provided a window of opportunity for the advocates of IMT. The process has attracted lot of national and international attention and acclaimed the status of the 'Andhra Model'. The A.P irrigation reform policy is based on the neo liberal belief that scaling down the irrigation bureaucracy, increase of water charges and transfer of operation and maintenance of irrigation infrastructure and water distribution to user associations would lead to growth in irrigation sector. The salient features of A.P policy of participatory irrigation management (PIM) is the scale and the big bang approach that it adapted in implementation. Instead of taking for granted the neo-liberal policy discourse, the paper presents how different policy actors attributed meanings to the irrigation reform policy implemented in the state. The paper examines the A.P irrigation reform policy and the proclaimed success. It aims to stimulate debate especially on the role of hydraulic bureaucracies in irrigation reforms. The paper reports on research carried out in Andhra Pradesh in 2001-2003

Presentation of the results/findings

In the literature bureaucracy is viewed solely as instrument for attaining policy objectives. The actual bureaucratic practices under reform are inadequately understood. The paper provides an alternative perspective of irrigation management reforms by analyzing the role of irrigation bureaucrats as important policy actors. In the case of A.P the irrigation bureaucracy developed a network of interests around them. In contrast to the policy objectives, the bureaucracy negotiated or engaged successfully with the policy process and could control the activities of water users associations. The lower level bureaucrats saw the reforms as threat to their jobs initially but cope up in the process by mediating with it. The senior bureaucrats saw the reforms as a positive step and supported the political executive. In the process they could advance their career goals. At the local level the additional powers that the bureaucracy acquired through the APFMIS act, resulted in a special relationship between the WUA leaders and the implementing bureaucracy. The economic interests of the both are protected through win-win arrangements. The lower level bureaucrats were successful in lobbying with the state and using legal means they resisted the state policy of transferring them to WUAs. The paper shows the evidence that the A.P irrigation reform policy did not result in a complete devolution of bureaucratic powers but it served to reorder bureaucratic control over irrigation management.

Conclusions and Recommendations

The A.P case study suggests that the political process of policy making is not completed after the formulation of a policy. It is necessary to place the struggles between policy actors in the broader frame of historical, political and bureaucratic transformations to understand the reform policies. As long as the irrigation department's self seeking interests continue, the autonomy of the water users associations are at stake. The A.P reform policy should focus on finding ways to strengthen the WUAs by introducing accountability mechanisms between the irrigation bureaucrats, users and political representatives. The policy lessons that are learned from Andhra Pradesh may be relevant to discuss and debate on contemporary models of institutional evolution and sustainability in water management.

Watering the Slums: Resistance and Reform in Bangalore's Public Water Sector

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Public water utilities in developing countries are routinely and justly criticised for not providing adequate services to the urban poor. Often large and inefficient, they struggle as institutions to remedy failed state-led planning models. In the literature on service delivery, most of the attention on innovative programs to alter governance structures and improve performance for the urban poor has been given to innovations through public-private partnerships, private sector participation and deliberate public sector reform. For many water and sanitation utilities, however, innovation is never so dramatic. Most never get the political moments at which such changes can be negotiated, developed and implemented. The lessons of this literature for utilities that continue to muddle through seem like a distant prospect for reformers hoping to shift the trajectories to which these organizations have so long adhered.

The political reality for most public sector utilities is quite different. Paths to reform can be slow, messy, resisted and frequently the result of initially unintentional or external drivers of change. The outcomes, however, can be decidedly pro-poor. Recently, much international attention has been given to scaling-up slum upgrading programs and domestic water supply connections in the wake of time-constrained targets set in the Millennium Development Goals. While important, such targets run the risk of masking the importance of how organizations learn, urban politics function, actors negotiate policy and other ways which drive genuine and sustainable changes in water governance.

This paper presents the case of the Bangalore Water Supply & Sewerage Board (BWSSB) which has made significant efforts to connect slum dwellers to its piped water supply. In 1999, the Board had no formal contact with the city's slums whose residents had to rely on haphazard access to domestic water supply through illegal connections, public taps, water vendors and borewells. Over the next four years (2000-2004), the Board demonstrated a new willingness to work with the poor significantly beyond the interest shown by most water utilities in India. In 2000, it undertook three pilot projects under a donor-funded program, after which it established a dedicated Social Development Unit to continue work in slum areas. Over a subsequent two year period (2002-2004), the Board connected approximately a further 50 of the city's 400 slums. Although the impact was not dramatic and the approach was not always consistent, for the first time some of Bangalore's slums received dedicated attention by a public water agency renowned for its prior complacency towards the poor.

Over an approximate five-year period, Bangalore's political, social, economic and administrative systems in place to deliver water services have turned decidedly more pro-poor. In a system of splintered government responsibility for slums, the BWSSB has opted to take some definitive responsibility and provide water to slum areas. For years, local government had failed to issue clear visions and policy directives for the urban poor, and responsibility for slums had fallen between the cracks created by the division of responsibility for service provision between state and local powers. Moreover, the city's political system had fostered the support of the growing corporate economy leaving poor groups to tread in a system in which their political representation had real little power.

This paper analyses the reasons for the utility's successful reform based on field research in Bangalore including extensive political interviewing and survey work. Holding the city, the organization and the overall sector efficiency constant, this research uses a natural experiment to elucidate explanations for success, in particular by highlighting intra-organizational variation in outcome. This paper finds that a crucial element was the establishment of partnerships between the utility's management, field-level engineers, communities of slum dwellers, and local NGOs. These partnerships resulted in the co-production of improved services in the form of domestic and shared water connections in the city's slums. This paper presents how such groups interacted, improving mediation, facilitation, and sustainability. It also explains how cooperation, bargaining and resistance between the utility, NGOs and slum residents varied across the city and describes the reasons for this variation in outcome.

This case also sheds light on the impact of new forms of urban governance emerging across India's cities. In Bangalore, the rise of a civic movement has significantly challenged the monopoly on the orchestration of governance. Important local NGOs have promoted participatory governance in city affairs, rallied citizens to their cause, issued report cards on service delivery agencies, reduced asymmetries of information and generally encouraged citizens to get involved in their government and hold it to account. Drawing on the language of new public management and participatory action, this third force has showcased the concept of good governance to Bangalore since the mid-1990s, making sincere efforts to include slum dwellers in participatory campaigns and to raise their profile in political discourse. Bangalore's third force has radically altered the political landscape and the sway of this civic movement on agencies like the Water Board is an important explanation for emerging good performance.

This paper concludes that it is important to build on local instances of success within an organization and disseminate the patterns that led to such positive outcomes across the organization, rather than routinely view public sector organizations as monolithic entities and judge them by their failures. It also argues that without understanding the local political context of such reforms, there is no scope for sustainable replication for other utilities still muddling through.

Institutional Development for the Water Sector in Honduras

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Presentation of Topic and analysis of issue: Honduras is currently under a Water Reform, which is carried out under a program of Modernization of the State. The Water Reform comprises institutional and organizational change within a political structure difficult to adjust along the reform process.

This paper examines the trend for Institutional Development in the water sector in Honduras. It emphasizes the incidence and participation of the actors in this Institutional Development that have developed and changed their attitudes along the years as a result of the development of reconstruction programs after the Hurricane Mitch.

International agencies, donors, civil society organizations are gradually revising or adding strategies within their agendas, from including projects with indirect support for local development to a direct participation in the water management reform. Moreover, initiatives from new organizations from the civil society, the public and private sector indirectly set up the path for institutional development. As in other parts of the globe, the implementation of the water management reforms requires strong willingness from the actors to achieve success. As an example, in Honduras donor agencies are gradually taking the lead in the process, by financing and setting up agreements for institutional reorganization, leaving the domestic participation for local development projects.

To analyse the institutional situation in Honduras, this paper relies on institutional development theories. The concepts are taken mainly from the new institutional economics (NIE) theories emphasizing the institutional change discipline, and the concept of instrumental value, which is very similar to sustainability (Livinston, 1993). The approach is not a constraint to the possibility of a convergence of old and new institutional theories. On the contrary, their application and integration could be beneficial.

In this environment, creating awareness and organizational change is necessary to achieve a holistic and integrated implementation of the water management reform according to the needs and potentials of the country. By defining water as one of the means of an integrated societal development, change in social behaviour and attitudes are the main factors for recreating trust in institutions and organizations in Honduras, a country where corruption is the major problem thus impeding sustainable development.

Findings: In the long run formal and informal institutions determine the performance. Analizing the Water Sector Institutional Development through the cyclic institutional change in water management (Challen, Livingston) Honduras is trying to get a consensus in issues like social, economical, technological and environmental change. Throughout the Honduran Institutional Development, the top down approach has been the key of guidance with some increasing bottom-up demand induced approach especially from the civil society organizations. As a consequence, actors receive more support in certain periods than others. Organizational change usually is a much more complex procedure than initially thought, especially in Honduras. Institutionally, the water sector is finding its way through enacting a set of laws and regulations for the water sector and related issues.

On the other hand, paternalism from donors and the government endangers the alienation of the population. In places where international cooperation have already a pre-determined line of action, and actors find it difficult to assume new roles as for example, NGOs that can not abandon their self-induced role as a project supervisor to be changed for the role as facilitator between the municipality and the community, the decentralizations process will face problems.

The eradication of Honduras severe problems such as corruption (UN) is recommendable to deal as a priority in order to secure effective institutional change. Any decentralization process, as Honduras is trying to carry on, must consider people in the local communities as the true actors. If a sustainable water supply and sanitation service should be achieved, Institutional Development with integrated governance is an effective option.

Assessing the Influence of Cultural Differences Between Suppliers and Users of Environmental Information on Informed Decision Making

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The State-of-Rivers reporting system in South Africa has achieved much in the way of packaging ecological information so as to be useful to decision-makers. State-of-Rivers reports have indeed become popular, flag-ship items and they are regarded by decision-makers and researchers as useful reference resources. In addition, because they are tangible and attractive products they are often used by field managers as testimony to the achievement of their ecological survey and reporting milestones. Yet evidence for the real impact of such products on influencing decisions remains elusive. This prompted inquiry into why environmental information, even when packaged to suit the perceived needs of decision-makers, has relatively little real impact on the management of natural resources or the prevailing paradigms that influence management processes.

Multi-scaled and devolved water resource management increasingly relies on the sharing of information and knowledge, and importantly, on developing shared understanding to achieve shared goals. This paper proposes that differences in world views are embedded in different contexts in which scientists and managers operate, and that these, when they become entrenched as group culture, present considerable challenges to sharing knowledge. Therefore, the acknowledgement of own and others' contexts becomes an added requirement for effective communication and the development of shared understanding. The paper also proposes that a cultural approach to understanding different contexts is helpful in terms of exposing underlying drivers that determine how environmental information is received and interpreted differently by people in different contexts.

Individual and group "worldview" provides the context within which new information is processed. As a result, people construct new understanding based on what they already know or believe, both as an individual and as a group of individuals sharing the same culture. Worldview is moulded by multiple factors, for example: era in which you grow up, environmental, demographic, cultural and geographic influences and disciplinary background. Identical information will always invoke different meanings since interests, motivations, beliefs, attitudes, feelings, and sense of relevance are always personal and changing.

The loss of content and particularly context involved in writing down what we know results in explicit information only ever being a partial representation of what we know. When written information is transferred from supplier to end user, the supplier essentially loses control over the subsequent use of that information. This is because explicit forms of information (e.g. written) will be interpreted and applied within the user's own experience and contextual understanding of the details and implications for action. Verbal sharing (two-way communication) to exchange context associated with the content is therefore essential for establishing mutual understanding of the subject matter and its value.

Cultural diversity represents wealth in experiences, knowledge and perspectives, but it can also constrain willingness to communicate and as a result, constrain the potential to develop shared understandings. Our study was conducted to explore the value of a cultural approach to interpreting contextual differences between players in the water field. An exploratory, qualitative method was used to interview managers and scientists operating at various levels in the water sector. From these interactions it was clear that cultures are not bounded categories or even disciplinary groups, but rather aggregations (loose or strong) of understandings that are variably persistent over time. From this we were able to construct a conceptual framework that allows us to interpret emerging themes in a systems fashion and to describe cultural differences both within and across disciplines using insights from the theory of organisational culture.

Key themes which currently appear to cause the most polarisation within and between scientific and management understandings were identified. These are (1) differences in understanding of the 'bigger picture', (2) the nature and value of information and knowledge, (3) perceived thickness of bureaucracy and (4) the way in which time is valued and allocated. Using the cultural framework, the themes are used to expose some of the underlying causes of observed perceptions and behaviours in the knowledge exchange process. For example, regional-level resource managers may perceive national-level managers to be insensitive to their concerns, while in fact bureaucratic protocols often prevent the sharing of concerns, not an inherent lack of willingness to communicate.

A cultural framework provides a useful framework for the interpretation of differences in understandings between players in the water sector, especially because it exposes intangible factors that determine how knowledge is received and valued. Such insights can be used to promote greater mutual interest and acceptance between cultural aggregations and assist knowledge providers in tailoring their products and services and to create mechanisms for sharing context.

By acknowledging the explicit properties of knowledge only, we underestimate the true effort required to transfer knowledge across contexts. Information or explicit knowledge can be passed on relatively easy; while the transfer of associated tacit dimensions requires intimate human interaction. People need to spend time together, develop trust in each other, learn more about each other's contexts and jointly facilitate conversions of knowledge between tacit and explicit forms. It is also important that the regulatory framework and associated processes should promote creative spaces where such interactions are fostered. Without this more comprehensive knowledge transfer, an adopter's ability to understand, replicate or exploit new knowledge is severely constrained.

Basin Management in a Metropolitan Setting – Soft Solutions for a Hard Problem.

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Presentation of topic and analysis of issues: Soft solutions have expressions at transnational, national and local levels. This paper speaks to the challenge of devising sustainable water solutions at the local level in a highly decentralized environment. Solving highly complex issues without central government support requires investment in building and maintaining a credible sub-sovereign institutional framework.

The Imperative. Seattle faces a serious problem. In a community with critical water supply limitations, federal action listing several species of Pacific salmon under the Endangered Species Act required immediate action for salmon protection. This imperative was imposed without legislative, legal or fiscal support from state or federal government. Absent a unifying framework, approaches had to be devised that were complex and created a non-coercive political environment.

Seattle is a metropolitan area of 2 million people clustered across four river basins. These rivers are spawning grounds for Pacific salmon that provide important fisheries in Alaska and Canada. Among the causes of salmon decline are diversion of water for municipal use and degradation of river basins by urban development. The dilemma for local authorities: responsibility for managing both water use and urbanization so as to protect endangered fish, without guidance or resources from the central government.

The lack of national or state leadership is compounded by Seattle's political tradition of autonomy, rugged individualism, and private property rights. Integrative solutions have had to be strategically negotiated. Largely-voluntary institutional arrangements have been crafted, supported by intergovernmental agreements, cost-sharing, and a few key new laws. The investment in dialogue and trust-building is significant and on-going.

Decentralized Solutions. Seattle has created "soft" solutions in three dimensions:
1) Water Supply. Water supply is provided by 158 water utility districts, each with its own defined service territory, separate elected commissioners, and legal water rights. In the face of the salmon imperative, the water districts were drawn together in a "forum" and were persuaded that they must collectively guarantee environmental flows. They developed a collaborative water resource decision-making process. The forum devised share-the-shortage agreements, conjunctive use systems, and demand-management standards – all without infringing on the political autonomy of each district. The new framework, which is largely peer-enforced, is key to both urban and ecological sustainability in the region.

2) Land Use. Sprawling suburban growth around Seattle degrades salmon streams and riparian habitat. Jurisdiction is fragmented: there are more than 70 separate cities and towns, each with its own land use and environmental regulations and its own economic goals. The state's growth management law, designed to require coordinated local planning, has been amended to include the salmon imperative. Local authorities must now consider "best available science" in devising development regulations that will preserve and enhance salmon habitat. "Critical areas," where flooding, landslides, wetlands, salmon streams, or aquifer recharge are at issue, must be identified and protected. The law provides a framework for crafting local solutions which can vary across the landscape.

3) Basin Planning. Lacking a central legal or fiscal infrastructure, the salmon imperative forced Seattle to design its own IWRM process. In each of the river basins, all of the local governments were brought together with key stakeholders such as state and federal natural resource agencies, developers, water utilities, and environmental NGOs. Over the past five years, these unwieldy groups have created watershed plans for salmon recovery. Operating under contracts and funding formulae developed voluntarily, and with shared staff, the watershed groups inventoried the fish habitats of their river basins, sponsored the science necessary to identify limiting factors, adopted restoration strategies for healthy fish runs, mobilized citizen support, and launched improvements to key waterways. The framework for

voluntary agreement, rather than competition, for restoration priorities, has been a “win” for local politicians – as well as for fish!

Discussion of results: Dimensions of Seattle’s success include six years of consistent achievement of river “minimum flows,” and many miles of streams restored or reopened. There is a high level of citizen support for “saving salmon,” 100% participation in basin planning by local authorities, and buy-in from most of the region’s business and civic leadership. Salmon recovery plans from adjacent river basin are being integrated this year to form a master strategy for the region.

In the negative column are the ad hoc nature of the new institutions, the inefficiency of devising IWRM plans piecemeal as a local political process, and the considerable commitment that will be required to maintain these alliances long-term. It is an open question how often politics has trumped science – or whether the fish will return.

Conclusions and Recommendations: Seattle’s experience demonstrates that movement toward water resource sustainability is possible in the absence of national leadership or a central framework. When the autonomy and interests of local authorities, politicians and stakeholders are respected, new institutional arrangements can be crafted. Much of the needed integration must take place “outside the water box,” and intense dialogue and negotiation is required. While these sub-sovereign solutions are not “tidy,” they can achieve positive results.

Pollution Prevention in India: HyWaMIS (Hyderabad Water Management Information System) - an integrated approach

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HyWaMIS is a research and development project funded by the European Commission through the Asia Urbs Programme involving local governments and research institutions in India, Austria and Italy (www.cnet.at\hywamis).

Background
The City of Hyderabad, India with its 5.2 million inhabitants and a population growth of about 10% per year is not only an important centre for the State of Andhra Pradesh but also for India. Uncontrolled industrial growth in the past in and around Hyderabad as well as the specific topographical situation of the city have already led to significant environmental contamination, especially in the Industrial Development Areas of Patancheru and Bolaram.

The Hyderabad Water Management Information System (HyWaMIS) being developed is a planning tool that will serve as a comprehensive information system providing information on water quality and industrial wastewater emissions. It will also help local government bodies and policy makers to integrate information about the water management situation and related socio-economic issues, and to increase the quality of municipal planning and thus contribute to improvements in the efficiency of industrial and agricultural activities and domestic water supply, the information available to governmental and non-governmental organisations and citizen's quality of life.

In order to design and develop the system in a way that meets the needs of the people concerned with water management in Hyderabad, the project activities involved representatives from seven different stakeholder groups. By engaging these participants in considering the challenges of water management in the case study of Patancheru, the foundations have been laid for a continuing process through which the actors may negotiate through some of the conflicts of interest which currently make collaborative efforts extremely difficult.

Objectives
The development of this water information system is providing the city of Hyderabad with a tool for the integration of existing data. This approach is intended to contribute to meeting the manifold objective functions for different stakeholders aiming at sustainable water management.

The main specific objectives are:

- The general design of an integrated Water Management Information System
- The establishment of a stakeholder platform for conflict resolution
- Comprehensible and transparent presentation of industrial emissions and water quality
- Recommendations for pollution prevention and control
- Raised public awareness on water pollution and quality

Stakeholder Process

Generally the HyWaMIS initiative seeks to open participatory ways of information gathering, and conflict resolution through stakeholder platforms for building civil-society capacities for integrated water management.

A questionnaire was distributed to local stakeholders in Hyderabad in order to identify information needs, technical constraints, and expectations of the stakeholders for a water management information system as well as to learn about their views on water management issues.

Subsequently, over the last two years three stakeholder workshops were hosted by the Birla Science Centre and the Hyderabad Metro Water Supply and Sewerage Board with the aim to discuss user interests and objectives and to establish a joint information basis for water management issues. The workshops contributed to improving the social and political climate between citizens, industry, SMEs, agriculture, NGOs and government bodies in the region.

Furthermore, a group of experts formed an advisory panel to give direct feedback to the development of the Information System and to help formulate recommendations for the project's case study, Patancheru. This advisory panel met six times and is a forum for debate, information sharing and conflict resolution. The members are experts from authorities, industry, and citizen groups who previously had not had the opportunity to meet around one table to discuss the management of Patancheru's water supply. A key element was the supply and sharing of available data between the different institutions to which the guided process made a key contribution.

These activities have brought together institutions, independent experts, and local people suffering from the situation to support the development of the Information System. The stakeholder process will be continued under the title "Hyderabad Environmental Stakeholder Platform".

Data Collection

Data collection and analysis concentrated on the industrial area of Patancheru and Bolaram focussing on industrial wastewater emissions and contamination of water bodies. The collection of industry data has proven to be difficult as the required information is scattered among various institutions and agencies.

Design and Implementation of the HyWaMIS Information System

Originally, HyWaMIS was planned as a web based tool with access to distributed data sources. However, limitations in the local IT network infrastructure led to its development as a standalone application. Available data and databases were reformatted and collected on one central host which is located at the Hyderabad Metropolitan Water Supply and Sewerage Board (HMWSSB). Nevertheless, the system is designed for online data access of distributed data and databases.

Use of a methodology to support the design of a Multi-Stakeholder Platform in the case of a water and sanitation project in Tiquipaya (Bolivia)

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Presentation of the topic and analysis of the issue:
Tiquipaya is a Municipality situated in the peri-urban zone of Cochabamba city, Bolivia. Nowadays, drinking water is distributed by community-based Water Committees and just a small part of the population has a sewage system. In this situation Tiquipaya and the nearby Colcapirhua Municipality decided to implement a joint water and sanitation project, called MACOTI. The critics of many Water Committees to this project led to a series of conflicts in 2003.

In June 2004, the Vice-Ministry of Basic Services, proposed to organize a Technical Table (TT) in Tiquipaya to undertake an in-depth review of the project with the stakeholders and achieve a negotiated agreement. This document describes the implementation of this platform. It followed a Generic Methodology for design and evaluation of MSPs elaborated by Negowat Project; the Facilitator of this process.

Presentation of the results:
Baseline analysis
Tiquipaya was split apart between groups supporting the project and others opposing it. There was no on-going discussion among them and there was no agreement on the reasons for the conflict and the failure to discuss it.

At the end the demand of the project opponents for the socialization of the project, the interest of the Municipality and Vice-ministry for executing it and the interest of its supporters to avoid big changes in the project, made all these groups accept the implementation of the TT.

Ex-ante evaluation
The moment to organize the TT was opportune. The atmosphere had calmed down 6 months after the conflicts of 2003, the Mayor who arrived in 2004 was more open to discussion and the Vice-Ministry supported the TT. However some stakeholder groups would boycott the process and do not accept its legitimacy. Due to it much time was devoted to obtain the stakeholders' support to the process.

The legitimacy of the Facilitator (Negowat) was based on their long time working in the area and the support of the Vice-ministry. Negowat decided to appear as neutral not making any proposal on the project itself.

Design of the TT
A proposal for TT implementation was discussed with representatives of all stakeholders mainly in order to know under which conditions they would accept to participate.

Six points can be stressed about the design of this platform.
1) Negowat played the role of Facilitator, with Tiquipaya Municipality and the Vice-Ministry as formal inviting organizations.

2) The official objective of the TT was to: 1) create a space for socialization, analysis and discussion of MACOTI project and 2) propose motions to improve it. Additionally its recommendations should be implemented by the municipality and its implementation should not stop the execution of MACOTI project.

3) The TT was focused on the discussion of MACOTI project with stakeholders of Tiquipaya. The themes of discussion were the technical design, the financial one and the future institutional model, in that order. The agreements were reached by consensus rule.

4) Most of the stakeholders were represented by their leaders and anybody could come and participate in the discussion; at the end this flexibility did not harm the negotiation process.

5) The communication between the TT and the public was through information bulletins. These were distributed to all the stakeholders in Tiquipaya. Several newspapers and local television channels were invited to attend, but they did not come.

6) At first, four sessions of two days each were planned but in the end five sessions were executed. No specific capacity-building meetings were organized. A summary of the MACOTI project was elaborated and the participants often asked for more detailed information during sessions.

A set of rules for debating was applied in order to make sure that debate would remain calm and participants would respect each other.

Monitoring and evaluation
The results of the evaluation are based on indicators defined in function of the objectives of the TT and the actions of the Facilitator.

The accomplishment of the general objective can be explained in relation to:

Socialization of the project. Though was not possible to make in-depth changes in the technical and financial aspects, the participants were able to distinguish the positive and negative aspects of the project.

An indirect achievement was the improvement of the relationship among the stakeholders with contrary positions. They accepted to sit together and argue about the MACOTI project without reaching a conflict.

Propose changes to improve the project. It was difficult to introduce changes in a project already at the beginning of its implementation. With exception of the institutional part, very few changes were proposed.

The TT established a common view about the institutional model for the organization that will manage the system in Tiquipaya.

Conclusions and recommendations:

Some lessons learned from the process are:
It was important to maintain the structure of the platform flexible. The facilitator put a lot of effort to define the number and appointment of representatives, but at the end it was more useful to manage it openly.

It was necessary to verify the carried out stakeholders' mapping with the stakeholders themselves. One important stakeholder was ignored in the beginning.

The consideration of reimbursement of the costs of participation of representatives in the TT would have enhanced the regularity of their attendance.

The opposition showed by some groups to the involvement of important stakeholders and the difficulties of the participants to focus their opinions around the issues discussed manifested their lack of culture to deal with conflicts within platforms.

The TT implementation shows the potential of this kind of processes to solve differences about specific issues. The carry out of a platform during the design stage of MACOTI project would have avoided the conflicts around it.

Transboundary Governance and Politics

Ms. Margaret Catley-Carlson, USA
Chair, GWP and ICARDA

Transboundary issues are complex, and important. There are 261 basins – the number is growing with political change – with some 40-60% of global population living within them. There is very little formal international law, although there is a lot of good (and not so good) existing practice from riparian states. Customary practices work in a number of instances. As population pressures grow, these will be strained. Water for irrigation needs will rise from current levels to feed another 2 billion people. Some say by 10% - some say by 30%. But these rivers now don't reach the sea. Industry needs 20% more water in the next 20 years. Two billion more people means a 70% rise in drinking water needs. How do we manage the needs associated with Toxic dumps? Seasonal flows? Environmental needs? Fish?

Above all, Transboundary covers more than rivers: there is impact on groundwater, on lakes, on land and water use – AND vitally, on coastlines and Marine life.

Can't We Just Apply The Law? Yes, where it exists. In terms of General Purpose International Law of the Transboundary, there is not much formally on the books. The principal UN conventions took 30 years, to negotiate,, got 104 votes, and has been ratified by only 15 - needs 36 to come into force. China and Turkey are very important NO voters. The Treaty will be very influential, ratified or not.
Principles are based on *Equitable* and *reasonable* access with *Reasonable* given primacy. And how do we work Integrated Water Resource Management Principles into this mix?

If Law does not provide the ready answers, we turn to Methodologies in use, in particular Problem Solving Approaches, Indicators, Monitoring Systems . What can we learn from existing Successful Transboundary RBOs : from IJC, Danube, Colombia, Rhine, Rio Plata? Would the Mekong, Vietnam Nile basin initiatives survive without donors?

Four Methodologies are explored: HELP, the LEGAL IMPACT METHOD, the Global Public Goods Concept, and the GWP Toolbox and methods.

Global Water Partnership (GWP) advocates a process to promote Institutional Change: bringing together Stakeholders, creating neutral platforms for discussions; moving beyond Government hierarchies, advocating new water management methods, taking into account a wealth of Global experience, , adding in public consultation to create collective action and support for analysis, problem and solution identification and implementation – most often by Governments which need this kind of support.

The GWP ToolBox has examples of case studies that show how the above have been tackled around the world. Conflict Resolution, Information Needs, Participation Methods and many many more issues are covered. These tools help water managers to move toward the 'ideal' River Basin Organization: Trusted technical competencies; the capacity to focus on serious recurrent problems (flooding, draught, supply shortages), the political and administrative ability to provide solutions acceptable to all stakeholders; broad stakeholder involvement and some form of sustaining revenue.

Here's a Vision Statement from our Central Asia office on what a well functioning Transboundary system would mean for their area:

- Sustainable water supply;
- Uniform and fair distribution of water resources over sub-basins under significant reduction of unproductive water losses;
- Introduction of democratic water resources governance principles owing to involvement of all stakeholders and economic sectors, interested in water resources use, into water management;
- Solution of a part of social problems related to fair water supply of the population and, first of all, by drinking water, and poverty reduction;
- Solution of the environmental problems occurring due to economic activity; and
- As an ultimate goal, improvement of general water and land productivity.

Intra-state conflict resolution between local communities and central governments – Namibian cases

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Water is the basic human need – improved livelihoods - and basis for all development. When it comes to allocating water for use in Namibia, priority is given to meeting domestic use and second, to the reasonable protection of aquatic and wetland ecosystems. Namibia is a dry country where water resources are scarce and getting increasingly vulnerable and valuable in a competing environment. Rainfall is low and variable and droughts are common. The country's only perennial water occurs at the borders which are far away from demand centres and all the internal rivers are ephemeral rivers. The availability of water from these shared perennial rivers depends on agreements with other basin countries and development upstream.Until recently, water management was based on the Water Act of 1956. This Water Act was designed to serve commercial farming, mining, and the major urban centres through increasing supply as a means to cope with water scarcity. Relatively few resources were directed toward Namibia's indigenous rural population. Although there were not property rights in public water, private water vests sole and exclusive use and enjoyment in the owner of the land where such water is found (riparian rights). As a result, most water rights were in hands of private landowners with the exceptions of groundwater in the government controlled areas where a permit was required to sink a borehole or build dams with capacity greater then 20 000 m3. The doctrine of riparian rights is not consistent with modern tenets of water resources management, because it does not provide equitable access to water.

Since independence, Namibia's water policy has been re-oriented to get rid of the old water management system. The introduction of the Water Supply and Sanitation Policy, set priorities of water use and put communities in charge of their water supply services. The Water Policy White Paper promotes principles of equitable access to water by all Namibians (as all water belongs to the State according to the Constitution), public awareness of Namibia's fragile environment, and relevant stakeholder participation in planning and management of water resources and water services. With a newly approved Water Bill, the principles of basic human right of access to safe drinking water, equitable access to water resources by all citizens to support a healthy and productive life, and integrated planning and management of water resources to promote economic and sustainable development of the country as a whole will be enacted.

Because of Namibia's colonial and apartheid history, access and use of water resources have been inequitable and unreasonable. In the post-independence period, population growth and economic development have resulted in cases of water disputes between different users. This is evident at both the local and international level wherever water is shared. Many economic activities in Namibia and its basin partners require water which in many basins is inadequate to meet the need of such activities and users. Upstream users and landowners have a secure water supply while the downstream users must wait for their share. It is essential to identify and integrate all issues relating to the resource base both for reasons of efficiency, and to address the socio-economic and environmental challenges Namibia faces.

To avoid conflicts and/or minimize their negative effects, there need to be a shared vision for the management of water and other natural resources within any water basin. A joint institutional framework to develop appropriate joint strategies for the planning, development, management, utilisation and protection of the water resources is required. For this reason, Namibia has moved towards the adoption of an integrated basin-scale framework for water resources assessment and management by establishing basin management committees. Development and management of natural resources policy are more effective if implemented over a whole water basin, reflecting the relation between water, land, vegetation and fauna, and the water basin's ecosystems. The Water resources management bill thus states that, for the purpose of proper management of the water resources of the basins in Namibia, the Minister or interested persons within the basin may establish a Basin Management Committee (BMC). The BMC approach provides the opportunity for basin communities and government to work together to ensure that total water basin management is achieved and conflicts are avoided. Their main function is to advise on the way water, land and other natural resources are used and to develop plans for the basins, by integrating the interests of different stakeholders, including the environment. Basin management committees have been formed in the Kuiseb and Cuvelai basins. A participatory approach was used where all stakeholders were able to contribute towards the formation of the committee. Throughout the formation process, stakeholders came together through workshops and discussed, analyzed and considered issues of the basin as well different activities that can be carried out. In the end they were able to develop a common vision in each basin.

As a developing country, demand for water has increased rapidly due to population growth and economic development. This leads to several cases of water disputes between users mainly because of inequitable allocation and unreasonable use of the resources. In any country's internal river basins, water is shared among many different users, such as farmers, industries and the environment. Namibia's existing water law was written to serve partial interests, reflecting its colonial and apartheid heritage. Lack of adequate information regarding the resource base among users contributes to conflict. The on-going legal reform process and new basin-wide structures of governance are helping to move Namibia toward better management of water resources and conflict resolution.

Water Resources Management in the Tigris-Euphrates River Basin: Evolving Discourses and Practices

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There is evidence that good governance is a fundamental requirement for socio-economic development, and for water this can be achieved through an integrated water resources management approach (IWRM). IWRM has become a concept and strategy for policy change in the water sector, taking over from the traditional understanding and practice of water resources development, mainly directed at policy and institutional changes on international, national and sub-national levels. IWRM requires a new holistic approach and an unprecedented level of political cooperation on a watershed basis. Hence, the challenge is to facilitate IWRM in transboundary river basins. This paper will look into the evolving nature of water resources management in the Tigris-Euphrates river basin through analyses of the current water policy and management practices of the riparians. After a brief conceptual discussion on the evolution of the IWRM approach within the global water policy dialogues, the paper will set on to elaborate on the current water policy debates in the Euphrates-Tigris river basin. In this respect, in depth interviews are conducted with the concerned authorities at the government institutions, which do play key roles in water resources planning, development, management and allocation in Turkey. In addition to these, equal attention is paid to the search for crucial views of the water related non-governmental organizations (NGOs) and water user associations on the theory and practice of the IWRM in Turkey. Collection and analyses of the standpoints of these major stakeholders reflect the domestic water policy discourse in Turkey. Yet, these analyses are supported with the presentation of the recent initiatives of the concerned authorities in the Turkish water sector to harmonize the prevailing domestic water policy discourse with the basic strategies of the European Union, namely the European Union Water Framework Directive. These recent initiatives currently organized within the framework of a pilot project, which aims to prepare an integrated river basin management plan to be used as an example for further implementation in Turkey. Through their contacts with concerned authorities in Syria and further analyses on the Syrian water sector, the authors have observed that Syrian water policy discourse is displaying increasing attention on demand management practices along with supply augmentation measures. Hence, the paper will look into these policy changes in Syrian water sector that have been taking place recently. Early signs indicate that these measures related with the technical, institutional and legal aspects of demand management have already played a significant role in alleviating mounting pressures on water resources. The paper will argue that these positive developments in the Syrian water policy discourse might well play a constructive role in the integrated management of transboundary water resources in the region. Iraq has been facing political crises and abnormal conditions for the last couple of years, if not decades. Yet, there have been serious and sustained efforts in Iraqi water sector to reorganize the institutional and legal structure. That is, Ministry of Irrigation has been recently reorganized under the new Ministry of Water Resources with important policy instruments and activities. These and other developments in the Iraqi water sector are gathered through interviews with concerned people in the water sector and particularly through information exchanges with the scientific community and the members of newly emerging water NGOs such as the Iraqi Expertise House for Water Resources, Environmental and Development Studies. It is noted that in the Iraqi water sector urgent attention have been paid to providing adequate and safe water supply and maintaining good water quality for responding the needs of the community. Yet, medium and long term plans and policies are also well under way to review and reform the water supply and demand management in the country.

Water dispute in the Tigris-Euphrates region clearly stems from the uncoordinated nature of water management and development practices. Adequate solutions to this problem are built on coordinated regional action based on the IWRM, which include participation, consultation and inclusive political institutions to enable the mediation of the conflicting interests of water users and the agencies, which manage water. Socio-economic development priorities are urgent in the region. Hence, in the last section, the paper offers to tackle integrated water resources management as part of larger framework of overall socio-economic development of the region.

Negotiating the Ganges water: theory, practice and way forward

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Background and issue: The Ganges and its tributaries are shared by India, Nepal and Bangladesh. Of these co-basin countries, India and Nepal are upper riparian countries where most of the Ganges basin is situated. Bangladesh, on the other hand, is the only lower riparian country that faces the risk of being adversely affected by water resources developments upstream. Life and livelihood of over 30 million people in Bangladesh and the environment of about 37% of the country directly depends on the Ganges.

In 1975, India commissioned a barrage on the Ganges at Farakka, about 18km upstream from the Indo-Bangladesh border. The purpose was to divert the Ganges flow during the dry season into the Hooghly River and improve the navigability of the Calcutta Port. This unilateral withdrawal immediately caused a 50% decline in the Ganges flow in Bangladesh. Such a drastic decline caused huge economic and environmental damage and forced Bangladesh to seek out a negotiated settlement with India. Since 1972, numerous meetings and dialogues have been held on the Farakka issue that lead to the signing of two water sharing agreements and two interim MOUs.

In this backdrop, this paper will present a retrospective analysis of the Ganges water negotiation process. The chronology of events will be viewed in the context of 'life cycle' of an agreement. The various positions assumed by the negotiating parties will be categorized according to the topology of negotiation strategies. The negotiation process will be judged based on a set of efficacy criteria. Finally, the 'multi-track diplomacy' approach will be proposed as a 'way forward' to deal with the outstanding and future transboundary water issues.

Key findings: In terms of the 'life cycle of agreement,' the Ganges negotiations have gone through the full cycle. The 'preparatory phase' of the negotiation process ran through 1972–1974, when the Joint Rivers Commission (JRC) was formed as the official platform for engagement. Subsequent phases – negotiation, ratification, and implementation – followed during 1975-1982. The first Ganges water sharing agreement was signed in 1977, which was followed by two interim MOUs signed in 1982 and 1985 respectively. Eventually the second treaty was signed in 1996 for a 30-year period. During this period, the original agreement of 1977 was amended, and the protocols re-negotiated and changed before the treaty of 1996 was ratified. Thus, the process of negotiation had reached the stage of 'full implementation.'

Regarding the strategies adopted, the initial discussions got started off in a 'competitive' (taking the pie) mode. Initially, India and Bangladesh had polar-opposite views on Bangladesh's water requirements in the dry season and on flow augmentation. The negotiations at this stage were not carried out on 'level fields' as India had the advantage of being the upper riparian state; India also had the physical control over the Farakka Barrage and its operations.

As the situation became desperate, Bangladesh was forced to raise the Farakka issue with the UN on two separate occasions. This created political pressure on India and induced her to adopt a more 'cooperative' (sharing the pie) approach and commit for a mutually beneficial and equitable solution. India made an 'opening bid' and granted some initial concessions (most notably the guarantee clause in the 1977 agreement). However, once the water sharing problem was partially resolved through the agreement of 1977, both the parties reverted to their initial positions on flow augmentation – the lesson being that the spirit of cooperation should not be taken for granted.

Unfortunately, the 'integrative' (re-defining the pie) approach was not tried during the course of the Ganges negotiations – both the parties were reluctant to abandoned their 'hard' positions in favor of a 'systematic problem solving approach.' Many of the building blocks of the 'integrative strategy' such as sharing of information, engaging with a spirit of reconciliation, and assessing the full range of alternatives are included in the mandates of the JRC. Yet, these options have not been adequately pursued during the Ganges negotiations. Perhaps the complex interplay of ideology, science, politics, multiple parties and personalities made it very difficult to embrace a more holistic perspective.

In terms of efficacy, the Ganges negotiations have had ‘mixed’ outcomes. The treaty of 1996 has significantly lessened the political tension between Bangladesh and India. This is a big step forward but the flow augmentation issue still remains unresolved. Bangladesh is not happy about certain aspects of the implementation. The JRC still continues to meet, but only when sufficient political pressure is mounted. On its own, the JRC seems to lack direction, momentum and authority. This underscores the most important lesson learned from the history of the Ganges negotiations – when the negotiating parties come across a window of opportunity (e.g., favorable political climate), they must capitalize on it, as major opportunities are only rarely encountered in transboundary negotiations.

Looking ahead: In the past, negotiators primarily relied on government to government (Track 1) diplomacy, which was slow, bureaucratic, and riddled with politics. With the advent of SAARC, the prospect of employing a multi-lateral and multi-stakeholder approach appears to be a real possibility. Now, the top-level dialogue may be complemented by contributions from various interest groups such as NGOs, businesses, educationists, lawyers, activists, and the media. Such a ‘multi-track’ approach may be combined with the international framework agreements to draw up a ‘blueprint’ for the elaboration of future agreements on specific transboundary water issues.

Institutional Power: Decision Making on Large-Scale Hydropower Development and Water Resources Management in China

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This paper will focus on the institutional and policy context of hydropower decision making in China, particularly as regards large-scale development on trans-boundary rivers. Currently there is much heat but little light in the debate surrounding development of large hydropower stations on transnational rivers in southwestern China (primarily the Lancang-Mekong and Nu-Salween). Supporters of the dams, mostly but not exclusively in China, cite the need for poverty alleviation, energy production, and regional development while downplaying concerns about potential negative social and ecological impacts. Opponents of the dams in China and abroad counter that the ecological and social costs of such mega-developments are potentially unacceptably high, and that the dams, if built at all, should first be subject to a rigorous and independent assessment of what those impacts might be on a basin-wide (i.e., transnational) basis. The most strident of such opponents often blame an unspecified "China" for pursuing a unilateralist development strategy that ignores the risks of dam development to downstream countries and communities.

Such simplifications, however, fail to recognize (or acknowledge) that the hydropower projects are also highly contested within China, even within and among government offices. In addition, blaming "China" does little to contribute to improving communication or understanding that might lead to more cooperative and pluralistic basin-wide development. In order to make a modest contribution to understanding the political and social negotiation processes regarding large hydropower development in China, therefore, this paper will offer a comparative analysis of four hydropower case studies on trans-provincial and trans-national rivers in China: Sanmenxia (Yellow River), Three Gorges (Yangtze River), Manwan (Lancang-Mekong River), and Liuku (Nu-Salween River). The analysis will focus on how decision-making processes have changed in China during the reform period, particularly within the current context of electrical industry reforms, enterprise privatization, and development of western China. The goal of the paper is to shed some light on the complex institutional dynamics behind the planning, approval, financing, and implementation processes of large-scale hydropower in China.

Hydropower development planning for the Lancang (upper Mekong) began in earnest in the early 1980s. In 1986 construction on the first dam on the main channel of the river, the Manwan hydropower station, was launched through a partnership between the Chinese Ministry of Hydropower and the Yunnan provincial government. This institutional arrangement, referred to as the "Manwan model," was hailed by the Chinese leadership as a groundbreaking model for central-local partnership in large-scale energy investment, and an example of the leadership's commitment to reform and modernization in the then state-run energy industry. Following completion of the Manwan dam in 1995, construction began on the second Lancang River hydropower station at Dachaoshan, in 1997. This time, financing for the project was provided through a four-way partnership involving central and provincial government bodies, along with a government-owned power company and the Hongta (Red Pagoda) group, one of Yunnan's primary tobacco producers. The "Dachaoshan System," as this arrangement came to be known, was also trumpeted as a sign of industrial modernization and continued economic reform that would reorient many of China's most important industries along axes of economic efficiency rather than political expediency. The third Lancang dam, Xiaowan, begun in 2002 as the flagship project of the newly formed stock company devoted to Lancang hydropower development, was said to represent the culmination of industrial reform efforts.

Alongside the changes within the electrical and hydropower industry came equally significant changes within the governmental regulatory apparatus itself. These changes included the reorganization of ministries and a consequent shuffling of each ministry's jurisdiction, both at the central level and down the administrative line to local governments. The rapid changes, particularly since the beginning of the Tenth Five-Year Plan (2001-2005), have left government officials themselves frequently wondering who in practice retains authority over different aspects of water resources development, in particular large-scale hydropower development. National and regional (inter-provincial) pressures resulting from the Great Western Development campaign and sub-policies such as "Send Western Electricity East" further muddy the waters and complicate the picture of the politics of hydropower development in China, and underscore the need for a thorough analysis of the changing institutional and policy landscape. The key implication of this paper for policy makers, academics, non-governmental organizations, and others is that any sincere appeal for increased cooperation among upstream and downstream countries must begin not with a condemnation of a unitary "China" bent on pursuing a unilateralist development agenda, but with a more careful look at the political economics and institutional dynamics behind such development. This is especially true given that several of the important "China" projects are motivated in part by actors (government and enterprise) in neighboring downstream countries.

Mediation of the Civil Society as a Way Out of the Imbroglio in Cooperative Water Management in the Ganges-Brahmaputra-Meghna Basin

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The Ganges-Brahmaputra-Meghna (GBM) basin faces unique challenges in river basin management that surely has not received adequate professional attention. The basin is relatively rich in water resources, if the annual average run-off is considered. At the same time, the basin is the home of about 700 million people, a good part of which live below the poverty line. While scarcity of water is usually considered as a reason behind poverty, the GBM basin offers an example where a large annual run-off co-exists with the largest chunk of poverty in the world. This provides a very important challenge to sustainable water management.

Guided by traditional engineering with a reductionist worldview, construction of a series of large dams in the Himalayan catchments of the basin is being projected by government engineers as the solution to the poverty of the region. The series of dams are expected to moderate the Monsoon floods, supply greater volumes of irrigation water, generate hydro-power and also augment the lean season flow in the rivers. Thus, a situation characterized by hydrological extremes is proposed to be converted to one providing the basis for rapid economic development.

The independent professionals in South Asia do not agree with such views. Many among them, guided by the eco-hydrological viewpoint have described such interventions as uncertain and risky. Not only are the seismic activities in the region considered as a major risk to high dams, they also point to the dangers posed by such projects to the ecosystem services provided by water in the basin, which serve as a livelihood support for a large number of the poor people. In addition to the well-known problem of inadequate rehabilitation of project displaced people, restoration of environmental flows in the rivers is increasingly demanded by many independent professionals. The professionals in the civil society view the official plans for dams as wasteful of the limited financial resources of the South Asian region, and if executed, would enhance the risks of human induced disasters and socio-economic inequities.

These conflicting visions of water management in the GBM basin and their growing engagement in public platforms are reviewed in the paper in the background of the emerging paradigm shift in water management and its policy implications. In addition to the obstacles related to the aspect of knowledge for water management, the region has another important barrier obstructing cooperative river basin management. That is nationalistic slant connected with water projects. Political-economy of three co-riparian countries of Bangladesh, Bhutan and Nepal are substantially influenced by their respective water policies. Conflicts, real and imaginery, among the co-riparian countries play an important role in national politics. The GBM basin has been well-known for the conflicts between Bangladesh and India over sharing of its lean flows. The intense and large Monsoon precipitation, on the other hand, has made the basin famous for annual summer floods, and high dams are proposed as solutions. In the case of Nepal, which has a large hydro-electric potential, debates among opposing viewpoints on whether to undertake the construction of the several dams on the Himalayan rivers proposed by either India or Bangladesh, is a central item in politics. The impression an average Nepali has is that the dam project will bring relatively smaller benefit to their country, as opposed to India. The recent proposal of India regarding the interlinking of rivers has added to the situation characterized by lack of both technical information and mutual confidence among the countries. The situation can be termed as a stalemate in river basin management, both from the point of view of generation of knowledge and realization of the objectives of poverty removal.

The critical and growing engagement of the governmental engineers and the professionals of the civil society has achieved a little success in drawing out some technical information from the official files. The very important policy debate that has emerged on the water future of South Asia between the water resource officials promoting large projects and those civil society professionals is crucial for the advancement of a holistic water science for South Asia. The belief behind the paper is that this engagement has the prospect of breaking the ice on the question of cooperative management of the GBM basin. On one hand, the civil society professionals have the professional ability to infuse new and holistic concepts in water management. On the other, it has the social and professional status that would be useful in generating approaches that transcend the national political limitations and progress towards sustainable water resource development. The details of this very potent process will be analysed and presented in the paper.

The core of the debate has the following points:
The official engineering proposals for large structural interventions are not informed of or based on a clear understanding of the ecology of the Himalayan rivers. There is an urgent need for filling up this knowledge gap before interventions are thought of.

Large structural interventions are reductionist prescriptions. They look at floods as unmixed harms. This viewpoint can not recognize the great material contribution made by the ecosystem services provided by river flows, specially in the delta and estuaries.

Performance of the existing interventions needs to be examined in the basin perspective, to provide data for possible future interventions. Ecological economic assessment needs to be followed, in place of a reductionist benefit-cost assessment.

Water Management in the 21st Century: Institutional and Participatory Challenges to Successful Water Governance

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Presentation of the topic:
Water is an element that takes little notice of political and administrative borders, and successful water governance is faced with both the physical problems of water quantity and quality, and with challenges to the development of methods for efficient water management. In 1999 the National Research Council highlighted a number of research imperatives for the coming decade. Among these imperatives were 'understanding institutions…' and 'improving methods for decision making…'. The report also noted that knowledge needs to be gained to be able to 'identify specific combinations of policy instruments…' and to 'identify specific international and national institutions that can effectively link the international, national, and local levels…' (Committee on Global Change Research 1999, p. 318). These statements stress the importance of both formal and informal institutions at different spatial levels, yet the role of these in water politics and the implementation of policy have not as yet been sufficiently examined. In this paper three challenges to water governance will be examined using examples from the European Union's (EU) Water Framework Directive (WFD), which in turn represents the approach adopted by the EU in the EU Water Initiative and in EU water policies in other parts of the world. The WFD represents a new approach to water management in most countries, as it stipulates a management model based on hydrological borders and watersheds as opposed to traditional political and administrative borders. The paper will analyse water policy implementation strategies and present a typology of institutional contexts with a focus on how institutions can interact, how scientific information is used in these contexts, and how strategies can be developed to increase public and stakeholder interaction with water institutions.

Presentation of results:
The first challenge is the adoption of agreements taken at the international level by national, regional, and local institutions. Problems affecting implementation include economic, political, cultural and social issues, geographical discrepancies, shortage of financial resources, training and organisational problems, and administrative capacity. Political and administrative values and beliefs also play an important role, as these influence both perceptions of the nature of the water-related problems to be tackled, as well as belief in the optimal ways to manage them. While considerable advances have been made in understanding the processes through which decisions and agreements are made, less progress has been made in understanding the specific characteristics and problems facing the implementation of water resource management at different geographical and administrative levels. Ideas originating in 'new public management' have dominated the field of policy implementation during recent decades, yet a growing awareness has developed that problems of implementation cannot simply be solved by approaches influenced by economic perspectives. Institutional (both formal and informal) perspectives must also be analysed and incorporated into the drive to successfully implement international agreements at lesser geographical levels. In order to do so different forms of institutional analysis such as institutional rational choice, historical institutionalism, social/cultural institutionalism, and political institutionalism must be utilised. The second challenge is that of institutional cooperation, that is, both inter- and intra-institutional interactions, especially in the case of transboundary water management where institutions originating in different socio-political and cultural contexts need to cooperate. Transboundary water management presents a major challenge to politicians, planners, administrators and scientists, due to the involvement of different political and administrative systems. Besides the problems of water supply in many parts of the world, the secretariat of the United Nations Commission for Europe also states that pollution of transboundary waters is a widespread phenomenon. The third challenge is that of developing mechanisms in order to involve stakeholders and the public in decision-making and implementation, as well as in interactions with the institutions responsible for these, while at the same time retaining the efficiency of these in water management. In order to achieve informed input into these processes methods must be developed that encourage deliberation, that is, stakeholders and the public must be empowered through access to information, and enabled to analyse the probable outcomes of choices and different lines of action. The interaction and communication of stakeholders and the public with water institutions must

also be analysed in more detail in order to identify ways to improve participation in decision-making and implementation.

Conclusions and recommendations:
Increased focus must be placed on the institutional contexts within which water policy is implemented, as prudent decisions or agreements are only the first step towards successful water governance. Success is also dependant on the interaction between institutions, and between institutions, the public, and stakeholders. In order to facilitate water implementation, institutional typologies must be developed, presented, and discussed. This paper will analyse a number of typologies, and discuss their applicability for water governance.

Stakeholders' Heterogeneity and Water Governance in the Chilika Lagoon, Orissa, India : A Political Ecology Analysis

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Urgency and centrality of an effective and sustainable system of water governance have become the guiding spirit for evolving collaborative water management mechanisms. 'Participation', 'dialogue', and 'decision making' are some of the key means towards this end, if not the end in themselves. Not only the focus but also the actors in this matrix are the stakeholders, who participate, decide and act and the ultimate outcome is a product of these interactions. Of late, the diversity and heterogeneity existing within this entity of 'stakeholders', have been found out to be the sine qua non for an ecologically sound and socially just system of water management. Like any other environmental problem, the one pertaining to water and its equitable management and distribution could be envisioned by understanding the dynamics and properties of the 'politicized environment' (Bryant, 1998) in which a given resource (water in this case) is contested. By adopting the strategies of political ecology, this paper dissects out the heterogeneity existing between and within stakeholders and its subsequent influence on the pattern of interactions and power sharing at various scales of decision making and thus the ultimate actions.

Chilika, Asia's largest brackish water lagoon along the east coast of India, a Ramsar site is an evolving social-ecological system (SES). Ecological diversity and biological richness have rendered this ecosystem a highly productive one. It is this rich productivity which is the bone of contention and this spans a wide spectrum, from survival and subsistence concerns to economic and commercial interests, to concerns of ecological well being and wilderness. Hence Chilika has become the ground zero for a wide ranging confrontations and competitions, Save the Chilika Movement (Chilika Bachao Andolan) being the most widespread. Past incidences of conflicts, violence, and loss of human lives provide an overview of the degree and extent of this contestations. The richness of social-ecological diversity has been nurturing an equally diverse and heterogeneous stakeholders. Chilika sustains the livelihood of more than 0.2 million fisher folk. And thus they constitute the primary stakeholders.

The diversity persisting within this community is very often eclipsed by the term 'fisherman' which treats them as a small and socially homogenous unit sharing common interests and shared norms. The most evident parameter of this diversity is based on different social castes to which they belong. This diversity is further enhanced by the immigration of fishing communities from the neighbouring state of Andhra Pradesh, adding a new dimension of local and non-local dichotomy. This seemingly homogeneous fishing community is further politically fractured and socially differentiated in complex ways and along lines of age, gender, class, ethnicity, religion, political affiliation, understandings and most importantly along the traditional fishing methods and institutions.

Shifting the focus of analysis on to other stakeholders brings forth the enormity of heterogeneity. And each group is segregated within itself based on interests, expectations, duties and approaches. The various departments of the state (provincial government) have been assigned specific tasks and they range from that of the fisheries department to tourism and revenue department. Their actions and interventions are part of their own priorities, and resonance among these is very difficult, if not impossible. The overall management of this unique albeit contested ecosystem now rests with the Chilika Development Authority (CDA), which is a very recent administrative set up. Its priorities are again subjected to the pull and push of multilateral institutions (World bank, UNDP, Ramsar Convention), government directives (provincial and national) and political interests. One of the supposedly instrumental and active stakeholder in this entire process is the civil society and prominent among them are the environmental NGOs (ENGOs). Interestingly there are marked differences among their opinions and modus operandi.

The state capital (Bhubaneswar) based Orissa Farmers' Grand Alliance (Orissa Krushak Mahasangh) espouses the causes of 'wilderness', whereas the village based Save the Chilika Movement (Chilika Bachao Andolan) struggles for the 'survival and livelihood security' of those dependent on this ecosystem. Differences in perceptions and discourses on the environmental and societal problems facing Chilika are thus socially constructed and influence the subsequent processes of negotiations and actions. This act of social construction subsequently amalgamates with that of the political processes of representations and expectations of other stakeholders. The fisher folk communities, who are the grassroots stakeholders are very often confused by this enigma, and this makes them further vulnerable to self-centred interests. Commercial and economic interests are mostly centred around the rich potential of this ecosystem for fisheries, prawn culture and ecotourism. In order to gain legitimacy these interests make unholy alliances with the peoples' representatives and the bureaucracy. This is very often followed by social and economic marginalization of the weak, voiceless and powerless. Save the Chilika Movement has its genesis in connection with the states permission to a private corporate sector for developing aquaculture in Chilika.

With a political ecology synthesis, this paper discusses the politics of issues of water resources access and use in Chilika. By roping in a diversity of stakeholders and actors, this analysis provides a broader framework based on which meaningful and sustainable alliances and dialogues could be forged among them at various scales. Alliances based on mutual trusts and respects provides the skeleton on which grows and evolves a system of effective water governance ensuring participation in decision making and power sharing, justice, equity, sustainability and empowerment.

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Cause of Water Conflict and Social Negotiation Processes for Effective Water Policy - A Case in Kangwon Province, South Korea

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Citizens of Kangwon Province located in the eastern high mountain region of the Korean peninsula of South Korea have been suffering from central government's policies. Many dams for flood control and water supply were built and large and small reservoirs created in the province due to the physiographic conditions. As the country became industrialized, the central government needed to conserve water resources to secure nation's water supply clean and safe in both quantity and quality, especially for the Seoul metropolitan area of more than 24 million people. Kangwon province located in the upstream watershed of the Han river that supplies water to the megalopolis.

The central government has imposed numerous limitations on or banned industrial developments in the province to protect water quality, especially in the north Han river watershed that supplies about 45% of water to the Han river. Because of the forced underdevelopment, industrial productivity in, and access roads and other transportation systems to the region are very inferior. The quality of life in this region has been degraded because the number of residents of local administrative districts has decreased, real estates have devaluated, and opportunities to have better educations and to experience cultural performances became unequal compared to other areas of the country. Residents have realized that these inequality or discrimination stemmed from the dams and they have not been properly compensated. They began to ask the central government to compensate their sacrifice and furiously oppose any plans to build dams for any reason. Another important reason that makes locals rage is that the locals are completely excluded from the water related decision-making processes including dam construction and water use. Nation's water is exclusively managed by Korea Water Resources Corporation(KOWACO) by law.

Korea needs to develop more water resources for sustainable development in the near future. But every government plan to build dams has failed because of the opposition by local residents and civil and environmental activists during the past decades. Korean NGO leaders also strongly oppose to build dams because dams have devastating impacts on the natural resources and environment. It is now the government's responsibility to persuade the local residents and civil activists before planning of dam construction. But it is a never-easy task for the government because the point of view on dam construction between opponents and proponents are completely different. The consequences are extreme confrontations between them and the drift of government's water supply plan by dams.

It is time for both opponent and proponent to understand each other and compromise to develop effective water management alternatives. The alternatives must include the compensation for the residents in the upper watersheds, allow the locals to join in the processes of water use and dam construction planning to protect and maximize their interests, and also include policies and incentives that can cure the distrust and sacrifice caused by the forced underdevelopments.

Chuncheon Water Forum(CWF) was planned by local NGO leaders and water experts and supported by Kangwon Provincial government, Chuncheon city administration and KOWACO to help establish well-functioning water governance and find solutions for water related conflicts in Korea. CWF has been held very successfully in the last two years(2003 and 2004) and looks forward to advancing to a key international water forum in far east Asia. More than 200 NGO leaders from about 140 NGO groups, 150 water experts, 200 government officials and interested citizens had attended at the respective forum. CWF is different from the water related academic and research institutions in Korea which support government plans and are not trusted by NGOs and local residents. CWF well understands that participatory dialogue and effective dialogue process among all parts of society involved in and affected by a water decision are most important in bringing the issues to the forefront and arranging cooperative works to find alternatives.

Institutional approach to develop water policy alternatives that can contribute to reduce the differences of point of view on water development between the opponents and proponents, satisfactorily support the compensation for the upper watershed's endeavors to keep good water quality as well as to help achieve the government plan for water resources management, has not been made in Korea. However, without institutional approaches, reasonable and acceptable alternatives by all parties could be practically impossible in Korea. Even if it is very difficult to bringing the interested parties and issues into a forum, CWF believes that this is the only way to follow the derivation of the water policy alternatives. It is believed that a long and tough dialogue on water related conflicts and alternatives among all parts of society has just begun by means of CWF. And CWF is dedicated to play a key role in the political and social negotiation processes by cooperation with local, national and international institutions.

Sustainable integrated water resources management in the Cuvelai-Etosha Basin in northern Namibia

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In Namibia, new opportunities have been created for an integrated approach to the development of water resources. Policymakers accepted a new National Water Policy in 2000 and the parliament passed the Namibia Water Resources Management Bill in November 2004.

The on-going reform of the water sector in Namibia requires improved governance in the management of water resources by combining:

- An improved legal and institutional framework.
- Emphasis on integrated water resources management at basin level.
- Improved monitoring capacity.
- Involvement of stakeholders at all levels.

Concurrently, the new Namibian Water Bill, calls specifically for the implementation of the policies of integrated management and stakeholders' involvement in the water sector and for initiatives, which promote the coordinated development and management of water, land and related resources without compromising the sustainability of vital ecosystems.

The Department of Water Affairs of the Ministry for Agriculture, Water and Rural Development has started an initiative, which aims at the provision of equitable access to safe water resources through sustainable and integrated water resources management in the central-northern parts of Namibia. It operates within the natural boundaries of the Cuvelai-Etosha Basin.

The Cuvelai Basin as a whole is shared by Angola and Namibia, but it is of great importance in Namibia for the following reasons:

- Whilst it is the most densely populated area of the country and home to more than 40% of Namibia's population, its development was hampered before Independence, when severely affected by war activities.
- Poverty is widespread and the poorest political region in the country (Ohangwena) is situated within the Cuvelai-Etosha
- Its limited natural resources are already under pressure and subsistence agriculture is the only form of economic activity for most people. Communal land tenure prevails.
- The ephemeral river delta ending in the Etosha Pan is a unique ecosystem of great conservation value, but threatened by environmental degradation.
- The area is subject to regular hydrological extremes of floods and droughts.
- Availability of water resources and their direct link to unsustainable use of land and other natural resources is the most critical constraint on socio-economic development and for the uplifting of the poor.
- Rehabilitation of deteriorated small earth dams (5000 m3 or less), use of sewage water and desalination need to be investigated as alternative water sources.

The Cuvelai is also a unique ecosystem with an ephemeral river delta ending in the Etosha Pan (Etosha National Park), which is a Ramsar site (wetland with international importance). The basin has great conservation value; however, it is severely threatened by environmental degradation.

Since land and water productivity are closely interlinked, coordinated efforts are being made to establish an integrated management approach connecting the critical issues of access to land, sustainable management of fragile natural resources and the sustainable utilisation of water. Thus the "single sector approach" is being avoided. The challenges of communal land reform are critical to social stability but have not been approached in a holistic manner. This project will make an attempt to link land reform and integrated water resources management. Significant changes in governance of water and land can only be achieved through full participation of stakeholders in appropriate institutional structures. Basin Management Committees (BMC) and the new Communal Land Boards will play a crucial role.

The Cuvelai-Etosha is home to many people living below the poverty line and the poorest political region of Namibia is situated here. Poor people depend to a large degree on natural vegetation in agro-ecosystems. Securing water rights would protect the rights of the poor and favour a more efficient and equal allocation of water across uses and users. Equal access to productive assets such as land and water is expected to have a profound impact on poverty.

The initiative in the Cuvelai-Etosha Basin targets five main areas:

- Adequate institutional arrangements for IWRM (basin management committee and subcommittees, inter-sectoral coordination) and creating linkages to communal land reform measures. This key element of the project is to avoid duplication and to ensure synergy with land reforms and initiatives in other areas of natural resources.
- Full involvement of stakeholders (education, awareness, capacity, decisions). All indicators show that the inhabitants of the Cuvelai-Etosha Basin need to be familiarised with these new concepts, and their understanding and support are essential.
- Adequate technical support for IWRM (monitoring/information systems, human resources capacity, water resources assessment, research programmes). There is a general shortage of technical expertise and no good information base. These support systems must be developed during the project.
- Planning for sustainable and integrated management of water resources (integration with land and other natural resources and socio-economic development and environmental protection). Evaluation of water resources; devising of development plans.
- Capacity building for IWRM implementation.

Current activities are focussing on establishing the institutional framework, involvement and organising of stakeholders and establishing water basin committees.

The poster session would provide an overview of the natural and socio-economic conditions of the Cuvelai-Etosha basin and describe the approach followed as well as the challenges faced when establishing in integrated approach to water basin management.

Water and Politics: Bangladesh Perspective

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Bangladesh is a deltaic land blessed with the Ganges-Brahmaputra-Meghna rivers systems. The country has the problems of too much water in the monsoons and too little in the dry season. Unless water is conserved, when it is in excess, for use when scarcity follows, the problems for flooding and drought will continue to plague the country. Besides, demands for freshwater are growing rapidly in the urban and industrial sectors. In agriculture, in fisheries, in inland navigation and for controlling salinity.

Simultaneously, agricultural water logging is degrading water resources and salinity are no longer problems of the coastal area alone but occur in and around embankments and dams. Construction of flood-control embankments and roads are impeding water flows and both the wetlands and their fishery resources are under threat. Other pressure on the wetland are form desiccation and encroachment for Boro rice in the winter season. Callous interventions along the course of common rivers caused severe environmental disruptions in both West Bengal in India and Bangladesh set in motion by the infamous Farakka barrage built on the Indian part of Ganges. One erosion victim in West Bengal has aptly called Farakka 'a devil delivered by Delhi'.

Bangladesh government signed a treaty with India in 1996 without appreciating the depth and complexity of the problems. The all time low water level of the Ganges after signing the treaty proves the fact that the treaty itself is nothing but a piece of paper while considering the interest of Bangladesh who still not getting the proper share of water. So, the much-hyped Ganges water-sharing treaty can scarcely undo the ecological damage triggered by excessive withdrawal of the waters during the dry season and veritable deluge during monsoon as the floodgates are opened to ease pressure in India.

Indian river-linking project: a political agenda ?
India's plan of inter-linking trans-boundary rivers to create a new "national water grid" seeks to provide increased amount of surface water from trans-boundary rivers to other parts in India.

At a conference on "Regional Cooperation on Transboundary rivers: Impact of the Indian River-Linking Project" held in Dhaka in December, 2004, many Indian speakers, mostly experts on water resources management, have expressed strong reservations on the inter-linking plan of rivers on serious technical and environmental grounds.

Among them is an India eco-activist, Ms. Medha Patekar said: "Water has become an electoral issue in India and river linking project is a political agenda. The government of India looks at the project as a sort of gift to the voters." Furthermore, it has been reported that the people of Bihar, Orissa, Assam, West Bengal, and Karnataka are opposed to the project.

But the India's High Commissioner to Bangladesh, at the conclusion session of the conference reportedly defended the linking plan. She argued that firstly it is a 'plan' only, not yet a project," and secondly India's share of water per capita is much less than that of Bangladesh (she has been quoted placing India at 2,200 cubic metres per capita versus Bangladesh's 19,600).

The attitude contained in the statement has reflected the dynamics of relations of big and small states that has been summed up by the Greek historian Thucydides (460-395 BC) as follows:

" The strong do what they have power to do and the weak accept what they have to accept."

The plan of linking the mighty rivers of the Himalayas has caused grave concerns among people of Bangladesh for mainly for two reasons: ignorance of the plan in its details and the size of the plan. India has not thought it fit to take Bangladesh into confidence as to the layout of the plan in respect of the Himalayan component, which comprises 19 diversion points, 16 reservoirs, and 19 water transfer links, despite the existence of the Indo-Bangladesh Joint River Commission and of the current bilateral friendly relations. Many in Bangladesh have reluctantly come to a view that the lack of providing information of the plan at an official level to the Bangladesh authorities demonstrates that India is not keen for regional cooperation in the matter.

Proper utilization of water

Bangladesh has to rely on its own plan of water management and utilisation. The Ganges Barrage project within Bangladesh was conceived in the 70s. Short canals from the Ganges Barrage would have led water into the moribund rivers of the delta, using them to distribute water for salinity control in the Sunderbans, consumption for domestic and industrial use, and irrigation. But nothing seems to have advanced so far on the Ganges Barrage project.

The Ministry of Water Resources of the government of Bangladesh has at various times commissioned pre-feasibility studies for barrages and associated canals at locations on both the Ganges and Brahmaputra rivers. Experts say that the studies have recommended works on water utilisation of rivers. If the water works would be in place, it would have led to increased amount of water into the North Central, North West, and South West areas of Bangladesh.

Experts say that the government of Bangladesh also undertook studies that came to be known as the New Line, a proposal to build barrages on the Brahmaputra and the Ganges within Bangladesh and link them with a canal further south. This would have allowed both Bangladesh and India to access all the waters of the Ganges and Brahmaputra. The proposal did not proceed.

Another proposal, the Farakka-Paksi-Mawa Complex (FPMC), was suggested by a foreign expert, J.S.A. Brichieri-Colombi, of University of London. The proposal was designed to allow both Bangladesh and India to abstract their legitimate share of water from the main rivers, while avoiding some of the problems raised with other proposals. The designer thought it a "win-win" solution for both countries.

The linkages between poverty, environment and transboundary water management in southwest China's Yunnan Province

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Introduction

Yunnan is one of China's southern border provinces, neighbouring Myanmar, Laos and Vietnam. The province is remote and one of China's poorest. Moreover, the challenging physical environment adds to the difficulties of poverty alleviation. The climate in the province varies substantially and about 94 % of the area consists of mountains. The several transboundary rivers flowing southwards from Yunnan make the region particularly important in terms of cross-border issues. These rivers include the Mekong, Salween, Irrawaddy and Red River. China has faced serious criticism for developing some of these rivers without negotiating with the other riparian countries or without considering the downstream impacts. Building large dams on the upper Mekong has in particular raised a lot of concerns and the planned dam cascade on the upper Salween has become a significant issue.

Due to abundant flow and steep topography, the exploitable hydropower potential in Yunnan is huge, accounting for some 90,000 MW. Noting that China is facing increasingly seriously electricity shortages and environmental pollution, it is not difficult to imagine that hydropower development in Yunnan is seen as one of the major solutions. Additionally, one of the justifications presented for developing hydropower in Yunnan is poverty alleviation.

The aim of this study is to understand the position of Yunnan as an upstream region of the international rivers. The study discusses the linkages between poverty and transboundary water management. It examines whether the pre-conditions in which the river projects are undertaken in Yunnan have reflections on the minimal considerations of the downstream impacts. The key questions are:

- To which extent Yunnan province should carry the responsibility of the transboundary impacts caused by river development within its territory; and

- Is the relevance of the projects to poverty allocation so great that Yunnan cannot seriously consider the transboundary impacts.

Findings

According to the Chinese Water Law, the planning and management of large water projects is directly under the central level of governance. The planned upper Mekong and Salween dams are all large scale (>300 MW). However, talking only about China as a whole in the river development scene is misleading. Yunnan has so far played a major part as the representative of China in several transboundary issues, such as being the member of the Greater Mekong Subregion program. It is obvious that the province has some kind of a role in the decision-making over the river development in its territory. However, it has not been very clear what this role exactly is. Additionally, the five state energy companies that have the development rights of China's rivers, have their own interests and pretty much of power. Because of the complicated decision-making structure, it is difficult to say how much real influence Yunnan has on the river development.

Simply thinking, the one who decides on the projects should also take the responsibility of the impacts caused by them. This leads to the second research question, as in order to consider the impacts there should be some resources available. Yunnan is a very poor province and has to allocate the scarce resources among multiple needs. It can therefore be speculated how much of the provincial resources is left to tackle the transboundary impacts.

Hydropower is both a major resource and the most attractive target of investment in Yunnan, and developing it will bring the province more tax money. Increased cash base would allow allocating more resources to different purposes. Developing hydropower could be argued by poverty alleviation if it was shown that it really contributes to this purpose. Unfortunately, this seems not to be the real case. As an example, with the Manwan dam on the Mekong in operation, electricity price near the dam is higher than before the dam. There are several reasons for that, including the inundation of local power production by the reservoir, scattered households causing expensive transmission costs, and the lack of transmission lines. Nonetheless, if hydropower development is to be justified by poverty alleviation, the results of building a dam should look different.

Conclusions

Can the disinterest on the transboundary impacts be explained by the difficult conditions and severe poverty in Yunnan? In other words, is the pressure to alleviate poverty so great that the province cannot afford loosing any potential benefits because of mitigating downstream impacts? It doesn't seem probable that the local people will get direct benefit from large-scale hydropower development. Some common benefits will be created by improved transportation facilities and the jobs that come along with the power plants, but these benefits will remain limited. The main beneficiaries of the dams are those who get increased energy access and cheaper energy prices, those who get profit from the energy business, and those who can collect taxes. A majority of the electricity produced by the upper Mekong and Salween dams will go to China's east cost, and exports to abroad have been planned. China's disinterest on the negative impacts downstream could be explained by poverty challenges only if majority of the benefits created by the dams would be spent on improving the local livelihoods. With the current setting, Yunnan province will only get a minor benefit in the form of tax money, and even that will not necessarily be spent for poverty alleviation.

Participatory Approach To Management Of Water Resources-The Katepurna Experience

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Katepurna water resources scheme has completed its 30 years of operation. The scheme is designed and constructed to provide irrigation facility to 8325 ha alongwith domestic and industrial water supply to Akola town and nearby villages. During the first 25 years, the scheme could irrigate on an average 2025 ha as against 8325 ha. As a result water used to be unutilized. Therefore, the Government of Maharashtra (GoM) has decided to allocate water for non-irrigation (domestic and industrial) purpose resulting in curtailment of irrigation service area to 5967 ha. The same also could not be brought under irrigation. As such the scheme turned out to be a failure.

The failure was attributed mainly to non-participation of users (farmers) in the irrigation management of the scheme. There had been prevailing a feeling among farmers that it was a Government scheme and they used to blame Water Resources Department (WRD) for poor utilization. On the other side, WRD used to blame users for the outcome. Earlier there were sporadic initiatives from WRD, but it could not be materialised in invoking participation of users in irrigation management.

A systematic and all round approach have then been undertaken to overcome the handicap of poor utilization. It consisted of engineering, agriculture, management, public awareness and capacity building measures. Initially, there was resistance from farmers towards departmental initiative. Distrust on officers was also evinced. However, the participatory approach radically changed the situation. Resistance is transformed into support and distrust into trust. Earlier there was no response to formation of water users associations (WUAs). The initial success and consequent benefits contributed towards assimilation of the concept by the farmers. The movement resulted into formation of WUAs on the entire service area. Farmers were so much convinced that they voluntarily came forward to take over management of tertiary level irrigation system. The transfer of management took place without rehabilitation. To establish coordination among WUAs and enable them to take over irrigation management of the entire scheme, scheme level committee has been established. The latter will be involved in planning and decision making. There is also a set mechanism for conflict resolution/grievances redress at various stages. The total and sustained approach has borne fruitful results by achieving actual irrigation at par with the ultimate irrigation potential of the scheme.

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

With the reality of water reaching to tail end, farmers who were deprived of irrigation due to allocation of water to non-irrigation started claiming their right of water. The scheme level committee deliberated on the demand at various forums. Ultimately it resulted in amicable understanding among all sector users and paved way for further reallocating water to irrigation use. ' Sinchan Sahayog' (Associative Irrigation) – a NGO active in irrigation sector and having representation from all sections of the society at district level as well as state level, has facilitated and strengthened the participatory dialogue.

The Katepurna experience has been replicated by users in other schemes in the district leading to better water resource utilization. To continue the dialogue further, 'Sinchan Sahayog', federation of WUAs and irrigation division is working hand-in-hand. This arrangement has shown its relevance when there was low water yield 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 sections of society.

Discussion of Results:

With all round measures, the Katepurna scheme could irrigate 5940 ha area in 2000-2001 against the potential of 5967 ha. Secondly, 65 WUAs were formed on 18, 000 ha area in Akola district, which is 70% of area under jurisdiction of the Akola Irrigation Division. The actual irrigation in the district could boost up from 5000 ha to 13800 ha along with fulfilling increased domestic and industrial water requirement. The Katepurna example has shown that with true participatory initiative it could transform failure into success. It has given impetus to participatory irrigation management programme in the region and the State as well. The GoM has taken policy decision to make participation of farmers in irrigation management mandatory based on experience from Katepurna and other projects in the State. The contribution of the Katepurna scheme is recognized at national as well as international levels.

Conclusions:

The Katepurna scheme demonstrated that the true participatory dialogue among all sector users and stakeholders could result in efficient management of water resource. The appropriate institutional arrangement in the form of federation of WUAs, Sinchan Sahayog and the irrigation division has facilitated better coordination and prompted continued dialogue. The social acceptability to the initiative can be clearly seen from its replication in other schemes in the district. The water resources infrastructure developed for the society had been previously unable to deliver the goods that it was supposed to, but with true participatory dialogue and consequent actions resulted in better water governance benefitting society at large. The Katepurna example underlines need for true participatory dialogue for sustainable water resources management.

Politics of Water: Lessons from hard and soft Solutions in Kandara and Ngabuya Water projects, Kenya

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Presentation of Topic and Analysis of Issue: Successful implementation and sustainable management of community water projects require a careful mix of hard and soft arrangements. Installation of physical infrastructures must be combined with a well thought-out institutional and governance framework with a human face, implying need for a continuous participatory dialogue amongst stakeholders. Otherwise, ideological differences between project financiers, implementers and water consumers can easily derail otherwise well-intentioned projects. Kandara and Ngabuya Water Projects are such examples.

Kandara Water Project was started in the 1970s as a joint effort between politicians, government and external financiers. Local population was brought on board later to legitimize the project and contribute labour power. A lot finances, time and effort were spent on infrastructure. Political input was also very high with political leaders working closely with financiers and government to ensure the project took off. Their enthusiasm and participation was spurred by vested interests, particularly the obvious political benefits the project would bring. Like politicians, the government, financiers and professionals also had vested interests that propelled them to be thus actively involved. However, the shortcoming in the whole scenario was in the overemphasis on the hard solutions – the infrastructure - at the expense of the local participation of the community, which was the direct beneficiary of the project. There was generally therefore very limited and meaningful local participation of communities in the design, planning and implementation of the project. In addition, the project failed in having a human face aspect to ensure sustainability. Therefore, at the point of handing over, local communities did not have a sense of ownership of the project. To them, the project belonged to the politicians, the government and outside financiers. Initially, the project appeared successful. Later, however, there was evidence of the project not doing so well. Poor mix of hard and soft solutions, with overemphasis on the former, led to this dismal performance.

In contrast, Ngabuya had a better mix of the two strands of solutions, with a deliberate effort not to overemphasis on either one. Located in a smaller locality within the wider area formerly covered by the giant Kandara project, Ngabuya involved the local people from the inception to the implementation. Lessons learnt from Kandara were helpful, particularly in the initial stages of project design and implementation. Whereas there was the initial putting up of the necessary infrastructure for water intake, conveyance, reticulation and storage, there was also deliberate injection of the human component to ensure smooth implementation and sustainable management. Although the project is young compared to the Kandara, the management of Ngabuya project is much better in terms of the mix of hard and soft solutions. Political leaders, for instance, are not shut out from the project. However, they do not play a central role in the running of the project. There is emphasis on participatory approaches in the management of the project. All stakeholders are involved, hence ideological differences are not allowed to interfere. The local community also has a strong say in what happens in the project, thus inculcating a sense of ownership. This has helped in the delicate balancing act of social and political processes in the running and management of the project.

Discussion of Results/ Findings: The mammoth Kandara Water project placed a lot of emphasis on the hard solutions. The government and financiers put up the infrastructure needed for water intake, conveyance, storage and distribution. Consumers' contribution was restricted to provision of limited labour power in building the infrastructure. There was very minimal dialogue between the stakeholders on the management of the project. Politicians used the project to gain political mileage and win tickets for re-election while financiers were made to believe that the project was a success due to the apparent political backing attracted. Lack of a well-coordinated participatory dialogue between the concerned parties led to the below-average operation of the project.

The not-so-good performance of Kandara project and the subsequent lack of water at all in some areas led to the launching of other smaller projects like Ngabuya. Learning from the experiences of Kandara project, this (Ngabuya) project has tried to put a mix between physical infrastructure and a sound management framework with a human face. Subsequently, there is continuous participatory dialogue with very little interference from political leaders. This does not mean that politicians are shut out of the project. Rather, what they are restricted from is undue interference with the day-to-day running of the project as this can adversely affect the success of the same.

Conclusions: Kandara and Ngabuya projects are good examples of what to avoid and what to emphasize in project initiation and implementation. Political and social negotiation processes have worked differently in the two projects. In the case of Kandara the balancing act has not worked so well, with the result of overemphasis on hard options. However, in the case of Ngabuya, the balancing act has worked well so far, hence the optimism in the sustainable management of the project.

Grassroot Participation And Management For Rural Water-Related Envirommental Problems In Akwa Ibom State

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Presentation of Topic and Analysis of isuues: Grassroot participation in the management of rural water-related environmental problems aimed at providing sustainable and safe water for drinking, farming and other domestic and public uses is hereby discussed. The scheme integrates the rural water stakeholders comprising the women, youths and elders into a network for the containment and abatement of water-related environmental problems that includes flooding of river line communities, silting of rivers and water bodies from overlying farmlands, pollution of water bodies from refuse dumps and animal grazing activities, erosional hazards, and outbreaks of diseases such as Typhoid fever, Polio, Hepatitis, Diahorrhea, Dysentery and Cholera. It x-rays the participatory approach to include sustained public awareness and education programmes hinged on a values-based approach using TV, Radio, Newsletter, Magazines, and Illustrative Drama as well as the creation of a water sanitation agency (within the local government authority), a training scheme to develop manpower as well as a knowledge enhancement programme with detailed drafting of a curriculum for the primary and secondary schools and the setting up of water use and rights groups in these schools.

Key elements of the project included:
The political, technical and non-technical concepts. The political aspects of the framework consider close collaboration between the peoples representatives at the village council, clubs, associations, peer groups, church hierarchy and pressure groups, This particular framework centered basically on the ways and means of reducing and managing refuse and waste right from the source to minimize it's effects on water and the environment when disposed off carelessly. The non-technical includes institutional and attitudinal aspects. Institutional involves institutional structure, institutional arrangement, organizational procedures and capacity of responsible institutions (still lacking).

Strategies

a) Aggressive education and awareness of the need for waste reduction,
b) Encourage community and private sector participation in waste reduction at source,
c) Initiate integrated management of waste and promote the development and identification of markets/outlets for recovered waste products,
d) Review, strengthen and update periodically existing laws and regulations for the environmentally sound management of solid waste,
e) Ensure compliance with existing laws and regulations on waste management through effective monitoring and enforcement,
f) Provide, upgrade and maintain infrastructures needed for the collection, transportation, treatment and disposal of waste,
g) Encourage community and private sector participation in the commercialization and privatization of waste,
h) Foster cooperation among all tires of government, the private sector, CBO's, CDA's and NGO's in the effective management of waste.

The only impediment in the near future will be adequate funds to ensure that these objectives are pursued to fruition namely:

a) Encourage and mobilize all stakeholders including CDO's, CBA's and NGO's to ensure wastes minimization, reuse, recycling and recovery strategies,
b) Develop an infrasturctural capacity building process involving women directly in the sound environmental management of waste,
c) Mandate the organized private sector to adopt waste reduction techniques,

d) Encourage and fund existing though limited research into waste related pollution control technologies as well as new means of effectively dealing with the falling standards of health and agriculture within the community,
e) Adopt the polluter-pay-principle in the management of waste,
f) Carry out periodic evaluation of progress achieved in the implementation of the objectives listed herein.

The scheme incorporated developing literacy skills, creating lasting awareness on major issues of development activities in the fight against poverty, disease, ignorance, environmental degradation, uphill farming, promoting self image and economic development, thus enhancing the earning capabilities of the women and their active participatory role in these projects. The use of illustrative situational drama was also applied to create increased understanding and awareness of water issues and the nature and root causes of water problems. These skills gained enabled participants to apply their energies and talents to solve water problems.

Concordance of Various Order Preferences under Decision-Making and Water Management

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The realization of sustainable water politics must be based on coordinated decisions, satisfying the various local requirements and concerns of different parts of society and the society as a whole. One-sided management under lack of social acceptance is fraught with serious negative consequences. The various needs as well as concerns of various societal groups and strata are required for their concordance. At the same time these needs and concerns may clash with themselves. Actually, it is a question of the competition of decision procedure and decision criteria. Each party not only purposes his objects and concerns, but also promotes his own decision criteria and decision procedures. In a certain sense, the group and corporate egoism is especially hazardous, when they obtrude their concerns and profits upon the whole society, pose their concerns and local requirements as public benefit. It is often intensified by their monopolistic state. The various nongovernmental organizations (NGO) and funds seems the very important matching link which able to bring the concerns about an understanding and promote sustainable water management. They are not engaged for specific groups or structures and have not specific concerns, so they express of interest of society as a whole to the utmost and are the essential institution for making of sustainable and concordance decisions.

Problems of community and NGOs involvement are considered by examples of such large nature-reformative projects as interbasin flow diversions and the Katun dam project.

The closed basin of Caspian Sea is especially sensitive to water disbalance. Recession of Caspian Sea level began since 1929 and has fallen by 2.5 meter until the eighties. The project of water transfer from upstream of some rivers located in northern part of the European Russia and belonging to Arctic Ocean basin, to Volga River basin was designed for stop this recession. Other destination of this project was extension of irrigated area in lower reach of Volga River. This project had many defects from ecological, social and ecomonic points of view. The inhabitants of northern rivers' basin were indignant since the construction of dams and creation of water reservoirs in marshland would have destroyed their habitat essentially. Many public organizations, scientists and engineers have joined the criticism of the project. However the powerful grouping was interested in this construction including development corporations of waterworks and irrigations as well as designing firms, research teams and universities serving the project. But the nature itself breaks into the dispute here. Raising of Caspian Sea level, begun unexpectedly, strips the project realization of main sense.

Second larger project was the project of transfer of a portion of the Siberian rivers' runoff to the Central Asia. The huge channel in width more than 200 meters and about 2000 kilometers in length was planned to lay lengthways Turgai Valley for water delivery to Aral Sea basin. High cost of project, big water losses, evaporation, underflooding, waterlogging and occurrence of saline land, water disbalance in downstream and others are among arisen problems. The qualified and really independent project appraisals were organized by NGOs, which have convincingly proved inconsistency of project. Works at the realization of this project were suspended, but its reanimation is possible yet.

The third project is the project of Katun hydroelectric power station in the Upper Ob River basin and Altai region. The two large cities Barnaul and Novosibirsk are situated at this basin as the numerous amount of townships are the main water consumers. The Novosibirsk Dam and Novosibirsk Water Storage Pool are constructed for the control of water consumption and electrical load-factoring. Lately Novosibirsk City is pressed for water deficiency because of tail-water level decrease and water scoop uncovering. Recently the vehement strife of opinions about the Katun Dam construction recommences again. The power engineers and hydro-builders are interested in the construction of this dam. The electricity production and the possibility of tail-water regulation are among the advantages, which they promise to society. On the other hand, the unique object of recreation and landscape importance will be lost. The region of probable construction takes on special significance as object of tourism and recreation. According of calculation of independent economists, the tourist industry and using of ecological and recreational potential provide for most economic profit under rather smaller ecological costs. In case of creation of Katun Hydroelectric Power Station the formed water basin underfloods the deposits of salts of mercury available there. In result mercury will begin to collect in a water basin and to act in water area downstream, poisoning health of the person and all fauna. The formed water basin will disturb ways of migration wild animals. The valley of the river of Katun passes on a zone of a geological break. Earthquakes there are often. The motion of coast from each other is fixed. These circumstances give additional risk to construction of hydroelectric power station that was confirmed by the unexpected severe earthquake in 2003.

The given examples show that not only ministries and government agencies but also various nongovernmental ecological organizations and community provide the effective dialogue process. The nongovernmental ecological organizations and the public control play rather positive role, carrying out a feedback, promoting acceptance of correct and the most effective decisions. The role of NGOs and communities is extremely great and indispensable for the balancing of narrow departmental interests with interests of a society as a whole, for the coordination of the local, momentary purposes and benefits with the long-term purposes and interests of a society.

Understanding the Relationship between Government and Governance for Effective Implementation of Water Policy

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Due to fundamental changes in the South African political environment, and the increasing emphasis on sustainable development in the international arena, South Africa has been undergoing a period of rigorous development and revision of government tools. These tools include policies, strategies, guidelines, procedures, legislation, regulations and by-laws. The meaningful application of the tools depends on an enabling environment, characterised by among other things, participation; transparency; accountability; and equity. The intention is that these requirements should promote interaction, co-operation, synergy between government spheres and governance.

The discourse on sustainable development is a reflexive discourse, representing a fundamental departure from the hydraulic mission era, which focuses on managing supply by expanding horizons in the quest to rapidly grow the national economy. This typically relates to the provision of basic infrastructure. The new paradigm focuses on managing demand, thus living within (and adapting to changes within the system) the constraints of the environment, reflecting a society becoming increasingly concerned by the intended and unintended consequences of its actions. This paradigm focuses on building institutions to manage demands on water resources. Another trend reflects decentralisation of management and, in certain cases, decision-making.

This simple model illustrates the broad context in which water resource management is being practiced globally and within the South African context. Whereas many countries have already achieved the basic infrastructure required to provide water-based services to people, South Africa is still moving towards decentralised and demand-oriented management - within the constraints of a water-stressed state and a fledgling democracy. This implies that while parts of South Africa are still requiring provision of infrastructure, other areas are well sourced and need to build institutions and put into practice the principles of sustainability, equity, accountability and transparency.

Based on these principles and with the main objective of promoting sustainable development, a number of government tools have been developed. However, these government tools have not been implemented successfully. The lack of effective implementation renders these tools ineffective and weakens not only government, but in the end governance.

Implementation of government tools and successfully functioning thereof in a truly democratic and equitable system requires three equally important requirements, namely:

- Well thought through and well formulated government tools.
- Good governance, and
- Enabled implementing institutions and mechanisms.

Government indicates the management structures of a country, consists of elected officials and represents the “official” physical structures of the administration of a country. Government is the first dimension of a democratic administration and the main “product” of government is government tools with the overall process of formulation and implementation of government tools defined as the government process. In a democratic society, government process should reflect the aggregation of societal interests as articulated by civil society and its interest groups. South Africa's government tools; are acknowledged globally as cutting edge and based on a broad vision founded on respect for the relevant principles and themes of sustainable development and the acknowledgement that ecosystems are human life support systems.

Governance has been defined by the project as the process whereby civil society articulates interests and then tests, monitors and audits the manner in which government addresses those concerns or articulated interests of society. That is, society tests the fiduciary trust of the elected officials, holds government accountable for their actions and contributes to establishing the legitimacy of the elected government. Governance has become well practiced in South Africa. However, some principles to ensure good governance, like communication and equity still need to be entrenched deeper into society.

An implementation institution constitutes two types of assets.

- Tangible or physical assets, namely government departments, organisations, associations, groups for example the Department of Water Affairs and Forestry's Regional Offices and Water Forums representing government and governance.
- Intangible or non-physical assets critical for the present and feature success of institution, namely skills, capabilities, capacity, knowledge, relationships, etc.

The tangible assets of the implementation institutions are largely in place in South Africa. Government needs to streamline the establishment of the decentralised implementation structures, such as catchment management agencies. Government should also provide "proof" to show actual aggregation of the articulated interests and concerns within the formulated government tools and decisions, as civil society (the governance structure) is showing increased apathy towards participating in government processes, where there is a perception that their concerns are not properly addressed. Achieving good governance is therefore at risk!

The intangible assets of the implementation institutions are not adequately addressed. The capacity to act, make decisions, use available knowledge, capabilities and other human competencies skills are insufficient, as are the mechanisms to promote their development.

In South Africa, the full potential of these government instruments are not realised largely due to inadequately resourced implementation institutions. Adequately resourced relates to the capacity for informed action, which in turn is constituted by appropriate experience, concepts and information, as well as informal operational networks. The paper will elaborate on possible ways to optimise these intangible aspects.

Negotiating Accessibility, Affordability and Quality in Water Management: A Case Study of Agbadagbudu and Onipasan Springs in Ibadan, Nigeria.

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Presentation of Topic and Analysis of Issues

The rapid urban growth in developing nations has posed major challenges in water planning and management. This is the case with Ibadan, Nigeria, the largest city in Africa South of the Sahara. The provision of the water is far below the demand. In 1997, less than 30 percent of the over 2 million population of the 11 local councils were adequately served from the urban water systems in Asejire and Eleiyele dams. It is very evident that the municipal government and her various institutions could not cope with the situation as a result of inadequate finance, poor maintenance and water planning without the people, amongst others.

It is not surprising, therefore, when efforts to manage and use the existing 24 natural springs in the city of Ibadan came as tangible alternatives to municipal water supply. This idea is anchored on the SCP/EPM approach developed by the UN-HABITAT in the 1990s. Its fulcrum was the Working Group Concept which emphasis active, persistence participation of all stakeholders. The exercise is facilitated in the city by the Sustainable Ibadan Project through a city consultation where identification, prioritization, agreement, strategic planning on water issue were concretized. The development process thus embraces a social network and trust both horizontally and vertically between the service provider and the beneficiaries.

The natural springs were developed in their various locational communities. Affordable user charges were introduced for efficiency and maintenance of the service. The project is been managed by the concerned communities based in the working group concepts.

By the sample test and qualitative analysis of the physiochemical properties of the developed spring waters, it was proved that indicator from the spring water is equal to if not better quality than municipal water supply.

Discussion of Results

Spring water often used as sources of water supply in Nigeria's rural areas is a high quality, affordable and easily accessible natural source of water supply. The physio-chemical components are the same with any other treated water sources. The development strategy is easy without any sophisticated technology. Resources for the project implementation are locally sourced through a sense of self actualization and built-in social capital of the beneficiaries - they are partakers and architects of the improved social infrastructure.

Conclusion and Recommendation

Each of the two natural springs serve about 60,000 people within 1.5 km. locational radius. A simple technology of collecting water from a protected source through direct flow into underground tank, to which hand pumps were fixed to fetch water is used. The project is community driven, owned and managed. With this strategy, water supply shortage have been reduced within the city in the last five to eight years of consolidated natural spring water development.

The need has now become more urgent for improved reinforcement, mobilization of the working group members for transparency and accountability. An efficient monitoring and evaluation process are to be in place alongside with improved sanitation and disinfection exercise of the spring sources. With these, a better management and replication of the process is attainable and sustainable.

The Role of Science and Technology in Strengthening Good Environmental Governance

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Presentation of topic and analysis of issue: South Africa is a country that has a relatively young democracy, where government policies have been formulated and other government tools (strategies, guidelines, by-laws and regulations) are being developed. Despite the excellent policies and strategies developed, government departments are facing tremendous pressure in meeting their mandates, particularly with regards to the natural environment. Responsibility of the natural environment is divided across a wide range of government departments and other agencies. Not only is such a division likely to lead to implementation problems associated with government policies and tools, but it would likely result in conflicts between government departments when their mandates and goals are overlapping, or when natural resources (e.g. a river and an estuary) are connected to each other, but managed by different government departments.

A holistic view of all policies and a clear representation of what is to be managed, by whom, and at what level is needed. This requires a more efficient and co-ordinated process, both within and between government Departments and other institutions. Such a philosophy is encapsulated in the concept of good environmental governance, where the integration of openness, participation, accountability, effectiveness, coherence and democracy underpins its definition. In South Africa, a co-ordinated process of good environmental governance is needed in the water resources management arena to ensure that our government policies and tools are effectively implemented. Once established, such a process could be extended to other Southern African Development Community (SADC) countries, especially in the context of transboundary water resource management, where South Africa shares water resources with fellow SADC countries.

The role of science and technology organisations in good environmental governance has not been debated previously. Science and technology organisations should contribute to the evolution of policy processes from development to implementation by, (i) using their multi-skilled and multi-disciplinary teams to address the processes holistically, (ii) using the outcomes of their work to develop cross-sectoral perspectives, and (iii) using their ability to translate policy into effective implementation. Close interactions between science and technology organisations, government departments and non-governmental organisations, as well as civil society can provide an ideal forum for sharing knowledge on good environmental governance processes in the context of water resource management. Such an approach may likely eliminate several problems associated with isolated government departments dealing with similar issues in their respective mandates.

This paper examines and explores our current understanding of environmental governance and the role science and technology organisations can play in this debate. The information discussed aims to stimulate discussion on how the science and technology community, in particular research and development institutions, can strengthen its contribution to good environmental governance in South Africa.

Access to Water as a Human Right.

Prof. Juan Miguel Picolotti, Argentina
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"More than a billion people in the developing world lack safe drinking water – an amenity those in the developed world take for granted. Nearly three billion people live without access to adequate sanitation systems necessary for reducing exposure to water-related diseases. The failure of the international aid community, nations, and local organizations to satisfy these basic human needs has led to substantial, unnecessary, and preventable human suffering. … [A]ccess to a basic water requirement is a fundamental human right implicitly and explicitly supported by international law, declarations, and State practice. Governments, international aid agencies, non-governmental organizations, and local communities should work to provide all humans with a basic water requirement and to guarantee that water as a human right. By acknowledging a human right to water and expressing the willingness to meet this right for those currently deprived of it, the water community would have a useful tool for addressing one of the most fundamental failures of 20th century development."

The CEDHA Right to Water Initiative aims to improve sustainable access to water through the use of law.

The objectives of the CEDHA Right to Water Initiative are to:

- Promote access to justice of victims of human rights violations resulting from non-sustainable use of water resources;
- Incorporate a human rights perspective in water resource regulation and legislation;
- Promote legal precedent recognizing the right to access drinking water as a human right; and,
- Increase awareness of the links existing between human rights and access to drinking water.

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- Increase awareness of the links existing between human rights and access to drinking water.

The actions of the CEDHA Right to Water Initiative include:

- Providing free legal advisory services to victims of human rights violations resulting from non-sustainable use of water resources;
- Undertaking legal actions in defense of victims of water contamination before judicial bodies at the local, regional and international level;
- Building capacity of civil society leaders on the links existing between human rights and access to drinking water; and,
- Advising public decision makers on the inclusion of a human rights perspective in water management policies and legislation at the local, regional and international level.

The current activities of the CEDHA Right to Water Initiative include:

- Legal advisory services and legal representation in cases of megadams in Latin America (Yacyretá and Corpus Christi);
- Legal advisory assistance to Ríos Vivos, a South American coalition striving to impede further damage to water resources in the region and other social and cultural externalities caused by the misuse of water resources;
- Publication of legal research on the links between human rights and access to water; and,
- Participation and organization of a workshop at the upcoming World Water Forum Japan 2003

This presentation will show the human rights violations which occur due to water mismanagement. This presentation will review the legalities an human rights issues resulting form such water misuse.- We will review 2 local cases of water misuse and discuss the resulting violations while brainstorming the legal mechanisms (both local and international) available to provide access to justice to victims.
One of the cases will be around a community that suffer lack of water, and from cedha we help them that the government give to the community safe water.

The other case is about the yacyreta dam, that is one of the more largest dams in latinoamerica, we will show the environmental and social impacts.

Finalising the Project: Development of the Pungue River Basin Joint Integrated Water Resources Management Strategy.

Dr. Rikard Lindén, Sweden
SWECO International

Co-Authors: Mr. Manuel Fobra
ARA-Centro, Mozambique

Mr. Thomas Murinye
ZINWA-SAVE

The Background

It is now almost three years since the presentation of Launching the project: Development of the Pungue River Basin Joint Integrated Water Resources Management Strategy was held at the Stockholm Water Symposium in August 2002. The Sida-funded Pungwe Project has been implemented and been run in full force for these years. Experiences, both good and bad, have been gained by the Mozambican and Zimbabwean water authorities as well as by Sida and the Consultants. Projective objectives have been met but also been reformulated since the reality was not always as anticipated when initiating the project.

The Pungwe Project now stands in front of one of the major challenges, to propose bi-national development plans for future equitable use of the water resources in the Pungwe River basin. This paper describes how the joint efforts of scientific fact finding, institutional capacity building and mobilisation of stakeholders have lead to the proposed development plans, which will be presented to the water authorities of the two countries in May 2005.

The Pungue River

The Pungue River rises in Eastern Highlands in Zimbabwe and then flows in a rapid descent to the Mozambican plain before it reaches the Indian Ocean at the City of Beira. The basin has a total area of about 31,150 km², of which 95% is located in Mozambique and only 5% in Zimbabwe.

The Pungue River is a shared watercourse. Its waters are scarce and at the same time potential flooding threats the middle and lower reaches. The Pungue River involves only two riparian countries, which is unusual in Southern Africa. Unusual is also the distribution of the water resources with some 28% of the total flow being generated from the 5% of the catchment located in Zimbabwe and the diverse and unequal development in the different reaches. Major developments in the upper, Zimbabwean parts are the water transfer scheme for the supply to the City of Mutare, commercial tea estates, small-scale farming in communal lands and tourism. The middle reaches, in Mozambique, are largely undeveloped and sparsely populated but hold a potential for irrigation and tourism development e.g. in the area of Gorongosa National Park. In the lower part of the basin major economic and social interests are irrigation for sugar cane, the water supply to the city of Beira and prawn fishing around the estuary.

The Pungue Project

The project commenced in early 2002 and is anticipated to terminate in 2006. It has the development objective "to achieve a sustainable, equitable and participatory management of the water resources of the Pungue Basin, and increase the derived social and economic benefits for the people living in the basin, and other stakeholders". So far the project has achieved the following:

- A monograph describing in detail the environment, the socio-economic situation, the water resources, the water demand and the infrastructure of the Pungwe River basin.
- An increased institutional capacity in the regional water authorities in terms of producing and storing reliable hydrological data.
- A description and understanding among the regional water authorities in both countries of the legal and institutional framework that is relevant for management of the bi-national river.
- An established Pungue Basin Committee in Mozambique representing more than 100 mobilised stakeholders in the Pungwe River basin.
- An initiated dialogue between the stakeholders in the two countries through the Pungwe Sub-Catchment Council, Zimbabwe and the newly established Pungue Basin Committee, Mozambique.

- An initiated dialogue between the both the regional and national water authorities of the two countries in future management of the water resources of the Pungwe River basin

Remaining challenges are to implement a business mind set at the staff of ARA-Centro, to ensure sustainable stakeholder consultations within and between the countries regarding water management, and to drive the dialogue between the water authorities of Zimbabwe and Mozambique into an equitable and manageable agreement on the IWRM strategy for the Pungwe River.

The Development Options and Stakeholder Consultations

To reach development of the Pungue River basin to improve social and economical conditions for the people, development of the water resources must be made. Unlike many other river basins, e.g. in southern Mozambique, there is, however, not already an urgent water demand that has to be supplied. Instead development in water supply and water demand must go hand in hand for a socio-economical development. This put the water authorities in a difficult situation since there is no obvious infrastructure or project to take into action. There is even a question to which comes first, supply or demand?

This situation also put large emphasis on the stakeholder participation. The stakeholders have an opportunity to direct the development into the direction they prefer since it is not already pre-decided which infrastructure development will come. Therefore, much effort has been made in the Pungue Project to identify, mobilise and educate the stakeholders in the whole basin. Large stakeholder, such as the sugar cane estates and urban water companies are already active, while small stakeholders often have no knowledge of their possibility to influence. Many consultation meetings have been held to present the results and proposals of the projects. Meetings have been spread between both geographical locations as well as between different stakeholders groups to ensure that the correct level of detail can be conveyed.

The paper

The paper will, apart form providing a description of the project, focus on the stakeholder participation to obtain development plans which are anchored among the wide spectra of stakeholders in an international river basin. It will present experiences, good and bad, from the stakeholder consultation process.

Integrated Water Resources Management as a Coordination Problem

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Presentation of the topic and analysis of the issue: In recent years, the concept of Integrated Water Resources Management (IWRM) has been propagated as a response to rising water conflict and resource degradation. In its definition, the Global Water Partnership emphasizes the process and coordination character of IWRM and specifies the objective of such coordination, namely, enhancing welfare under ecological and social restrictions. The basic assumption thus is that 'integration' is achieved through 'coordination'. Coordination relates to different dimensions, (1) horizontal coordination at the level of the river basin, (2) horizontal coordination among different water using sectors, and (3) vertical coordination among different levels of government. This raises the question how these different dimensions of coordination can be realized from an institutional point of view. In the policy discourse, there is often an explicit or implicit assumption that it is desirable to establish new organizational units, such as River Basin Organizations, which are responsible for the integrated management of water within the hydrological confines of a river basin. Other analysts take a more comparative view and differentiate between the organization and a coordination model, where the latter refers to voluntary negotiations among existing jurisdictions to cover the river basin or sub-basin. In contrast to a mainly empirically oriented body of literature, this paper analyzes the choice of alternative coordination mechanisms in water resources management from a theoretical, rational choice perspective. In doing so, it builds upon Fritz Scharpf's (1997) distinction of modes of interaction and institutional settings as procedural and structural elements of coordination respectively. Based on this typology, alternative arrangements are compared with respect to their capacity to enhance welfare, to solve problems of distribution, and to ensure the legitimacy of policy outcomes.

Discussion of findings: It will be argued that the two ends of a spectrum of possible coordination mechanisms are represented by freestanding (inter-jurisdictional) negotiations on the one hand, and hierarchical direction within river basin organizations on the other. However, the analysis of these two 'extreme' arrangements reveals that both have significant shortcomings. Theoretically, an omniscient and benevolent hierarchical decision-maker could impose an optimal and fair solution. However, once the autonomy of various stakeholders in water resources management are recognized, it is difficult to conceive under which conditions decision-making powers would be transferred to a hierarchical decision-maker. Moreover, even if such a transfer took place, information and motivation problems remain an issue. Thus, except for rare exceptions where a delegation of competencies to an independent river basin organization may be justified and well-designed mechanisms ensuring participation and accountability are in place, inter-jurisdictional negotiations appear to remain the most important mechanism for coordination in water resources management. However, while negotiations are desirable from an efficiency and legitimacy point of view, transaction costs may be high and the capacity of freestanding negotiations to solve social dilemmas and to overcome problems of distribution tends to remain limited. These negotiation problems may, however, at least partly be remedied by a greater degree of institutionalization, be it through the build up of networks and trust, the set up of regimes, the involvement of an agenda setter, or even through the creation of a formal river basin organization as an institutionalized form of collective decision-making. In the case of inter-jurisdictional organizations, the decision-making organ will usually work on the basis of unanimity. In lower-level association-type organizations with multiple individual members, a majority vote may significantly lower decision costs, and help to overcome joint-decision traps. Examples such the German water associations, the French basin agencies and the International Commission for the Protection of the Rhine confirm that actors in the water sector make use of such combinations of negotiated decision-making and different forms of institutionalization.

Conclusions and recommendations: The analysis shows that the choice of adequate coordination mechanisms in IWRM appears to be less a question of markets (negotiation) versus hierarchies, but the challenge is to complement negotiations with carefully crafted informal and formal institutions that contain opportunism and reduce transaction costs. This may include the building of trust, the set up of a negotiation regime, the involvement of an agenda setter, and, under certain conditions, also the set up of an association or an international organization. While many of the arguments developed within this paper can also be found in the empirical literature on river basin management, the primary purpose of this theory-based paper is to develop them in a systematic fashion.

The Need for a Political Approach to Analyzing the Management of Water Services.

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UNESCO-IHE Delft

Since the discovery that water acted as a carrier of (waterborne) diseases the provision of water services has been subject to government interventions in many countries. The intervention of government was, however, strongly technical in nature, meaning that government focussed on setting quality and standards and in financing expansion of the service network. The water services sector in this era was dominated by technical solutions to the problem of inadequate water and sanitation services. This 'technical approach' to service provision, remained the main approach to service provision until the 1980's and the Drinking Water Decade (1980-1990).

The main drivers for shifting the approach to include more 'non-technical' elements in approaching the provision of water services are twofold. First of all, in many industrialized countries service coverage approached 100% and the quality and reliability of service provision was high. Having achieved this, more attention was given to managerial aspects of service provision. At the same time, the public sector in general was subject to numerous managerialist reform processes as government was being 're-invented' (Osborne and Gaebler 1992). Secondly, disappointing results of the first part of the drinking water decade lead to a realization that for water services to be expanded and improved in developing countries increasingly attention had to be paid to 'software' side of service provision (as opposed to the 'hardware'-focus that had previously dominated the water services sector) (Black 1998). As a result, in addition to the 'technical approach', which had dominated the sector a 'managerial' approach was developed (and is still developing).

Although, the addition of a 'managerial approach' to the water services represents an added value, we argue that in order to have better understanding of the water services sector, a third approach to the provision of water services should be developed. This approach is a 'political approach' to water services, which should take the main political players/organizations in a region as its unit of analysis rather than the water utility. Although the role of politics has been identified by many authors (Foster 1996, Spiller and Savedoff 1999), it is often analyzed from a managerial perspective (the politicization of management which leads to less managerial autonomy for the management of the utility). Understanding the obstacles and opportunities to improving the provision of water services requires an in-depth analysis and understanding of interest and balance of power between local and national stakeholders.

The problem is that just a technical or a managerial approach to water services is not enough to fully understand the issues. For that reason an effort will be made to develop a political approach and to show the different insights that can be gained from such a more integrated approach to the issues at stake.

The reasons for developing a 'political approach' to water services are twofold. First of all, with the overwhelming majority of service provision still in hands of public utilities, the role of local and national political developments is of direct influence on water services. Illustrative are decentralization processes in many countries, which are often broad decentralization processes initiated for political purposes, in which water services is only one sector being impacted. Secondly, the increased attention paid to the role of the private sector has strongly polarized the water services sector. Since the early 1990's, following the 1992 Dublin Principles, which emphasized that water should be seen and treated as both an economic and social good, increased attention was given to the role of the private sector in service provision. During much of the 1990's the World Bank and other international and national agencies strongly promoted a larger role for the private sector in the provision of water services. This has lead the water sector to gain increased interest from NGO's and community organizations strongly opposed to the provision of public services by the private sector. Most illustrative and well-known of this polarization is the 'Cochabamba Water War', which lead to the cancellation of a concession contract in the Bolivian city of Cochabamba. Understanding episodes such as the 'Cochabamba Water War' requires application of a political approach.

Benefit Sharing and Stakeholder Participation: Challenges for the Nile Basin Initiative

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The 10 countries of the Nile River Basin in North-Eastern Africa together comprise about 300 million people, representing nearly half of the sub-Saharan African population, of whom about 150 million inhabit the basin itself. Poverty within these countries is widespread with as many as half the population living on less than a dollar a day. Coupled with this are huge disparities in wealth both within countries and between different Nile basin countries: as an illustration, the GNP/capita of the richest basin state is equal to ten times that of the poorest.

In addition to entrenched poverty and inequality there are specific development crises, including the impact of the HIV/Aids pandemic in many countries, and in some areas, the long-term consequences of protracted civil and inter-state wars. In short, the Nile Basin is a hugely complex development arena with the capacity to impact on just about every sub-region within Africa and the neighbouring regions of the Mediterranean and Middle East. Improving socio-economic development in basin countries through better water management and resource governance can play a very significant part in reducing poverty in a key part of Africa.

The Nile is the world's longest river system, and one of its most complex. The landscape of the basin (which covers approximately 3.2 million km2) is hugely varied from the wet highlands of Ethiopia to the aridity of the Nubian desert, the globally significant swamplands of the Sudd in South Sudan to the huge volume of storage in Lake Victoria, the world's second largest freshwater lake.

The challenge of developing an effective cooperation agenda between 10 basin states remains immense. Nevertheless, since the early 1990s huge strides have been made towards a more cooperative understanding and common development agenda shared by the Nile countries. Its greatest embodiment is in the Nile Basin Initiative (NBI) which, since 1999, has provided an institutional basis for cooperation based on a common vision and strong backing from the international community. Now at the stage of implementing investment projects fully funded by donors, the NBI represents an unprecedented opportunity to develop the waters of the river in such a way as to optimise the basket of benefits available to all countries and thereby to enhance significantly socio-economic development, the protection and conservation of key environmental resources and to prevent future conflicts arising.

Central to the NBI's objectives is the important role it can play in reducing the very serious poverty suffered by much of the population in the basin. This is clearly acknowledged in its policy guidelines which state that the primary objectives of the NBI are to:

- Target poverty eradication and promote economic integration.
- Develop the water resources of the Nile Basin in a sustainable and equitable way to ensure prosperity, security, and peace for all its peoples;
- Ensure efficient water management and the optimal use of the resources;
- Ensure cooperation and joint action between the riparian countries, seeking win-win gains;

It was recognised early on in this process that the potential win-win development objectives of the NBI, including improving overall basin management and governance of resources, required the inclusion of a wide variety of stakeholders, central to which should be key parts of basin civil society. Yet at present civil society involvement lags far behind and much has to be done—and fast—to ensure that it becomes central to the development process.

One of the most significant roles that civil society can play is in integrating interventions in the water sector—perhaps the development of new storage, hydro-power, watershed management or flood control—into the broader socio-economic development context of the basin, including potential impacts on poverty in specific sub-regions. This it can do through harnessing local knowledge, bringing a range of non-state stakeholders into the development process and building networks of interested parties through which information can be disseminated and lessons learnt.

Many civil society organisations (CSOs) in the Nile basin are already engaged in debates on PRSP design and implementation, sector-wide approaches, grassroots participation and multi-stakeholder dialogues. Others have key sector-specific knowledge on the environment, water supply and sanitation interventions, on social issues surrounding poverty, and on wildlife conservation and biodiversity. Many have detailed knowledge from long-term involvement in communities on how to connect Nile basin interventions to the livelihoods of the poor, the need to protect existing livelihoods and to increase the diversity of livelihood options available to poor communities.

The author examines the challenges that exist in achieving civil society involvement, as well as some of the current initiatives that are emerging to enhance civil society participation. He presents an analytical framework for understanding how civil society can best understand, engage with and influence the NBI—through examining in detail the concept of ‘benefit sharing’ as applied in the basin. He concludes that the NBI has to involve civil society fully and in a structured, consistent manner in all its development processes in order to ensure that the concept of benefit-sharing can be successfully implemented to meet the NBI’s stated objectives and to ensure that benefits are shared in an equitable manner.

Impacts of global mega-conferences on water

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UBC

Since the early 1970s, the United Nations has organized a series of mega-conferences to address pressing global problems. It started with the Conference on the Human Environment in Stockholm (1972), and was followed by Population (Bucharest, 1974), Food (Rome, 1974), Women (Mexico City, 1975), Human Settlements (Vancouver, 1976), Water (Mar del Plata, 1977), Desertification (Nairobi, 1977), Science and Technology for Development (Vienna, 1979) and New and Renewable Sources of Energy (Nairobi, 1981). Twenty years later, several of these issues were revisited: Environment (Rio de Janeiro, 1992), Food (Rome, 1994), Population (Cairo, 1994), Women (Beijing, 1995), and Human Settlements (Istanbul, 1996). Environment was further considered in Johannesburg in 2002.

However, water was only considered in Mar del Plata in 1977: there has been no follow-up mega-conference since then.

World Water Council initiated the World Water Fora. The First Forum, organized in Marrakech in 1997, was a modest affair. The Second Forum, in The Hague, in 2000, was attended by some 4,600 people. The Third Forum in Japan, in 2003, had some 24,000 participants. The costs of these water mega-conferences have escalated rapidly. The Secretariat cost of the Third Forum has been estimated at $28 million, which was more than 16 times the cost of the First Forum.

None of these water-related global mega-conferences have been evaluated independently. Their impacts and cost-effectiveness are now unknown, even though their costs have escalated very rapidly with each succeeding one.

In order to determine the impacts of the global mega-conferences, the Third World Centre for Water Management has conducted a study with the support of the Sasakawa Peace Foundation. The events evaluated were Mar del Plata, Dublin, Rio and Johannesburg Conferences, Freshwater Consultation (Bonn, 2002) and the three World Water Fora.

A questionnaire was sent to 2,698 people all over the world, among whom were all the members of the World Water Council and International Water Resources Association, as well as the participants of major water conferences, including Stockholm Water Symposium of 2004. Responses, received from 65 countries, were analysed. Additionally, special impact analyses were conducted for certain countries and regions: Australia, Bangladesh, Brazil, India, Japan, Scandinavia and Southern Africa. These analyses were reviewed by a select group of international experts at a workshop in Bangkok, 29-30 January 2005.

The overwhelming view of the people who participated in the survey was that the mega-conferences are having little or no impact in advancing knowledge-base, or on institutional and national policies; they are no longer cost-effective, have become a type of water fair, and need to be radically restructured. There is a less of a consensus as to how future mega-conferences should be structured so that they become cost-effective and impact-oriented.

The survey identified the following benefits: they provide an opportunity for water people from all over the world to meet each other; give an opportunity to everybody to express their views on a global stage; provide a focus for water professionals to learn about other people´s work; increase, at least temporarily, the profile of water in the general development agenda; concentrate the mind of politicians on water issues; and may enhance the prestige of the host country and the people associated with their organisation.

The main disadvantages identified were: they are loo large and unfocussed in terms of aims, formats, contents and participation; they have minimal impacts on national and institutional policies, investments, or work on the ground; they do not fit into broader water development and management processes; they may not be attended by the appropriate participants in order to achieve their stated aims, they tend to be dominated by people and organisations from the industrialised countries and by well-organised special interest groups; they generate too many mixed and conflicting messages; they tend to propose global

solutions to water issues and fail to consider specific local solutions; ministerial declarations are ineffective and irrelevant; they fail to involve people from other sectors such as finance and development policy; and they are becoming increasingly expensive and decreasingly cost-effective, both in direct and opportunity costs. Overall, the disadvantages are substantially more than the advantages.
The impacts of mega-conferences can be increased if the organisers of these events make a special effort to maximise their benefits and minimise their disadvantages. Thus, it is important that issues such as creating a link between ministerial declarations and subsequent local actions as well as providing a path to apply new knowledge to real life situations in a particular region should be taken into account. Additionally, the success of these conferences should be measured in terms of outputs and impacts, and not by the number of people who participate or the number of countries that are represented, as has been the case in the past.

The paper will focus on the impacts and cost-effectiveness of the mega-conferences on water. By identifying the strengths and weaknesses of these events, it may be possible to ensure that these mega-conferences not only provide a platform where people from different background, sectors and countries meet, network, interact and share experiences, but also that specific problems from specific regions are discussed and solutions are found which can improve water policies, planning and implementation processes and promote stakeholder participation. Furthermore, since resources available are limited, such meetings should be better focused to obtain concrete outputs and maximize the participation and learning experience of each attendant, and thus improve the life of as many people of the world as possible.

The Conflict vs. Cooperation Paradox: Fighting Over or Sharing of Palestinian-Israeli Groundwater?

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Different mantras are heard these days from analysts studying relations between Israel and Palestinians on water issues. One is apocalyptic: 'The next war in the Middle East will be fought over water'. The second mantra is more peacefully reassuring: 'The transboundary nature of water creates an interdependency between states that obliges cooperation'. Neither is accurate. Both conflict and cooperation exist, nonetheless, and often simultaneously.

The paradox is explained by two phenomena: a) misunderstandings of the term "conflict", and b) a narrow focus and simplifed analysis of a very broad and complex subject. By re-establishing the definition of "conflict" as 'a situation in which competing actors have different interests that they are prepared to aggress for or defend' and recognizing the inherent different intensities therein, this paper stresses the distinction between conflict and war, and presents a conflict framework which helps to understand the distinction, and to classify different types of conflict.

The limiting effects of a narrow focus are examined through a range of theories. Regime Theory coupled with the analysis of the effects of dissimilar levels of development reveal how internal and international conflicts lead Israel to maintain its hegemonic position and corresponding "hydraulic supremacy". Realist politics has shown that cooperation over 'low political' issues (such as water) has limited influence over 'higher political' issues (such as land) over which the competitors are savagely fighting. Security Studies theory reveals a vast asymmetry in power relations, and the resultant set of tools available to Israel to maintain its 'hydraulical hegemon' position. An examination of the dynamics active at the Joint Water Committee established for the joint Palestinian-Israeli management of shared aquifers, reveals that one of the results of this asymmetric containment is that coercion is often viewed as cooperation.

A Theory and Conflict framework illustrates the vast scope of this area of study, particularly under different types of conflict. It is shown that a narrow analytical focus has the polarizing and misleading effect of amplifying either conflict or cooperation on water issues. The clarity shed on the subject by this paper may assist in increasing the cooperation and decreasing the conflict.

Improved access to water: an enemy in disguise?

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This study investigated how improved water supply influence farmers, their land use, and the environment in and around the semi arid, saline Ombuga grassland in central northern Namibia. Due to a growing population, resulting in a continuously escalating demand for land to cultivate in northern Namibia, land for grazing has become scarce. Thus, Ombuga grassland, which is among the rapidly decreasing open access grazing areas in central northern Namibia, has become an increasingly important grazing resource for cattle from all over central northern Namibia.

Both soils and ground water are naturally saline in Ombuga grassland, which makes the area less attractive for crop production and permanent settlement. Even though lack of fresh water was a limiting factor for any utilization of land in the area, Ombuga grassland has been used for livestock grazing at least since the late 1940s. However, before the late 1960s the Ombuga grasslands were sparsely populated by San and Ovahimba semi-nomadic pastoralists (Erkkilä, 2001). The first permanent settlements in and around the Ombuga grasslands were established in 1968 (Christelis & Struckmeier, 2001) centred around hand dug wells. Population numbers were low until the beginning of the 1990s, when a rapid increase led to the present population of approximately 2400 inhabitants, living in about 480 households (NPC, 2002).

In 1992 access to water was improved by the construction of a system of water pipelines into the grasslands. The pipelines provide the northern central parts of Ombuga grassland with fresh water at water points at approximately 5 km intervals.

In November 2004 interviews were conducted with representatives of 16 of the 80 households in Onkani, a village located on the edge of the Ombuga grasslands. The questions focused on past and present states of the environment and changes in environmental conditions in the area and, if changes were noted, what opinions interviewees have about causes and effects of these changes. Emphasis was put on clarifying how the improved supply of water in the form of the pipeline providing fresh water to the area has influenced the pattern of agricultural activities and the economy of the households.

Our results show that all interviewees moved to the area in recent time, i.e. a majority of the respondents arrived in the area after 1970. All respondents stated that they migrated from the more densely populated areas north of the Ombuga grasslands. The most common reason for moving to the Ombuga grasslands was to find grazing for the livestock and land to cultivate. This indicates increasing population pressure in the areas surrounding the Ombuga grasslands forcing people to migrate to less populated areas, further into the grasslands where they can find sufficient grazing for their livestock and land for crop fields.

When interviewees were asked about the past environmental conditions in the area they stated that there were high abundance of tall grasses, tall trees and shrubs in the past. There were few homesteads, few livestock and plenty of wildlife. The access to mopane worms and other veld foods were better in the past. Some of the respondents stated that the rainfall was better in the past.

All interviewees were asked what natural resources they depend on for their subsistence. On this question all respondents answered that they depend on water, crop fields, grazing and fire wood. Veld food used for own consumption and to produce traditional medicines for livestock was regarded to be an important resource by a minority of the interviewees, while a majority of the respondents stated that they don't need veld food for their own consumption or for treating livestock, as they can buy what they need.

On the question if they have noticed any changes in the quality or access to the resources all interviewees stated that they have observed changes since they came to the area. The most significant negative change is a negative change in quality and availability of grazing. Respondents stated that the grasses are not as abundant as they were in the past. It was also said that grasses have a lower quality now compared to the past 'grasses are not as strong as they used to be…'. Some farmers have noticed a shift in grass species composition. Palatable perennial grasses, e.g. *Panicum maximum* (Jacq.) and *Schmidtia pappophorides*

(Steudel), have decreased or completely disappeared from the area, being replaced by less palatable perennial grasses, palatable and unpalatable annual grasses and weeds.

When asked about the causes of these observed changes the farmers responded that increased number of livestock in the Ombuga grasslands, with consequent higher grazing pressure, is the most important cause of land degradation. According to the interviewees the number of livestock has increased dramatically since 1990 in response to construction of the fresh water pipeline. The number of cattle posts has also increased in recent years. Several respondents stated that people from all-over northern Namibia and even Angola are now establishing cattle posts in the Ombuga grasslands.

According to the interviewees, the pipeline has given farmers and cattle owners in the Ombuga grasslands better access to fresh water, both for human and livestock consumption. In the past settled farmers and herders had to depend on hand dug wells and rain water collected in shallow depressions in the veld. These water sources provided water of generally low quality and were less reliable, and did often not hold water for the entire year. On the negative side the interviewed villagers stated that when availability of water no longer limited access, large numbers of livestock were brought into the area from other parts of the region. This resulted in numerous new cattle posts being established close to water points. Many of these cattle posts gradually turned into permanent homesteads surrounded by crop fields, which in turn has led to movement of cattle posts southwards, deeper into the Ombuga grassland. The respondents stated that, according to their opinions, the quality of grasses along the pipeline has decreased due to overgrazing. These changes were observed as far as 10 km from the watering points.

The findings of this study, based on farmer's perceptions, emphasize the contradiction in development efforts, in this case exemplified by improved supply of fresh water. Farmers/cattle owners admit that the primary goal, to improve the access to water for the inhabitants of the area, was met. However, the overall situation for households does not seem to have improved but has rather become worse as they now experience tough competition for the grass resources. In response to the grazing pressure along the pipeline, they are now forced to move their cattle to areas not reached by the pipeline, where they again have to depend on traditional less reliable water sources.

Workshop 7:

Approaches To Mitigate Land Degradation and Gully Erosion

Sediment yield and catchments scale erosion in the Ebro Basin from Holocene valley incision and sedimentation in Roman and present-day reservoirs

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In Spain, gullies are considered as the main sediment source responsible for the rapid siltation of reservoirs. Gullies present the most conspicuous erosion forms in the Mediterranean region. Land use and land use change within the cachment have a clear impact in gully erosion. Erosion and sedimentation links in fluvial systems are not fully integrated. This research will directly contribute to this research focus by the specific analysis of environmentally well constrained fluvial and colluvial sediments from small to medium catchments, in semi arid environments.

Focusing on catchment-scale erosion, temporal variability within the last centuries, sediment accumulation and storage loss in reservoirs of the central Ebro basin is studied. The area of study is located in the right margin of the central Ebro basin, South of Zaragoza and comprises two sub-catchments of the Ebro basin, the Huerva and the Aguas Vivas basins. Roman and present-day reservoir within the Huerva and Aguasvivas river, South of Zaragoza were selected in base of previous erosion rates investigations and the presence of several reservoirs building in both catchments since Romans times until the half of the XX century.

The Ebro basin was infilled in the Tertiary period with rocks correspond to fluvial and lacustrine clastics, evaporitic and carbonate facies. Holocene silt deposits have covered the slopes and the infilled valleys. There are at least two main accumulation periods (Subboreal-Subatlantic transition and Little Ice Age) separated from another two incision stages (Middle Age and Post-Little Ice Age), have been dated from archeological methods (Peña et al., 1996). A complex of terraces and glacis system represents the Quaternary deposits. Mediterranean continental climate is characteristics in the Ebro River basin, with a clear semiarid degradation in the centre of the basin. The mean annual precipitation is below 300 mm. Rainfall has a great interannual irregularity, with marked incidence of storm precipitations in spring and autumn. Temperatures have a seasonal contrast, with an annual mean of 15º and a mean annual oscillation of 18º. High temperature rise the 40° in summer. Erosion rates from gullies have been taking from more than 10 year at several sites closed to the Maria de Huerva (South of Zaragoza) village, using experimental plots and aerial photographs that have been taken by with air-balloons cameras sediment yield was calculated in 26,700 tnkm-2year-1. This gully incision in the Holocene sediments was extensively used during Roman times was produced after land abandoned in the beginning of the last century. At these sites, identification of sediment storage was estimated using GPR, and mapping and photos taken directly form the exposed gully and different values of sediment yield from Holocene times until the present, were calculated.

Previous surveys of sediment yield rates applied by the CEDEX in 20 reservoirs located in the Central Ebro basin shown a variation form 8 to 1,044 tnkm-2year-1. Besides the sediment yield values provided by CEDEX for the Las Torcas and Moneva reservoir sediment Additional surveys were applied in the unsurveyed reservoirs of Mezalocha and Almochuel using aerial photographs comparison from different periods of time. In the Roman reservoir of Almonacid de la Cuba erosion rates from different period of times were estimated using previous bathymetric data, obtaining sediment yield values between 8 and 56 tnkm-2year-1 from period between 14 year bC and 174 year aC. In the Roman reservoir of Muel, GPR and VES was applied in order to obtain the batimetric map of the reservoir, sediment cores from the reservoir was used to obtain dating using 14C, paleomagnetic and palinological methods. Applying GPR technique was able to calculate the bathymetry of the Roman reservoir and selected the place for coring and dating, finally allowing estimation of the sedimentation rate during Roman times; this was the first application of this technique in this kind of palaeo environment.

Besides the variability in sediment yield obtained from Holocene times, sediment cores and gully evolution will provided interesting information about climate and land use changes in the selected catchments.

Erosion Control and a Sustainable Environment: Scaling up livelihood approaches in Ebo ItuMbonuso

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African Youth Movement [AYM]

Presentation of Topic and Analysis of issue: Ebo ItuMbonuso is a densely-forested region but this green land is becoming unsuitable for cultivation and dangerous for human habitation. People are scared of what the erosion will do this year. Gully erosion, a product of human activities such as deforestation, unsustainable farming practices, path and road construction, and poorly constructed drainage systems, takes place when wear-and-tear on the surface land causes rainwater to accumulate in one area, causing loss of vegetation cover, localized erosion, and the formation of gullies. The resulting run-off from the hillsides pollutes the water supply, while landslides threaten villages and highway travelers affecting the incomes and livelihood of the people. Other causes of gully erosion were social in nature — and were best addressed through public outreach campaigns that actively involve rural villages, farmers, and herdsmen in the remedy since cultivating crops can create gullies if the small mounds of soil typically used to trap rainwater for infiltration around the crops are not adequate for the volume of rain.

Revival of traditional knowledge such as building terraced plots helped ensure that agriculture does not degrade the slope. Footpaths built alongside these terraces also improve the situation, if they follow the natural contours of the landscape. In addition, erosion was halted by harvesting rainwater from the roofs of houses, and restoring the traditional mud and tree-branch barriers, which villagers once constructed to contain rainfall in the forest. The villager's plant trees and bamboo, dig catch pits, grows grasses and construct weak unlined drains. The approach involves appropriate land use and farm management techniques such as forage production, woodlots, maintaining organic matter, manure applications and legume plow down, reduce tillage and direct seeding, conservation fallow and grassed waterways. We conducted systematic assessment of what enables people to cope with, recover from and adapt to risks and adversities - at household and community level [Knowledge management output], New institutional strategies and cross-sectoral coalitions were required to boost the resilience of local livelihoods in the face of multi-dimensional risks [Rapid-Response-Squad] and Good governance and income generation strategies were essential to create the environment in which more resilient communities can thrive [Skill Acquisition Support Centres].

Discussion of Result/Findings: Local knowledge has it that modifying tillage practices to keep crop residue on the surface can greatly reduce erosion. A crop residue cover also conserves soil moisture and improves soil tilth and fertility for better crop production. Traditionally, costs incurred for conservation tillage systems are usually similar to or lower than costs for conventional tillage systems over the long term. Preventing soil erosion helps to ensure the sustainability of the farm operation.

This project shifts the focus from what people lack towards what actions they took to survive crisis, what their priorities were and how to build on what was already there. It analyses the strengths, skills and resources available within communities and complements efforts on ownership geared towards attaining environmental sustainability, improving livelihoods and attaining the Millennium Development Goals [MDGs]. It shores up the Natural capital (water, land, forests, and minerals), financial assets (savings, income, and credit), Human capital (knowledge, skills, health, education, and physical ability), Social capital (reciprocity, affiliations, trust) and Physical capital [shelter, buildings, water and sanitation, tools, transport, energy and communications.]. It creates community consensus; builds on local skills and knowledge; empower women; provides tangible results to establish authority for future projects; strengthens local livelihoods; finds ways of replicating resilience beyond single communities and integrates risk reduction with development. Through the Rapid Response Squad set up by the villagers, there has been higher income of farmers and quick relocation of threatened villagers as well as community consensus on environmental protection, the hallmark of the project.

Property Tax Credits As A Tool For Watershed Management

Mr. Michael Kinney, USA
Dunn County LCD,
South Fork Hay River Priority Watershed

Presentation of topic and analysis of issue: Excessive soil erosion rates and the associated excess nutrients carried by soil erosion have resulted in significant water quality issues within the United States and elsewhere around the world. Minimizing erosion rates and improving efficiencies of nutrient management cycling is essential for sustaining agricultural production and reducing water quality pollution.

The South Fork Hay River (SFHR) Watershed was selected by the state of Wisconsin in 1993 to become one of the 61 state priority watershed projects in progress since 1978. Staff was hired in late 1994, and a Citizen Advisory Committee (CAC) was formed in 1995. From the very start, the CAC made it clear that they wanted a different kind of project. They wanted a voluntary program with low cost practices. We would later learn from the Wisconsin Department of Natural Resources (WDNR), that from 1991 through 1995, watershed projects were spending 13 times more money on barnyard structures than on all upland practices combined even though watershed plans consistently reported most non-point pollution was coming from upland runoff.

The project format was established to provide tax credits for developing and following a soil conservation plan that meets the tolerable soil loss, "T", and a nutrient management plan on all acres. A payment of \$6/acre for Non-HEL (non-highly erodible land) and \$8/acre for HEL (highly erodible land) cropland is paid only after the practices are in place. Farmers are also required to attend annual nutrient management classes.

Discussion of Results/Findings: The result within the first year was a sign-up totaling 16,333 acres (almost 30% of the available cropland) for nutrient management and updated soil conservation plans all for about \$120,000. In 2004, there were 21,412 acres, or about 46% of the available cropland, under contract for nutrient management plans and soil conservation plans. Funding limits prevented more farmers from participating. By comparison, historical participation levels of all other priority watershed projects did not exceed 20%. Furthermore, this program is on track to save \$4 million of the estimated \$6.5 million projected if we used the traditional watershed format.

Focusing on low cost practices also paid big dividends when addressing phosphorus discharge from barnyards. Under this program, low cost improvements in water quality achieved 100% of the 50% phosphorus reduction goal. And as of 2004, the total cost for addressing 14 of the top 15 barnyard problems was under \$30,000.

The priority watershed concept in Wisconsin is currently being phased out. Many factors lead to the current demise of the watershed concept in Wisconsin. The concept existed for about 25 years and was considered by many other states to be a leader. The author sites several significant factors which lead to this end. First, the program lacked the ability to forecast its fiscal requirements. Secondly, each county held the responsibility to sign contracts with farmers for projects and then eventually install them. Early on, counties adopted the habit of installing large structural practices for two main reasons. One, it was a way to bring state dollars back into the local farm economy. The second reason was the engineering focus of many county employees. Technicians were trained to build things. Low cost upland erosion practices were not a priority compared to the more visual structural practices. There was, however, one overriding factor that was common to all the parties which ensured failure of the program. In simple terms, they ignored the numbers.

Every watershed project went through a lengthy planning process which included an assessment of all non-point source pollution. No matter which part of the state a watershed was located, cropland erosion and its associated phosphorus would account for 75% to 90% of the total non-point sources of pollution. In light of this seemingly obvious fact, the program spent approximately 70% of its cost-share funding on concrete barnyards alone.

Conclusions and Recommendations: Focusing on low cost practices works. Measuring success is difficult but cost-effectiveness is one way. With a state average of 7 lbs of phosphorus per ton of soil loss, assuming a low soil loss reduction improvement of only .10 tons/acre, the cost is about $7 per lb of phosphorus reduced. Compare this to most barnyard projects which spent $200 to $300 per lb of reduced phosphorus.

Participation rate and overall cost are two other ways to measure success. We are approaching 50% of available cropland and farmers enrolled in the program as compared to a state average of 18% to 20% for 60 other watersheds. And cost wise, we expect to save 4 million dollars compared to a traditional project.

Another measurement of effectiveness is landowner awareness. Though difficult to measure, most farmers now see their farm as part of a watershed and that their practices impact water quality. Most are using less fertilizer and employing more conservation practices beyond what was required. But most importantly, most are still farming. As demonstrated by the Land Care program in Australia, watershed approaches to resource management works. As conservation professionals, we need to do what is best for the resource. In the end, we may just find that the best thing for the resource is also the best thing for the farmer, who owns the land and is by default the actual resource manager.

Managing Landscapes for Livelihoods

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Throughout basins, people and their livelihoods are connected by water. The negative impacts of land degradation are therefore felt throughout watersheds and basins as degradation undermines the quality and quantity of available water throughout the landscape. The effects of degraded water quality are well appreciated and can be summarized in two categories: effects on livelihoods and health, and effects on infrastructure. Traditional approaches to the mitigation of land degradation have met with limited success. One cause of this failure is a lack of sensitivity to the food security concerns of farmers when designing soil conservation programs. Land degradation is a very real threat to food security for many of the poorest and most food insecure living in Asia, Africa and Latin America. Another cause of failure is a basic misunderstanding about the causes vs. consequences of land degradation: that erosion is a consequence and not a cause of land degradation.

The mitigation of land degradation is a key entry point to improved water management in the future. Because farmers and pastoralists are the most suitable land and water managers, to achieve a balance between food production, poverty alleviation, and the mitigation of degradation, it is important to provide political environments that are conducive to their participation in positive land husbandry, so as to maintain vibrant rural economies and livelihoods. In this paper, evidence will be presented to support the following recommendations for integrated responses to land degradation:

- *The intensification of smallholder farming systems through the reversal of land degradation is already contributing to increased food security and providing other ecosystem benefits in many localized "bright spots"; further investments in resource conserving agriculture are an important response to all forms of land degradation.*
- *It is essential to link appropriate intervention strategies with specific appropriate technologies, and cross-pollination with local innovation is a rich area for opportunity and generating enthusiasm for possibilities and change.*
- *Management needs to create contextual conditions to allow proactive community action to occur.*
- *A shift in thinking on soil degradation will help to address root causes rather than the symptoms of degradation; especially understanding that all forms of erosion are a consequence of land degradation rather than its cause.*
- *Landscape-level approaches that take into account multiple stakeholders, the connectivity of landscape components, and integrate upstream and downstream concerns, can sustain the productivity, livelihood options and resilience of multi-functional agro-ecosystems.*

Specific needs to support these approaches include: a *greater appreciation of the role of farmers in preserving landscapes*, and investments in increasing their capacity to effectively fulfill this role. *Understanding how landscape mosaics work, and how to manage them*. Riparian zone

Effectiveness of intervention measures applied in mitigating severe soil/gully erosion in tropical areas of Nigeria and the Atlantic coastline

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A comprehensive inventory of soil and gully erosion development in tropical southern Nigeria is conducted. Over 3,000 erosion sites were identified with erosion at various stages of development. 1,200 (40%), of the sites are at the initiation/early stage, 1000 (33%) sites are at quasi-stable/transition stage and 800 (27%) sites are at mature/peneplain stage. Each site is particular and identified by its width, depth, grass/tree cover, and extension/growth pattern. In the study area, erosion is mostly propagated by slope instability and pore water pressure mediated by rainfall. Other natural factors such as excessive runoff and unconsolidated geology are complimented by the man-made factors. The man-made factors are construction-related excavation, deforestation and improper channelization. Poor agricultural techniques, road development and quarrying, also cause erosion.

Over grazing, a factor hitherto restricted to the Saharan zone, is becoming significant in the tropical area, as a cause of erosion. The erosion types range from sheet wash, rill, channel to gully types in the hinterland, and from channel, bank and gully types on the coastline of the Atlantic Ocean. Both overland and coastal erosion are essentially destructive, causing loss of soil fertility, washing off of roads and sides of airport runways, unearthing and breaking of water supply pipes, downing of electric poles and collapse of bridges and other buildings. Flooding, pollution and silting-up of surface water resources as well as loss of lives are recorded in erosion prone areas. In addition, collapse of jetties and dockyard facilities occur in coastal areas where bank erosion is common. Intervention measures are applied to mitigate, eliminate erosion or recover eroded areas. The intervention measures are: demarcation of river basins and studies of these basins to define catchments and sub-catchments in order to design and plan appropriate civil engineering and aggroforestry erosion control measures. The civil engineering measures are construction of flood channels, dams, embankments and catch pits. The aggroforestry measures are afforestation, selection and demarcation of grazing lands, adoption of sustainable agricultural practices such as use of hachure, banning of bush burning, use of rotation farming, reclamation of badlands and development of wetland.

Control measures also involve enactment of legislations to establish and empower environmental protection agencies at state and national levels. Statutes are devised by village and town organisations, local charities and non-governmental organisations (NGO) that act as environment vanguards. Other intervention measures are increase in environmental education through seminars and workshops, as well as capacity building by informal and formal training of environmental scientists, engineers, community workers and opinion leaders. While the magnitude of erosion in the study area is high, funding of the intervention measures is abysmally poor. Funds are raised from individual contributions, fines, donation from local charities, town unions and meager budget allocations from local, state and federal governments. Due to the poor funding, intervention measures have been less successful. The measures are haphazardly developed and poorly executed. There is great need for international donor agencies and governments to participate in solving this emergent environmental disaster. Donor organisations could contribute in areas of manpower development, education, and funding of regional-scale study of the erosion as well as the application of mitigation measures. To ensure effective use of funds, donor organisations should form partnership with local charities, organisations and governments in order that funds are used specific projects.

Soil Bioengineering combined with riparian vegetation restoration in the Lower São Francisco River, northeastern Brazil

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The São Francisco River Basin performs a territory in part of the Southeast and Northeast Brazil, with an enormous social, economic and environmental importance because of the multiple uses of water resouces and the richness in biodiversity .Its water resources are important to human consumption, energy generation, irrigation, agro-industries and incipient touristy activities. Since the nineteenth century these water resources have been exploited with lack of adequate planning, integrated Water Resources Management and environmental conservation. In the second half of the last century strong pressure toward the natural resources have been developed bringing all sorts of impacts. In the state of Sergipe, the So-called Atlantic rain forest, which includes part of the riparian remnants, is characterized, mostly by secondary forest. Most of the riparian vegetation remnants are an extension of the Atlantic rain forest, that used to cover 100 million hectares in the Brazilian Atlantic Coast, now reduced to isolated patches. Currently these fragments are still exposed to predatory exploitation, caused by fire, wood extraction and cattle grazing, even though they are considered “protected by law”.

Since the construction and operation of large dams which regulate the river stream, in this important river basin, the third largest in Brazil (GIWA Subregional 40A), a new morphodynamical behavior was established mostly responsible for the fast and progressive riverbank erosion, jeopardizing the flora and fauna. Landslides and sediment transport throughout the river stream toward an ascending sedimentation, also provoked by margin deforestation have contributed to major environmental impacts bringing problems to navigation and fishery activities. Because of the very low cohesion forces of the soil particles in the bank, there is an urgent need of riverbank stabilization along the river margin. Strong species that withstand the waves present in the river are needed to reduce the constant landslides that are mainly responsible for the river sedimentation and also loss of productive lands dominated by soils predominantly alluvial such as haplustult and ustifluvent. These soils are characterized by variations in resistance to soil rupture, both vertically and horizontally. A remarkable disturbance in the major extension of the riparian ecosystem along the river margin has led to riverbank destabilization, strong erosion and stream lateral migration and sedimentation, reflected directly in the numbers of sand bars.

Mitigation has been claimed in order to stabilize the strong river sedimentation and recovery the biodiversity, both important to avoid more environmental degradation and guarantee the livelihood of the native riverine population.

Soil Bioengineering techniques using prefabricated coconut fiber rolls (flexible “logs” made from coconut hull fibers), have been conducted in order to stabilize slopes, controlling landslides and consequently bank erosion. This technique provides temporary protection while the plant growth becomes established helping to recover the biodiversity in a severely degraded Atlantic rainforest remnant, with adequate species for this type of work such Erytrina velutina, Tapirira guianensis, Mimosa caesalpiniaefolia, Bowdichia virgilioides, Cedrela fissilis and Enterolobium contortisiliquum. Associated to the riparian vegetation restoration, through root reinforcement, bioengineering transfers shear stress in the soil to tensile resistance in the roots. Coconut plant (Cocos nucifera) is very common in all over the lower São Francisco, and the manufacturing of this river bank protection (mat) with natural fiber by the riverine population, also creates a urgent necessary source of income, and at the same time protecting the river channel of a serious and continuing sedimentation, which brings negative consequences to the biodiversity of the whole ecosystem. This approach supports the ongoing policies of the Revitalization Program of the São Francisco River Basin, supporting the idea of a river as an ecosystem.

Integrated Approach for Land and Water Resources Management Using Remote Sensing and GIS

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The increasing population growth is continuing to exert extra pressure on existing natural resources all over the world. An imperative need for the development and judicious use of these resources is therefore essential for sustainable development of a region. India is a semi-arid region facing a severe stress of increasing population followed by unplanned utilization and management of natural resources. Out of 4000 billion cubic meters of rainfall received annually in southern India, 41% is lost as evaporation and transpiration, 40% lost as runoff into seas and 10% seeps in for recharging groundwater. Proper planning and management of this run-off water is essential for effective management of water resources and decreased soil erosion. Keeping this in view, comprehensive evaluation and integrated management study has been carried out for Shivannagudem watershed of Andhra Pradesh in southern India with the aim of increasing recharge and sustainable use of water resources, decreased soil erosion and increased moisture conservation. Remote sensing and Geographical Information System (GIS), which play an important role in providing quick and accurate information about watershed characteristics, have been efficiently used for water resources management in the given study.

Since the main objective is to generate an action plan map for land and water resources development, the study involves the preparation of various thematic layers on 1:25,000 scale through visual interpretation of IRS-1D, PAN and LISS-III fused satellite data, SOI toposheet along with collection of collateral data and other field data. These maps are converted to digital format using AutoCAD software, processed using ERDAS and further integrated using Arc/Info and Arc View GIS software for the preparation of final action plan maps for water and land resources development. An action plan is generated which is optimally suitable to the terrain so that the level of production is sustained without decline over time. Various water resources development and management techniques, soil and water conservation measures and optimal cropping patterns are suggested for the overall sustainable economic development of the watershed. Three check dams are recommended to regulate the surface water flow thereby increasing its influence over the command area and the ground water levels. Percolation tank is recommended across the major streams considering the stream overflow and area criteria to distribute the groundwater recharge over large area and to have assured augmented water. Action plan for land resources development, suggests suitable cropping patterns in different parts of the watershed which help in reduced soil erosion, increased moisture conservation and improved productivity of the soil. All the above conclusions aim for optimum development of land and water resources and to meet the basic minimum needs of people thereby improving their socio-economic conditions. The information generated from such studies can be applied by decision makers for sustainable development of any given watershed area.

Water harvesting, land rehabilitation and poverty reduction in the Sahel

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A new multi-donor funded study will start in some Sahel countries in the second half of 2005. A key working hypothesis of this study is that the multiple impacts of investments in natural resource management (NRM) in the Sahel have been underestimated. This study will re-visit most of the 21 cases included in a landmark study published 16 years ago, called "Le Sahel en Lutte contre la Désertification: leçons d'expérience" (Rochette et al., 1989). Besides this, the study will include NRM experience which has emerged since the end of the 1980s.

The optimistic working hypothesis is amongst others based on the outcome of an earlier study undertaken on the northern part of the Central Plateau of Burkina Faso, which looked at longer-term trends in agriculture and environment (Reij and Thiombiano, 2003) . Around 1980 the economic and environmental situation in this region was dramatic due to low and decreasing cereal yields, expansion of agriculture over lands marginal to agriculture, frequent droughts and structural food shortages, rapidly falling groundwater levels (about 1 m/year), declining forest resources and no regeneration of important species such as Faidherbia albida, karité (Butyrospermum parkii??), baobab (Adansonia digitata) as well as disappearance of perennial grasses (Andropogon gayanus). Not surprisingly many families left the region and migrated to regions with higher rainfall and less pressure on the land.

This crisis triggered several reactions. One from some farmers, who began experimenting with traditional land and water management techniques, which led to the improvement of traditional planting pits or zaï, a water harvesting technique used to rehabilitate strongly degraded land. Besides this NGO staff began testing water harvesting techniques, which produced contour stone bunds as well as level permeable rock dams. The latter technique is used to rehabilitate gullies. Whereas the Yatenga region in Burkina Faso presented in the 1960s and 1970s an anomaly to the Boserup hypothesis that increasing population densities induce farmers to intensify land use, the new water harvesting techniques suddenly allowed farmers to rehabilitate strongly degraded land and to improve soil fertility management.

The study on the northern part of the Central Plateau shows that more than 100,000 hectares of land have been treated with water harvesting techniques, mainly since the middle of the 1980s. Average cereal yields have increased by 50% to 60% since 1985-88, whereas the assumption was that cereal yields would decline due to depletion of already low soil fertility levels. More trees are found on cultivated fields now than 15 years ago . In the 1970s and early 1980s cultivation of lands on the middle and upper parts of low slopes (glacis) was abandoned and shifted as much as possible to lower parts of the slopes and to valley bottom land (bas-fonds) (Stoop and Vierich, 1990). Since the introduction of water harvesting techniques, cultivation has moved back to higher parts of the slopes. This process started around the middle of the 1980s. In many villages water levels in wells have increased substantially (5m of more). Although part of this can be attributed to increased rainfall in the 1990s, there is little doubt that there is a causal relationship between the introduction of water harvesting techniques and local improvements in groundwater levels. In villages which used to see all their wells fall dry at the end of the rainy season, water levels improved immediately after lands were managed with water harvesting techniques. This process occurred also during the drought years in the first half of the 1980s.

Between 1975 and 1985, the village of Ranawa (Zondoma province) lost about 25% of its population due to strong outmigration. Its wells had no water and large tracts of land were degraded. In 1984/85 an NGO intervened and contour stone bunds and improved traditional planting pits were introduced in the village. Since then about 600 ha of land has been treated (recapitalization). All wells now have water and small vegetable gardens have been created around some of the wells. Even cotton has been introduced on a small scale. Since 1985 not a single family has left the village and it has seen its population more than double between 1985 and 1996, which is partially due to a return migration. The perception of the villagers is that many families are less poor than in 1985. Their main criterium for defining poverty is related to the levels of household food security.

Because household food security has improved, many families are less dependent on the market for buying cereals to make up for deficits. As a result many families invest more in livestock and the management of livestock shows a beginning transition from extensive to semi-intensive. This means that more manure is now available for maintaining soil fertility.

A recent small pilot study in the Tahoua department shows large-scale rehabilitation of degraded land since the middle of the 1980s . The accent has mainly been on mechanized bund construction on degraded plateaus. However, an IFAD-funded project decided to promote simple low-cost water harvesting techniques, and in particular improved traditional planting pits, which were popular and efficient on parts of the Central Plateau of Burkina, as well as half moons. The planting pits quickly became popular and contributed to the emergence of a land market, in which farmers and traders started buying and selling strongly degraded land for rehabilitation. Also in this part of Niger villagers indicate environmental improvements (rehabilitation of degraded lands, more trees now than 15 - 20 years ago), improved food security and better nutrition, local improvements of groundwater levels (in the village of Batodi from – 18 m in 1994 to -4 m in 2004) and an expansion of land under hand irrigation and/or crops grown on residual soil moisture in the dry season (in particular where water spreading dams have been constructed in valleys).

One surprising feature in Niger is the large-scale farmer managed natural regeneration of vegetation, which may concern about 2 million hectares. This process seems to have started in the Maradi department in the middle of the 1980s and has subsequently spread to other regions. Fields which used to have a few trees, now have 60, 80 or even up to 150 trees/ha. This has led to more complex production systems.

An important challenge is to express the multiple impacts of public and private (farmer) investments in natural resource management in monetary terms.

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Mitigation Factors for Ecological Disasters of Gully Erosion and Landslides in Southeast Nigeria: The Role of the National Assembly in Governance

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The Federal Republic of Nigeria is made of thirty-six States that are grouped into six geopolitical Zones of which the Southeast Zone is one. This Zone is made up of five semi-autonomous States that include Enugu, Ebonyi, Anambra, Imo and Abia. Even though flood disasters, soil and gully erosion and landslides occur in different parts of the country such as in the western and middle-belt regions, these severe ecological problems are more endemic and most destructive in the Southeast. It is generally-recognized in Nigeria that the 'epicentre' of ecological hazards may be located at Enugu, Anambra, Imo and Abia States where gullies and landslides have wreaked the greatest unimaginable havoc to the environment. While destructions of life and infrastructure may occur during the months of dry season, the rainy season of the months of April to October, annually, causes great and severely-destructive floods, soil and gully erosion and landslides.

During the flooding, soil outwash/leaching, gullying and landslides, human and animal lives are lost. Lands are moved away down-slope into the valley en mass. Forests and trees are uprooted and thrown away. Human dwellings, churches, infrastructure and utilities such as water schemes, telephone lines, electricity etc. are destroyed in urban and rural areas. Industries, markets, schools, open spaces etc. are damaged; surface waters such as springs, streams, lakes and rivers are impaired; agricultural lands and wetlands are silted up or rendered useless. In these States such as Anambra, over two hundred and fifty families have lost their compounds and houses that have been swallowed by gullies. They are forced by gullies to relocate elsewhere where they are now refugees in their country. The overall ecological malaise is most debilitating and indescribably-horrifying.

The Federal Republic of Nigeria, once more, embraced democratic governance in 1999 when power was wrenched out of the hands of a decadent military junta that held the country hostage in a military dictatorship for many years. During those periods that spanned many wasted years, affairs of governance suffered extreme destruction and decay. Our total environment was not left out of the malaise. Gully erosion and landslides were not properly-challenged and handled. A Federal Environmental Protection Agency (FEPA) was set up and a lot of funds were approved and released for tackling ecological problems. Some foreign governments and aid agencies gave grants-in-aid to support mitigation projects. Unfortunately, the impacts of the efforts of the military in combating ecological problems are not felt today. The civilian governance wants to change all that.

In August 2004, I presented a heart-rending report to fellow Senators at the Senate Chambers in the National Assembly. I gave a detailed treatise of the havoc being perpetuated by gully erosion and landslides in the Southeast Zone of Nigeria. As a short-term measure, a Committee of the Senate under my humble Chairmanship was set up to work in close collaboration with other members of the National Assembly. We went on a field and study tour of the gully erosion sites in the Southeast Zone. The Committee was mandated to prepare a Report of its Findings in other to recommend suggestions to mitigate the gully erosion problems. The report has since been submitted and actions for interim/short-term amelioration measures as to be demanded by the Senate are awaited.

The FEPA Decree dictated by the military government has been abrogated. The new Federal Ministry of Environment was established by this present civilian government in the year, 1999. This Ministry is being strengthened and will be equally-better funded in order to provide the required leadership in successfully-handling the ecological problems of Nigeria including those of the Southeast Zone. The Senate and the House of Representatives will also look at the presently-existing Legislation, Bills and Laws on ecological issues of the Nigerian environment in order to fish out any weaknesses, shortcomings and anomalies and amend them. After each of the Units of the National Assembly must have debated the arising issues and suggesting changes, amendments and solutions, a joint Session of the two legislative houses would come out with a joint Bill for the assent and signatory of the President.

The government of the Federal Republic of Nigeria together with the composite States and Local Government Areas has always welcomed good material and financial support from friendly nations and aid agencies to assist the people to tackle their ecological problems. These problems in the Southeast Zone and beyond have defied efforts at mitigation. Different governments of Nigeria have spent billions of Naira and tried to tackle the problems but to no avail. Also, millions of dollars have been provided, over the years, by friendly countries and other donor agencies in order to assist us in setting up civil-engineered and agro-forestry control programmes. The financial weight in tackling and controlling the gullies is much more than the resources of the different governments can afford if other socioeconomic needs of the people are to be equally-considered and met somehow. Our government officials will be ready to enter into genuine negotiations with donors for more aid. Efforts are, now, also being made to sensitize and educate the populace and political activists to create public awareness in understanding and tackling erosion to ingrain in them self-help measures and empowerment as the case may be.

Costs and Benefits of Land Degrading Activities versus Sustainable Land (and Water) Management, SLM

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The project: Within the framework of a World Bank project to develop a methodology for assessing economic costs of land degradation and the economic benefits of a Sustainable Land Management system, SLM, the project group (Gunilla Björklund, Uppsala, teamleader; Anna Brismar, Stockholm; Carl Christiansson, Stockholm University; Patrik Klintenberg, Windhoek Namibia; Jan Rudengren, SPM Stockholm; and Dan Vadnjal, SPM Rome) assessed different steps leading to such a decision framework. Each step includes the application of different methodologies. And together they compose a planning process that would result in a more sustainable and less degraded land use strategy, at national, local and land user's level.

Project development and results: As an initial step such a process should identify "hot spots", areas where driving forces including unsustainable land use activities are resulting in land degradation such as soil fertility loss, increased erosion and sediment load in water bodies, salinisation, etc. As the process should be applied to national as well as local and land user's level such identification needs to be done by applying methods for national-level as well as field-level environmental baseline assessment. An emphasis should be on assessing existing environmental resources at stake.

By engaging concerned stakeholders in the environmental baseline assessment including the socio-economic aspects, it would be possible to estimate the baseline economic benefits. Non-market goods and services provided by the natural resources make up such economic benefits. They need to be calculated by different types of methods. And by applying an Environmental Impact Assessment, in which socio-economic impact aspects of course are integrated, effects of land degrading processes are identified.

An important aspect that needs to be calculated at this step is to predict potential significant environmental impacts of future land use activities and how they may arise. Applicable methods are causal chain analysis/systems analysis, scenario analysis and different kinds of modelling.

A decision framework in the process to divert from Business-as-Usual to Sustainable Land Management needs to include measures at national as well as at local level. This means that stakeholders at all levels need to be involved. At the local level there is a need to convince the local stakeholder that the benefits of a certain mitigation measure is higher than the cost associated with not undertaking any measures or with the costs of the measure itself.

At national level a decision framework would, according to what is suggested by the group, be based upon National Resources Accounting, NRA. By including the value of non-market goods and services into a System of National Accounts upon which estimates of GDP are based it would be possible to understand trade-offs between economic developments and environmental goals. The principles behind NRA can form the bases for the decision framework for accounting the costs and benefits of land degradation and Sustainable Land Management.

Based on this, policy and strategy options need to be analysed, including by using different types of analysis to identify barriers for accepting and adjusting to the economic net benefits of a Sustainable Land Management system. Barriers that need to be considered at national level are inter alia political and legal framework barriers, economic barriers, institutional barriers, social barriers, and inadequate national management systems or lack of information systems. At local and land user's level the barriers may include: barriers related to information problems, barriers related to lack of local access to required financial resources, barriers related to social and cultural aspects, and barrier related to management, land tenure and access to markets.

Strategies to overcome such barriers include, first of all, promotion of a political framework and a legal system that is conducive to implementing Sustainable Land Management, SLM. The governments having ratified the UN Convention to Combat Desertification should ensure this. An important strategy is to ensure the governments' awareness of the national economic benefits of SLM as well as the long-term economic costs of refrain from investing in SLM. At national as well as at local and at land users' level capacity enhancement, awareness building and stakeholder participation are key strategies to overcome any barriers. Economic policy reforms and market regulations are other important strategies, in particularly at land user's level.

Conclusion: Any decision framework aiming at mitigating soil erosion and land degradation, including its environmental, social and economic impacts, and promoting sustainable land and water environment through SLM needs to include measures for assessing, calculating, and evaluating impacts of the degrading processes, including erosion. Such a framework needs further to propose alternate, more sustainable less land degrading systems. To be successful such a decision framework needs to suggest strategies and options to overcome barriers towards promoting a sustainable land and water system. One strategy may be to demonstrate the net economic benefit by a national transfer to a sustainable land management system, as described under the project.

Soil Erosion, and Its Impact on Agricultural Land Use Systems: A Case of Desertified Region

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Introduction
The present paper deals with erosion, its impact on agricultural land and mitigation methods for sustainable agricultural development of Thevaram Basin, Tamil Nadu, India.

Soil erosion by water and wind are the major processes of desertification and affect the social and economic status of farming community in the region.

Soil erosion is a natural process, but its rate has been greatly accelerated by human activity. The soil has been completely removed in some pockets. Accelerated soil erosion has been going on since vegetation cover were first cleared for agriculture and other purposes, a process, which began about 40 years before. Erosion lead to a destruction of agriculture and reversed at high cost, by importing new topsoil or complete re-landscaping of the terrain. In shallow soil, erosion leads to complete removal of the soil and exposure of bedrock and in deep soil the rills grow into gullies, which are too deep to plough over, and break fields into inconvenient fragments. Soil is also eroded from the areas between rills and gullies, removing the topsoil, which has the best structure, and most of the organic matter and nutrients. Erosion removes the most fertile topsoil, which holds very good organic matter and nutrients, and farmers incur costs for remedial cultivation and additional fertilizers. Eroded material re-deposited in buildings, roads, farmlands and water bodies.

Methodology
To assess the erosion problem, data related to Slope, rainfall, temperature, wind speed and direction, soil, crop conditions and water availability, land use have been collected t and assessed the different land qualities. Impact assessment has been carried out on the basis of land-use type, geomorphology, slope, demographics and existing infrastructure, intensity and areal extent, and its effect on agricultural yield, socio economic status, water quantity and quality, and building subsidence.

Result and Conclusion
Due to improper way of land management and forest cutting the following major impacts have been occurred in the region

- Economic Impacts: Losses in yields in both crop and livestock production,. Reduced income for farmers and leads unemployment,

- Environmental Impacts: Damages to plant and animal species, some times forest fires, degradation of land, loss of biodiversity.

- Social Impacts: Conflicts between water users, Low quality of life. Seasonal migration to other areas within the stressed area, or to regions outside the effected area. When the wind action has abated, the migrants seldom return home. The migrants place increasing pressure on the social infrastructure of the other areas, leading to increased poverty and social unrest.

The most cost-effective way of doing erosion control is by changing the land use and land cover, although a major role can be also played by conservation measures such as Shelter belts, wind breaks, or addition of a mulch layer, contour ploughing, field terracing and inter-cropping.

Vegetation cover is also the factor, which is most cost-effective, easiest to manage, through choice of land use, within the overall constraint of climate. Conservation measures, such as shelter belts, wind breaks, inter-cropping and terracing also play a part, but only within broader land use strategies, and are most effective at local scales. Action to control erosion requires both assessment and remedial strategies, and effective action requires considerable investment of time and money. Remedial strategies include changes in land use at regional scales, identification of sensitive areas for action at local scales, and detailed conservation planning at farm scales.

This paper aims to encourage the adoption of sustainable resource management practices and control the soil erosion so that the agriculture make a long term contribution to the Thevaram Basin's economic, social and environmental well-being. Over the years the land use has been influenced through regulation and subsidies for various conservation and protection practices. However, times have changed, and it is now over to land holders themselves to think carefully about how they can manage the erosion processes occurring on the land.

From hillslope to landscape scale - Soil erosion and reservoir sedimentation in Burkina Faso

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Soil erosion and reservoir sedimentation are major factors of land degradation in the semi-arid environment of Burkina Faso. Both, the loss of nutrient-rich topsoil from hillslopes and the rapid siltation of small reservoirs cause severe agricultural problems, especially in countries with temporally limited water resources. Therefore it is necessary to monitor on-site and off-site effects of soil erosion simultaneously and to develop new approaches to identify sediment dynamics within a complex system. By knowing the sediment budget of the catchment, sediment flows at different scales can be easier identified and management and control strategies for hillslope and reservoir sites can be better adjusted to required needs.

This research presents an integrated approach to measure sediment budgets of small reservoirs in Burkina Faso, to identify dominant factors influencing soil erosion and sedimentation on different spatial scales and finally to evaluate the impact of on-site and off-site effects of soil erosion on vulnerable landscapes.

The emergent behavior of the complex system is taken into account by following a hierarchical approach, which considers processes at each scale individually, but as contributing components to the whole system. Therefore, the landscape area is subdivided into catchment areas and these catchment areas are further subdivided into hillslope zones, represented by several soil transects. This research design allows insight into scale-dependent dynamics from small to large scale or from pixel to landscape scale.

At hillslope scale, soil profiles along transects are described to obtain information about systematic variations of soil properties. These catenary soil variations are assumed to influence erosion processes due to differences in physical soil properties. A detailed soil survey confirmed a well-developed catenary sequence and could provide information about soil genesis and landscape development.

The redistribution pattern of soil is analyzed by measuring Cs-137 in sediments. This approach presents a possibility to quantify soil losses and gains during the last 30-40 years. Cs-137 samples were taken both from transect along hillslopes and from sediment cores of the reservoir. Although the amount of the radionuclide isotope Cs-137 is comparatively low in West-African environment, results could clearly indicate zones of sediment loss and gain.

At a catchment scale, the sediment storage of three small reservoirs is studied by a bathymetric survey and retrieval of sediment cores. Depth and morphometry of reservoirs are measured by a transportable echo-sounder attached to an inflatable boat; sediment cores are taken across the reservoir using a Beeker-Sampler. By knowing age, size, depth and sediment thickness of reservoirs, sediment input into dams and sediment losses from contribution area could be calculated for a specific time period. Stratification techniques from undisturbed sediment cores allowed reconstructing of ancient accumulation rates. Actual sediment fluxes were monitored by sediment pans and water discharge measurements from the main contributing streams of the reservoirs.

At the landscape scale, remote sensing techniques and aerial photographs are used to extend information from field to larger landscape units. A Digital Elevation Model with a spatial resolution of 15m was generated from Aster-Images using PCI-Geomatics. Land use maps and land cover changes were obtained from unsupervised and supervised classification tools by ERDAS-Imagine. Additionally, ERDAS-Ortho Engine provided the possibility to derive a more detailed description of geomorphometric features from aerial images of each reservoir. In order to store, integrate and analyze spatial information from each scale, Geographic Information Systems (GIS) are used.

This integrated approach assist in analyzing erosion dynamics and sediment patterns on different scales. By knowing the sediment budget of the total catchment area, a better understanding of sediment flows and interaction on individual sub-scales is gained. Using a hierarchical approach, so called "hotspots" of erosion and sedimentation can be easier identified without neglecting important feed-back mechanisms of the whole system. Additionally, management and control strategies can be more effectively adjusted to landscape units in order to mitigate erosion and sedimentation problems, which is highly needed in developing countries facing soil degradation problems.

On the question of salt management of the Amudariya river delta (Aral Sea basin, Karakalpakstan)

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Presentation of topic and analysis of issue: One of the ecological pecularities of Karakalpakstan is the salinity of the soil. Over the last several years, the salinity of the soil has increased and it has had a very negative impact on the environment. The salinity of the soil affects the aggression of ground water and as a result the ground water destroys the foundations of buildings, construction work and underground communications. In addition salinization intensify of soil erosion. The soil cover dies and crop capacity is reduced because of the salinity of the soil.

To solve the problem of salinity and to soften the negative impact on the economy of Republic it is necessary first of all to determine the main factors causing the salinity and to devise methods for diagnosing the changes in the soil's salinity in the region.

One of the known reasons for the salinity of the soil of the Karakalpakstan area is dust storms, which blow salt from the bottom of the Aral Sea to the surrounding area and beyond.. The second reason for salinity is the mineral content of the water that comes from the Amu-Darya River and is used for irrigation purposes. A study showed that a third factor is the migration of salt from the deeper soil layers to the surface through irrigation.

To estimate the impact of the above mentioned factors on the soil's salinization, a special geological investigation was carried out in agricultural fields in the northern part of Karakalpakstan. During that investigation, a special boring machine was used. Holes were bored into the soil 11.7 metres deep. Soil samples were taken from each borehole and the water table was measured. Holes were bored on 15,000 sq. km of agricultural fields.

To estimate the salt concentration in the soil based on the above mentioned three factors it was necessary to calculate the salt content on the territory of the 15,000 sq/ km. The calculations were done on the samples from each borehole and the deepest soil layer was 10 metres.

Presentation of results: The analysis showed that the concentration of salt in the soil depends on the depth of the soil layer. For example, for the soil of 0-0.3 m depth the salt concentration is 5.66 ton/hectar to 777.2 ton/hectar. The average figure for the 44 boreholes was 747 ton/hectar. Based on the data of the salinity of different soil layers, 2 maps were made of the northern part of Karakalpakstan for soil at the 0-0.3 m to 0-10 m depth.

The results of the comparative tests show that one of the factors of soil salinization is the migration of salt from the deeper soil layers to the surface through irrigation. The amount of salt blown by the wind and water was also estimated.

The results of the analysis given in Table 1 show that the Natural Salt sources are the main sources of salt. At the same time the soil salinization may increase through irrigation and as a result, migration of salt from the deeper soil layers to the surface may occur. The figures of salt amounts which come from mineralized water from the river are quite impressive; 6 to 24 million tons a year.

Table 1

	Salinity components	Amount of salt per million tons for 15,000 sq. km	Amount of salt per thousand tons per hectar
1	Natural salt sources (data for 1994)		
	for 0-0.3 m depth	160	0.107
	for 0-10 m depth	1120	0.747
2	Salt which comes through irrigation (depending on the water volume – about 4-8 cu. km per year)		
	mineralization of water is about 1.5 gram/litre	6-12	0.004-0.008
	mineralization of water is about 3 gram/litre	12-24	0.008-0.016
3	Dust and salt migration from the bottom of the Aral Sea. Kosnazarov and Razakov (1991)	0.225-0.450	0.00015-0.0003

The smallest contributor to total salinization is the migration of salt from the bottom of the Aral Sea through wind, but this factor will become dominant over the next few years.

The following mathematical formula is given to predict soil salinization:

$$S = \int_v \int_t [W(v, t) + U(v, t) + D(v, t) - Y(v, t)] \, dtdv \quad (1)$$

Where $W(v, t)$ is a function showing the salinization of the soil through the use of mineralized water
$U(v, t)$ is a function of salt migration from the deeper soil layers to the surface
$D(v, t)$ is a function of salt migration from the bottom of the Aral Sea
$Y(v, t)$ is a function of the desalinization of the soil
v - is space, and t - is time
The type of $W(v, t)$, $U(v, t)$, $D(v, t)$ and $Y(v, t)$ may be determined by tests.

Calculating the salt concentration by using a given formula may give us an opportunity to determine the salinization of the soil. To estimate the salinity of soil it is advisable to introduce the concept of Ecological Reserve. Ecological Reserve can be calculated by using the following formula:

$$R = S(\lim) - S \qquad (2)$$

Where S is the amount of salt calculated using formula #1
and $S(\lim)$ is a limit in the amount of salt in the soil

Conclusions:

- The results of the comparative tests show that one of the factors of soil salinization is the migration of salt from the deeper soil layers to the surface through irrigation.
- The results of the investigation show that the salinization of the Amudariya river delta is a result of inefficient water usage.

The results of the investigation show that the salinization of the Amudariya delta occurs due to the irrigation of the Amudariya delta using saline water from the Amudariya river.

Urban and Agriculture Impact on Soil in Australia

Mr. Barry Lewis, Australia

Presentation of Project
Broad scale catchment disturbance has been a feature of the Australian landscape since European settlement. Between 1890 and 1930 the area under agriculture quadrupled and problems associated with land management started to emerge. In response to agricultural and urban expansion a nationwide program of dam and road building commenced in the immediate post World War II period. This resulted in the construction of more than 300 large dams on Australia's major streams with an increase in total storage capacity from 10,000GL in 1940 to over 80,000GL in 1983. As a further protection against drought and to maximise efficient management of stock, farm practices moved towards smaller paddocks and an increase in the number of farm dams. These practices have changed the basic hydrologic behaviour of agricultural catchments. On a national basis this expansion in farm dams has been poorly documented. As a consequence of the widespread harvesting of water on the small and large scale, Australia has the highest water storage per capita in the world. The widespread urbanisation in Australia has caused damage to aquatic ecosystems by eroded soil and other contaminants from construction sites, land subdivisions and areas where soil is exposed. Analysis of Issues Most sediment in Victorian waterways is eroded from the stream banks and from minor drainage lines and gullies. In some parts, particularly areas of intensive cropping and areas where topsoil is very sandy, erosion of hillsides contributes a highly significant proportion of sediment to streams. Water erosion accounts for most of the land degradation in Australia's non-arid zones. Most sediment is derived from stream banks and gullies. Pesticides and fertilisers are more likely to be associated with soil eroded from hillsides than from creek banks. At the time of European settlement, streams and their immediate flood plains could generally accommodate most flows and sediment loads. There are very few direct measurements of soil loss from grazing land in hilly country. Monitoring of suspended sediments in streams has given some indication of the serious nature of the problem. It is estimated that the actual erosion is about five times that measured as suspended sediment in streams. Most is carried as bedload rather than suspended sediment and comes from a number of point sources, i.e. bare ground such as cattle or sheep tracks, roads, landslips, and eroding minor drainage ways.

Remediation of bed and bank erosion, gully erosion, sheet erosion, agro-forestry erosion and construction site erosion will be discussed.

Discussion of Results
There are two issues - erosion and sediment control. Sediment control can be the trapping of water in a sediment trap dam, or the trapping of air borne soil particles by a windbreak. Sediment control is necessary because sediment in runoff is sometimes unavoidable, for example during excavation. Erosion control by stabilising the soil is the preferred approach because it tackles the problem at the source by preventing initiation of the erosion process.
Conclusions and Recommendations
Processes to control soil erosion include -

- Provide Protective Covers: Vegetation or mulch can reduce Erosion rates.
- Reduce Water Velocities: Establishing vegetation, contour slopes, install drop structures.
- Reduce Soil Erodibilities: Simply compacting soil to reduce rates of erosion.
- Increase infiltration: deeply rip or cultivate soil to reduce surface runoff.
- Divert Water Runoffs: Intercept drains, diversion banks or direct to channels or into pipes.
- Reduce Duration of Soil Exposure: minimise the area of exposed soil, or at any one time.

Processes to control sediment in runoff include -

- Lower Water Turbulence: reducing water velocity can result in deposition of sediment.
- Practical Techniques: implementing a suite of 'green engineering' techniques at strategic locations throughout catchment. Techniques include grass swales, bio-retention dams, wetlands and pollutant traps.

- Less Water Runoff Volumes: increasing the infiltration of water into the soil or by increased plant transpiration or evaporation. Infiltration of water can be increased by contour cultivation or ripping of the soil. Establishing vegetation with deep roots increases plant transpiration.
- ·Sediment Filtration: passing muddy water through a material, which has pore spaces smaller than the dimensions of sediment particles. Synthetic membranes or hay bales can be used. Beds of gravel retain fine sediment and are used in the sub-grade along eroded channels with larger rocks at the surface.
- Sediment Flocculation: The addition of filter alum or gypsum to water can result in sediment particles clumping together and falling out of suspension.

The range of solutions includes land use planning, stream bank maintenance, tree planting and improved engineering and farming practices. Soil loss can be minimised on pastured land by pasture improvement and sensible grazing management. In emergency periods, it is better to eat out pastures on soils, which are less vulnerable to erosion, on the flatter parts of the farm, and to protect pastures on more steeply sloping country. As most streambed and bank erosion occurs during flood periods, it is advantageous to prolong the duration of flow, lower the peak flow and maximise the opportunity for infiltration. This can be achieved by using management techniques such as surface water storages, chisel ploughing, deep ripping and pasture improvement over broad areas. The effect of soil detachment by trampling of stock in and near the stream during periods of low flow should not be underestimated. We should become more aware of the natural response of the stream to changes in the water and sediment from the catchment and focus our attention and management there. Applying the techniques discussed can also solve many erosion problems on construction sites.

Western Kamchatka: Economical Activity and Seacoast Erosion

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Western coast of Kamchatka consists of 3 tectonic zones: the northern part is a zone of slow elevation, middle is a stable zone, and the southern is of comparative submergence. Also we should state the negative character of tectonic movements of the Western-Kamchatka trough, adjoining the basin of Okhotsk sea. According to Hershberg, Ryazanzev (1982), the shelf of the south-eastern part of Okhotsk sea submerged during the last 17 thousand years with average speed 1,4 mm/year, what is corroborated by presence of ancient coastlines on the shelf.

Modern downwearingness of the coastal zone of Western Kamchatka, that is the line, graded and slopingly convex into Okhotsk sea direction, is a result of the latest great reconstruction of the seashore, that happened about 7-7,5 thousand years ago in the middle of Holocene. However, this process has not ended yet, that is reflected in the scour of the shores, occurring everywhere.

The main reasons of the deficit of detrital material and the release of waves energy, these leading factors of sea shore destruction in the conditions of Western Kamchatka, are the modern rise of the World Ocean level, excavations of the equilibrium profiles of underwater shore slope, and also the flooding and separation of firths by accumulation forms – spits. A significant role in the formation of the coastline is played by tidal streams with speed up to 2 m/sec. And, another important factor of intensive change (destruction) of the coastline is that the most part of it is build of loose deposits, which easily undergo washout.

So, the basic process on the shores of Western Kamchatka is washout, that is manifested on the low, built of loose deposits, parts of the shore by the overthrust of leveed bank to lagoon even in the negative balance of detrital rocks; and on the high, built of solid rock, parts by formation of active cliffs and wide benches. But directed bed load transport is registered only in the southern part of the coast, near Bolshaya river lagoon, and also to the north of Krutogorovo river. In another parts of the coast, the sand-pebble washing material is poured onto the coastal part of the bar, furthering its transporting to the East, and the delicate fractions of sediments are partially transported to the underwater slope and further on the shelf. So that littoral drifts exist only at the insignificant length of the coast, and total transporting as united and monodirected process in the coastal zone of Western Kamchatka doesn't exist.In the second half of 20th century, economical activity took the principal role in the erosion of the Western Kamchatka sea coast. The researches of the transformation processes of Western Kamchatka coast, that were held in 40th-50th, showed that the speed of destruction of sea spits in the places of location of fish-processing factories and fisherman settlements was 0,5-1,0 m/year. By the end of the century the intensity of anthropogenic activities influence had increased by several times.

And one of the leading causes of destruction of the Western Kamchatka coastline are automobile roads. Firstly, their construction itself was accompanied by destruction of the grass cover, fastening the surface of spits and protecting them from the washout. Secondly, the exploiting of the unfastened road-bed led to the formation of numerous ditches and ruts, which were poured out mainly with the sand and gravel, taken from the body of spits, thus provoking their washout.

For example, during the last 30 years the width of the spit where comes the regional importance road "Nachinkinsky sovkhoz – Ust-Bolsherezk – Oktyabrsky", decreased three times and here and there it is no more than 40 meters. Ten years ago in the Oktyabrsky settlement two streets with 2-storey concrete buildings were washed down. During winter storms of 2003-2004 at the 123th km of the road waves washed down 400 meters of the spit. And the autumn storm in the November, 2004 washed down another 300 meters of the road.

All that facts lead to the resurrection of the idea of transferring the fisherman settlements from sea spits and beaches to 2-5 km deep into the land. That idea, based on the thorough research of negative consequences of insufficiently considered economical activity in the coastal zone, was stated as far back as in the middle of 20th century (Zenkovich, 1947, 1950; Vladimirov, 1961). But neither that time nor later the prognosis of scientists was taken into account. And it could happen that the retribution will be the complete evacuation of the inhabitants of Oktyabrsky and some other coastal settlements.

Changing shoreline due to Coastal Erosion, Accretion and saline water intrusion due to the construction of Madras Harbour.

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India has 6000 km coastline with 11 major ports for the purpose of trade, passenger transport, military, shipbuilding, recreation and marine resources. The port of Madras planned and executed by the British regime from the year 1876 became one of the major ports in South India. This man made interference with the nature has created ecological imbalance, altered sediment transport phenomenon and shoreline dynamics as well as environmental issues. Since the port is protruding 1.5 kms into the sea from the shoreline resulted in blocking the movement of littoral drift playing a vital role in changing the morphology of the beach and coastline with severe erosion in the north of the harbour endangering the urban community near the coastline.

In order to control and mitigate the natural and man-made problems of beach erosion and accretion, protective coastal structures are constructed. However, these measures against the forces of nature have sometimes proved not only to be futile but also expensive and destructive. In India, for example, the construction of Madras Harbour has resulted in severe erosion of the beach to nearly 8 kms stretch and 1 km width on the North of the harbour and tremendous accretion leading to the 1.5 kms width and 10kms length and heavy siltation of the mouth of river Cooum in the South of the harbour blocking the natural drainage resulting in severe pollution of the river due to domestic and Industrial waste disposal. Coastal sediment movement is of particular importance because what may be beneficial to a harbour may prove detrimental for the preservation of a Coastal strip threatened by erosion.

The frequent changes in the shorelines and beaches are due to the changes in the littoral transport. Littoral drift which mainly manifests itself parallel to the coast as long shore sediment transport plays a vital role in changing the morphology of beaches and coasts.The long shore transport is directly related to the direction of wave approach or the angle of the wave to the shore. The long shore movement of sand on beaches manifests either as accretion or erosion wherever this natural movement is obstructed by the construction of man-made structures like jetties, breakwaters, groins etc. Such structures act as barriers to the littoral drift, causing a build up of the beach on the up drift side and simultaneous erosion on the down drift side.

The process of urbanization along the North and South Chennai coastal belt caused considerable lowering of water table elevation as a result of decreased recharge and increased withdrawals. During 1950's there used to be a quantitative balance in the hydrologic system due to rainwater recharge, due to less paved area and return of the domestic waste water to the ground water below in the absence of domestic and storm water sewer systems.

Due to the presence of the conditions like 1) Increased ground water extraction by pumping wells.2) Reduced groundwater recharge due to paved surface areas and installation of storm servers and 3) Decreased ground water recharge due to export of waste water collected by domestic and sanitary sewers in the coastal region results in not only to a decline in water table but also to ground water pollution and seawater intrusion.

Artificial recharge efforts like rainwater harvesting in and around every domestic house, installation of spreading basins along the coastal belt and certain regulation by the Government in pumping by private agencies for exporting ground water from the basin are underway to counteract these undesirable results of urbanization. Saline water intrusion in coastal aquifers is the most common pollutant in fresh ground water. Intrusion of saline water displaces freshwater in an aquifer.

Over the past century due to severe costal erosion along the north of Madras horbour, the shore temple was submerged under the sea and the coastline advanced 1 km up to the state highway near the well built up North Chennai metropolitan area connecting Chennai and Calcutta and severely eroding the highway endangering the safety of the multistoried buildings. This paper will discuss about the measures undertaken by the Government progressively to prevent the severe erosion along the North Chennai coast by constructing breakwaters made of randomly laid rock boulders and breakwaters made of cylindrical concrete pipes of 1.5m diameter and 3m length vertically sunk rip-rap along the coast and filled with sand and plugged with 0.3m depth concrete at the top and bottom to resist the severe breaking wave forces. Since this method was not found effective in preventing coastline erosion, later tetra pods of each weighing 10 metric tones were placed randomly during 1992 in the gaps in front and back rows of cylinders interlocking with each other as hybrid break water, which was found more effective in preventing costal erosion over a decade.

This paper will also address about the advancement of shoreline towards sea in the south side of the horbour every decade from 1876 to 2000 to the distance of 1.5 kms forming a beautiful Marina beach to a length of 10 kms. This paper will also present hydro-geological map showing extent of seawater intrusion along South Chennai coast to a distance of 3 to 4 kms inland over 50 years due to indiscriminate pumping of groundwater in the coastal urban areas to a stretch of 15 kms making the entire ground water saline in the southern metropolitan areas. This paper will also discuss in detail about the ways and means of mitigating this environmental issues and technological solutions.

Erosion-Related Environmental Problems in Nigeria:Analysis of The Problems, Consequences and Remedial Options

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Human-sourced, or-facilitated problems of environmental degradation often mar development efforts in many developing countries. In Nigeria (as one of the victims of the problems), funds (often acquired as foreign grants and loans) meant for infrastructural development have been severally diverted to unfruitful control operations, to the detriment of the welfare of the lacking people,. The problems of erosion (mostly the soil and gully erosion) in Nigeria are concentrated in the sedimentary basins. Soil erosion (as sheet outwash) comprising washing away of the arable agricultural top soil to undesirable location, constitutes an important barrier in crop yield within the sedimentary basins of southeastern Nigeria. Gully erosion (often with mass wasting) has been a major agent of 'badland' development and disuse of farmlands, access roads, recreational grounds, schools, churches and markets. Evidences of economic losses of gully erosion origin are many in Nigeria. The only access road to Madona Catholic Church, Agulu, Anambra State, has been bisected by gully erosion, leaving thousands of worshipers in distress. Urban water distribution pipes and pumping equipments have been extensively damaged at Imoka Water works, Greater Nkisi Water Scheme, and Ajali-Owa Water intake, each constituting the source of water supply to the urban centers of Awka (Anambra State capital), Onitsha (the commercial city of Nigeria) and Enugu (the capital of Enugu State), each with population estimate over 1 million people respectively. Well over 500 families have been displaced (relocated) within the past decade in the major towns of Agulu, Nanka, Nnobi, Nnewi, Amucha, Unubi, and Ekwulumili, in Southeastern Nigeria, as their ancestral homes, economic trees, farmlands and often their water sources were damaged.

Field observations and laboratory tests on soils from erosion-ravaged areas reveal certain attributes. Annual rainfall values range form 1800 millimeters to over 2300 millimeters. The rainfall pattern is characteristically double–peaked, with peak periods in July and September, coinciding with the peak period of active erosional hazard development and spread. Rainwater catchment programme is very minimal; Bimodal basinward surface water flow predominates, with no planned housing development and urban drainage schemes. Deforestation and unorganized agriculture and extraction of earth materials are on the increase. Active gullies (about 50 – 80 meter depth and up to 500 meters long) are concentrated in soil zones consisting of highly permeable, fine to medium- grained sandy materials, with very low to no cohesive force (with cohesion values from Triaxial shear strength test of 0-16. KNM-2); compared to the values of 40 to 65KNM-2 obtained in more stable areas. Plasticity indices of soil samples from 0-1.5 meter depth in erosion-prone areas range from 0-5, while the hydraulic conductivity (K x 10-2 Mhr-1) and transmissivity (TM2hr-1) values (evaluated from step drawdown method of pumping test analysis) stand at 7.18 and 1.72 respectively. The significance of hydrological, hydrogeological, geotechnical and socio-environmental factors in the development, spread and adverse consequences of erosion is indicated. Several attempted remedial programmes have failed to yield the desired results due to improper coordination, insufficient commitment by various arms of government, high poverty and illiteracy level of the victims, insufficient representation of relevant professionals in any organized control programme, and poor-to non- legislative backing to check the excesses of the entire population. The levels of community participation and government interest in environmental protection shall be enhanced through public awareness programmes, improved funding, and sincererity among the stake holders. Mitigation of hydrological, hydrogeological and socio-environmental input could be achieved by afforestation, improved rainwater catchments, promulgation and enforcement of legislation on agricultural practices, road grading and extraction of earth materials for construction; and construction and maintenance of catch pits. Incipient control through urban and sub-urban planning in the areas of housing and drainage schemes, multichannelling in areas of high flow volume and velocity, and selective grouting in highly permeable vulnerable target areas, shall be encouraged. The increasing gap in econo-political power between the government and the governed (a common characteristic of developing countries) shall be narrowed, to enhance partnership link in environmental protection.

Coconut peel in the mitigation of gully erosion

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Presentation of topic and analysis of issue: Soil and gully erosion are the major geo-environmental problems in the hilly areas of Idukki district, Southern India resulting in mass soil erosion and frequent landslides. The landslides have caused heavy damages by uprooting the trees, dissecting vast lands and blocking the road traffic. These problems conventionally redressed by contour bunding, contour trenching and gully plugging techniques. In normal gully plugging techniques, the gullies are plugged with the help of available local materials around the gullies and in this process, the moisture content is retained for a shorter period. In the process of revamping the gully plugging technique, a new attempt has been made to effectively use the coconut peel to arrest the gully erosion, as there is huge production of coconuts in Kerala state. In this experiment, the coconuts are peeled off and the peel/cover of the coconut in the form of bowl was put throughout the length of the gullies compactly and at every four metres interval, a bound is made with the help of excavated soil or stones around the gullies. The stream rushing down the hill slopes trickle down and a portion of it is retained in the bowl shaped coconut peel. The overflown/excess water recharges the adjacent portions of the soil increasing the soil moisture content. The main advantage of this kind of gully plugging is that the soil moisture is retained for a longer period and helps to develop the biosphere around the gully, which in turn reinforces the gully structure more effectively.

Decision of results/findings: The coconut peel gave greater cohesion power to the soil, strengthening the soil and the bund. In this process, the moisture content remain in the soil around the gullies for a longer period which favoring the growth of grasses and thus retarding the gully erosion, conserving the soil and reinforcing the gully structure. Further, the excess water trickled down the soil has augmented the ground water reservoir. The cost of construction of this gully structure is very minimum, affordable, ideal and successful gully plugging structure for high land areas of Kerala state.

Approaches to Soil/Gully Erosion Mitigation: Creation of Public Awareness Measures in Anambra State, Nigeria

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Climatic conditions such as geology hydrology geomorphology and population combine to make th rural areas of Anambra State of Nigeria susceptible to soil and gully erosion. Other causes include urbanisation, wrong farming methods, construction of roads with impropter derainage channels, excavation of soils and laterites as well as indiscriminate felling of frees and clearing of vegatation. On governmental level, ineffective policies, institutional inaction and often times, the pervasive corrupt tendencies of burdeaucrats tend to exacerbate the impacts in the urban and rural areas.

The worst component of the virutent attack of soils and gully erosion is the lack of appropriate public awareness creation to mitigate its compact in both the urban and rural areas in Anmbra state, of Nigeria. Since information and knowledge are key ingredients to affectively mitigate soil and gully erosion and prevents its potential disaster, promote environmental integrity and susbtainable development, proper public awareness creation will promote the collection, analysis, discrimination and utilization of erosion data and information. This requires greater dissemination from both the government. and the people especially in rural areas where poverty, water scarcity, flood, pollution and diseases have devastating effects. Therefore, raising the public awareness and political will, needed to implement sustainable gully and soil erosion management requires multi –media strategies promoting the values of soil and gully erosion mitigation, its disaster control and ptortection of environmenta resources.

In which precess of creation of awareness, erosion problems, features, origin, development, planning, desigers and management will be packaged for presentation using various methods and techniques. The print and electronic media, announcements in churches, schools and markets, prepared photographs, posters and hanbills will be distributed to the poor and news-hungry masses. Some brochures and pamphlets written in both English and the indigenous languages will be printed and distributed. Seminars and group discussions with the theme of “ People –participation in Gully Erosion Control” will be carried out. The ways and means of doing these will be graphically –displayed at the Poster Sessoin

The advantage of this public awareness creation will lead to Stakeholders having access to relevant or understandable information which will allow them make informed decision and participate meaning fully in ersoion management measures. It will also lead to collaborative efforts to acquire data, exchage lessions learned and to develop knowledge partnerships needed to fill information gaps hindering sustaianble erosion management. These efforts and partnereships will incorporate advancing information technology as well as treaditional and indegious knoweldge bases.

Erosion, Gullies and Landslides in Anambra State, Nigeria; A Case Study.

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Today, a fierce war is seemingly-raging between man and nature in Anambra State, Nigeria. The bone of contention is the land. Nature has dealt a heavy blow on the people of Anambra State, Nigeria, through massive assaults by sheet, rill, channel and gully erosion. Gullies have swallowed men, houses, economic trees, farm lands etc. Landslides have devastated villages and towns, sending many people to their untimely graves and rendering many others as homeless refugees. Large scale soil leaching, river silting and unchannelled flood water have wrecked and demolished man's claim to land. These ugly trends have annihilated aquatic lives and broken or blocked communication channels. Within the past forty years, over 155 lives have been lost in landslides and gully-based accidents in Anambra State, Nigeria. Over 200 houses (old and modern buildings) have caved in and collapsed into gullies within the same period. About fifteen major roads and more than twenty minor roads have, either been destroyed or disconnected by gullies and landslides. The Odor lake and Nkisi River that supplies water to Onitsha metropolis and Imoka stream that supplies water to Awka town and its environ have been silted up by soil erosion and landslides. These have unfortunately resulted into lack of water supply to the two cities by the Anambra State Water Board since the past six years. Within the last forty years, over 20 percent of wetlands and other agricultural lands have been destroyed by soil and gully erosion and landslides. Millions of naira worth of cash crops and economic trees have either been washed away by soil erosion or buried into gullies by landslides. These ecological problems have, therefore, wreaked intense social and economic disasters in the environment.

Soil and gully erosion and landslides may be classified into three categories. One category includes gully erosion and landslides that result from natural activities. The second category is due to anthropogenic (man-made) activities while the third category is as a result of combination of natural and anthropogenic activities. To make peace with nature, man must respect the laws of nature and realise the destructive effects and extents of each of these categories.

Control programmes can be achieved through the establishment of erosion blocks to facilitate the making of investigations, control and management programmes more practicable. The discretization of Anambra State into gully erosion blocks is primarily for the purposes of planning and management. In this way, the ecological problems can be appreciated and handled block-by-block.

Some of the basic factors that militate against sound and permanent solutions to the problems of flood, soil and gully erosion and landslides in Anambra State and other states in Nigeria include ignorance, lack of integrated professional approach by various professional stake-holders and adequate financial resources. Control programmes for erosion problems demand heavy financial resources to tackle them for which Anambra State cannot cope with alone. Financial assistance should be sought from very wealthy individuals, financial institutions, Local Government councils, State Governments, Federal Government, Non-Governmental Organisations (NGOs), national and international Aid Agencies etc. Funds from the above mentioned organisations should be controlled by the donors and people of the affected areas to ensure adequate appropriation of such funds.

This paper suggests some permanent control programmes through any or combination of the following methods: mapping of flood routes/channels, slope stabilization, design and construction of adequate road networks with standard side drains and culverts to channel flood water away to existing basins, agroforestry measures etc. Enactment and enforcement of environmental legislations/laws should be commonplace. Environmental education and public enlightenment campaigns should be regular events. With adequate financial resources and correct integrated application of the above control programmes, soil and gully erosion and landslides menace shall be mitigated in Anambra State, Nigeria.

Study of Landslides Using Multitemporal Remotely Sensed Data and Field Observations: a Case of Reservoirs Created on the Basis of the Volga River Valley

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At present remote sensing (RS) methods are effectively used for solving large amount of applied and scientific environmental problems. Among them are: implementation of monitoring of water quality, study of water dynamics, assessment of changes in ecological state of water objects; drainage basins study; examination of changes of coastal band; an identification, study and prediction of environmental disasters (floods, emergency pollution, soil erosion, landslides).

It is known that making of large reservoirs is accompanied by floods of the river valleys, by intensive destruction of a coasts and by different violations of natural conditions of adjoining territories. Scientists of institute «VNIIKAM» have investigated reservoirs of the Kamsky-Volga cascade (the Krasnoiarsky, the Rybinsky, the Tsimliansky, and other) on the basis of field observations and airborne remote sensing during many years. The most significant complex investigations accompanied by airborne remote sensing were carried out on the Kuibyshevsky reservoir in 2 phases: 1957-1966 and 1986-1990 years.

So far as at present the hazardous landslides at this region became acute problem, we made retrospective analysis of historical experimental data and examined an archive of high-resolution satellite images in order to choose images for mentioned two periods of investigations. On the basis of available ground truth and collected historical RS data and with support by relevant (regionally oriented) knowledge base the methodology for «landslides» was developed. Thus we can use this methodology for identification and study of landslides also on contemporary satellite images, even in cases when field observations is not available.

On large reservoirs created on the basis of the river valley exogenetic geological processes, like landslides, have extremely dynamic character. While filling reservoirs and during their exploitation occurs a reformation not only of a reservoir's «cup» and coastal line, but also wide coastal band. The annual seasonal oscillations of a level of water in reservoirs and a wind-wave action, prevents stabilization of processes and they are prolonged for many decades. Depending from a litological composition and character of bedding of rock, of relief type, of delineation of coast, hydro-geological conditions, landscape structure, extension of economic land use, the remaking processes proceed with different velocity and different types.

The filling of the Kuibyshevsky reservoir up to a design level - 53 m has taken place in 1956. As result of a raising of level of water an intensive eroding of reservoir's coasts occurred, it perimeter achieved 2400 km. It is obvious that at such extension the geological, hydro-geological and landscape conditions essentially differ on different latitudinal sites, and also on the right and on the left coasts. So for the Kuibyshevsky reservoir were established the different types of processes and consequently types of coasts. For a viewed 30-year's time interval landslides processes were not stabilized. The fresh frontal landslides, that captured coast at 200-400 m, were observed at many sites. Circus-shaped, stream-shaped and plastic landslides were also detected.

Analysis of the maps of landslides sites compiled on the basis of multitemporal airborne photography and field observations allow us to make conclusion that the process of landslides formation will be prolonged at least for following 20-30 years.

In the early 90-s by researchers of «VNIIKAM» have been made recommendations for preventing environmental hazard. Namely, while the erosion processes on the reservoir are not stabilized and continue to develop, implementation of a complex monitoring (on the basis of field observations, airborne and satellite data of high resolution) is necessary at the chosen test sites. A series of examined sites need in protective construction, on the some sites is expedient hardening of coast with simultaneous raising of moorings for passenger vessels. The special attention should be given to a drain and to a possibility to diminish amount of water use for gardening at the slope of the Ulyanovsks with its memorial and two railway bridges.

For reasons of change of sociopolitical system and economical crisis in country the making recommendations were not taken into account, and no actions were made. So the dangerous processes continue to develop. Within the urban area of the Ulyanovsks City "creeps" 24 km of the Volga and 7 km of the Sviaga slopes. And on territory from settlements Sengeleia up to Undor were registered 420 active landslides. The problems related to landslides processes development became especially acute in connection with construction of the bridge through the Volga River near the Ulyanovsks City.

The Socio-Economic Impacts of the Erosion and Silting-Up of North Africa Large Dams

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In North Africa countries, water demand is increasing at a rate of 8% per year and the dams currently supply the great part of the total demand (up to 80%). So the increasing development of water resources. requires an improved knowledge and understanding of the fluvial sediment transport (suspended, bed load) and of the deposition of sediments in reservoirs, which threatens the life of many dams. For example the annual sedimentation rates measured in north Africa, are very higher: 80x106 m3 year-1 in Morocco, 30x106 m3 year-1 in Algerian, and 15x106 m3 year-1 in Tunisia.

The paper presents particularly the analysis and results of sedimentation models, based on the silting-up of 74 large dams in north Africa (17 in Morocco, 39 in Algeria and 18 in Tunisia), and on turbidity measurements at gauging stations, used to investigate relationships between sediment yields and basin area, dominant soil nature, mean annual runoff and other parameters. Sediment yields in north Africa, resulting from measurements of silting-up of reservoirs by bathymetric survey (or other methods), are as high as 5,900 t/km2 year-1 (observed in Nekor watershed, at the Mohamed Ben Abdelkrim El Khattabi large dam in the N-E of Morocco), 7,200 t/km2 year-1 (measured un Ighil Emda damn Algeria), and finally 5,100 t/km2 year-1 (Kasseb reservoir, Tunisia). In Morocco, by 2050, 50 % of the dams built before 1988 will be unusable.
The various direct methods used for the determination of the rates of silting-up of reservoirs in North Africa, include:
(a) the bathymetric surveys,
(b) the sediment monitoring;
(c) the stereophotogrammetric method
(d) the use of degradation prediction relationships for the upstream basin.

The following methods have been employed to control erosion and reservoir sedimentation: in North Africa: (a) preventive methods: watershed management, reservoir management (sediment transport diversion, emptying and water supply management), (b) curative methods: evacuation of sediments by appropriate management, allocation of a "dead zone" for sediment storage, dredging of sediment, raising of dams, establishment of new sites.
The harmful consequences of erosion in North Africa, are multiple and affect several fields of the development. We note, in particular:

- the reservoir silting-up and the reduction of their service output,
- the impoverishment of the arable lands and their productivity (example: 100 million tons of soil are torn off each year under the effect of erosion),
- the effect on safety of the on its additional services and canals, examples of corrosion of the aprons of basic drainage sluices (valves of control flow and valve of guard),
- the corrosion of the moulding planes and aprons of the crest gates of the dam,
- the degradation of the galleries and the irrigation canals of drinking water supply and energy,
- the effect on the flood flow control,
- the increase in the risks of flood to the upstream of the dam, generated by the deposits of sediments,
- the threats for the transportation routes and the downstream infrastructures,…

In North Africa several relationships are established between sediment yields, watershed area, runoffs…, for various geological formations (marls, sandstone, limestone, schist and flyschs, dolomites, limestone, marl, granites and basalts) and relationships between E (annual silting-up of the reservoir in 106 m3 year-1), S (area km2) and the capacity (C) inflow (A) ratio (C/A).

A number of sediment transport models are currently in use in North Africa. These include:
(a) For permanent and uniform flows: The HEC-6 model of the US Army Corps of Engineers, based on Toffaletti, Laursen, Du Boys and Yang models with friction equation

(b) For non-permanent flow :

- the Fluvial-1 model of Chang, based on Du Boys model
- the MOBED model of Krichnappan (modified) based on the Ackers and White, Toffaletti, Sadok and Marche models with a mobile bed
- the alluvial model of Karim and Kennedy, based with a mobile bed
- the Garichar model of IMG Grenoble, based on the Meyer Peter equation, and taking into account armouring
- the Wendy model of Delft

For the bed load transport, the selection of models is complicated.
The calibration and validation of models constitutes a great problem because great differences are frequently encountered between measurements and motel prediction.

It is necessary to notice that the studies in this field, are limited and that a scientific effort of research remains necessary, in order to integrate all the concerned factors, and of which the goal would be to make it possible to the decision makers to define, advisedly and with full knowledge of the facts, preferential programmes of soil conservation and water, sedimentation in relation to the aspect of productivity of the soils. So the water demand management ought to include sedimentation problem as an important parameter. The mitigation measures require new understanding and approaches, and techniques are exigent to fight against erosion and silting-up of reservoirs in North Africa which threatens seriously the life of reservoirs.

Workshop 8:

Water Quality Degradation by Hazardous Substances and the Cost of Non-Action

Human diseases induced by chemical pollution: the Paris Appeal

D. Belpomme*

The issue of water is twofold : (1) the unequal sharing of fresh water resources worldwide and the worsening of this unequal sharing due to climatic warming, induced by the greenhouse effect ; (2) the decreasing purity of water due to its contamination by numerous chemical pollutants. Persistent toxic pollutants (PTPs) comprise heavy metals and persistent organic pollutants (POPs) : nitrates, pesticides and hormones from intensive farming, dioxins, furanes, polychlorinated biphenyls(PCBs), molecules from the combustion of fossil products including polyaromatic hydrocarbons (PAHs), food additives and pharmaceutical products... from the industry. The pollution of superficial ground water impacts on many ecosystems and the whole food chain, and therefore eventually on the human diet. POPs settle specifically in fatty tissue where they are stored prior to being released in the blood stream. At end of the food chain, the concentration of POPs in the human fatty tissue is 103 to 106 higher than in aqueous environment.

The critical breaking point now concerns health, due to the carcinogenic, mutagenic and reprotoxic (CMR) effects of these substances and to the allergenic effect of some. Human diseases are no longer only secondary to microbial or parasitic pollution (infections), but first and foremost, to chemical pollution (mainly chronic toxicity) induced by human activities. From such a pollution originate many diseases with a growing incidence, including cancers (50% could be related to chemical pollution), congenital malformations because of the foetus' vulnerability, sterility (in Europe, 15% of couples are sterile), food-related allergies (in France, 20% of the population is allergic), certain degenerative diseases of the central nervous system (such as Parkinson's disease in young individuals) and even possibly certain forms of obesity. Within the population, the child is the most vulnerable. During pregnancy, POPs penetrate the placenta, contaminate the foetus and after storage in the body, are likely to induce abnormalities of the central nervous system and/or a worsening of the physiological immune deficit, which itself can favour bacterial or viral infections.

This is what is explained in the Paris Appeal, an international declaration on the sanitary dangers of chemical pollution. It has now been signed by all the Medical Associations Boards in the 25 EU member states, and by over 500 scientists, including several Nobel Prize recipients. This appeal comprises 3 articles : 1. The development of many current diseases is induced by environmental degradation. 2. Chemical pollution constitutes a serious threat for the child and for the survival of mankind. 3. As our health, that of our children and future generations are under threat, the human race itself is in danger..

This Appeal offers 7 categories of measures, among which the reinforcement of the European program REACH*, the adaptation of regulatory toxicological standards to suit children, and following the ratification of the Kyoto Protocol, the need to implement as quickly as possible practical measures to fight climatic warming.

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* R.E.A.C.H : Registration, Evaluation and Authorization of CHemicals

The Welfare Costs of Non-action with Toxic Pollutants in Water: An Economic Perspective

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The United States' Clean Water Act, initially enacted in 1972 as the Federal Water Pollution Control Act Amendments and amended in 1977, gives the U.S. Environmental Protection Agency (EPA) the mandate to set ambient water quality standards for all contaminants in surface water. Although no federal laws have been enacted to directly control groundwater quality, various regulations such as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), commonly known as the Superfund, and the Resource Conservation and Recovery Act (RCRA), have helped cleanup groundwater contamination. Since these government interventions have and continue to incur considerable social costs, it becomes increasingly important for the U.S. to gauge the welfare costs of non-action concerning hazardous contamination in water. The importance of measuring these costs is also likely to grow in many developing countries.

In the U. S. valuation of welfare costs of toxic chemicals in water bodies has not received a great deal of attention partly because the problem tends to be localized and difficult to measure. A conceptual difficulty comes from the role of freshwater as a source of drinking water and the fact that toxic contamination may potentially get into water supply systems, and thus, pose serious health risks. What complicates the valuation is that the welfare costs are likely to be situation-dependent. That is, the estimated value and composition of welfare costs of hazardous or toxic pollution may be affected by such economic factors as composition of water demand, information given to the public, and as a result, the assumptions concerning the actions of private and public agents regarding the information.

The purpose of this paper is to determine what types of information may be important in determining the welfare benefits of preventing toxic contamination (or equivalently, welfare costs of non-action) when a given type of toxification occurs (or is likely to occur) in a given setting. It attempts to identify information and behavior issues that need to be considered when policy makers and others wish to obtain reasonable estimates of welfare benefits and weigh them against the economic costs of removing toxins. This paper will also provide reasonable "scenarios" for each type of toxic pollutant that may be found in water bodies (surface water or groundwater). We make use of two country alternatives--one in developing countries and the other in developed countries--to demonstrate, with specific examples of toxins such as arsenic, mercury and atrazine, how welfare estimates may vary when a particular behavioral/informational scenario or a particular type of chemical is applied.

Developing economies with limited physical and economic resources typically face the dilemma of meeting two competing needs--to increase the water supply while improving drinking water quality. Developed countries, on the other hand, typically enjoy sufficient water supply but are confronted with a demand for a continued improvement in ambient water quality by a relatively small minority or region facing water scarcity issues or high exposure to toxins. Regulators concerned with hazardous pollution have, in general, access to four generic types of freshwater policies: (1) prevention, (2) detection (monitoring), (3) corrective action (remedial response), and (4) public notification (information dissemination). Prevention includes stringent source controls while corrective action includes public water treatment, cleanup, and isolation. Our task as economists is to identify an optimal mix of policies that will result in the most welfare benefits relative to their costs.

Groundwater Quality Degradation due to Industrialization – the Cost of Non-action: A Case Study of Patancheru, India

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Groundwater is the most important drinking water source in many countries. Studies in the recent decades showed that the groundwater resource has been severely assaulted with many sources of contamination. The main sources of groundwater pollution include sewage systems, industries and trade, agriculture, traffic and waste deposits. A contaminant plume due to an industrial source can spread with time (often many years) with the natural groundwater flow over large distances of many kilometres and thus poses a long-term danger to water supply plants located in the same aquifer. Protection of the groundwater reserves and remediation of groundwater pollution is a key issue that has gained public attention in recent years.

While the pollution problem is enormous in the industrialized countries, in proportion to population, the problem is undoubtedly of similar magnitude or more in most developing countries. For example in India, the magnitude of damage caused to water resources can be estimated from the fact that about 70% of rivers and streams in India contain polluted water (Ministry of Water Resources, 2000). The incidence of ground water pollution is highest in urban areas where large volumes of waste are concentrated and discharged into relatively small areas. In most of the Indian cities and small towns, wherever wastage treatment facilities are provided, the methods of wastewater disposal include infiltration ponds, spreading or spraying onto the ground surface and discharge to stream or dry streambeds and solid wastes by landfills. Most of these treatment facilities are not properly designed and hence may provide a rapid pollution pathway to underlying shallow aquifers. As far as pollution from industries are concerned, effluent in most of the cases are discharged into rivers, streams, pits, open ground, or open unlined drains near the factories without any treatment, thus allowing it to move to low lying depressions resulting severe ground water pollution. In this paper, the serious problems of groundwater pollution due to the rapid industrialization without giving any attention to the sustainable development and environmental problems due to in-action are described with the help of a case study.

The study area covers about 160 sq km in Patancheru, Medak District, Andhrapradesh, India. In 1977, an Industrial Development Area (IDA) has been established in Patancheru and consequently about 400 big and small pharmaceutical and chemical industries have been started in the area. Some industries in the area produce bulk drugs and pesticides and hence use large quantities of organic and inorganic chemicals as raw materials. Thus the effluents discharged contain appreciable amount of these chemicals and their bye-products. Initially, in the name of rapid industrialization, the Government did not impose any environmental regulations to the industries. Hence very few of the industries in the beginning have any waste treatment facilities and the effluent produced in the process were discharged, untreated or partially treated, directly into various unlined channels and stream in the nearby areas. Some of the industries even dispose effluents in low lying areas or ponds dug in their premises. Also many industries used the existing minor irrigation tanks as effluent settlement tanks. In this process, the surface water in the streams and groundwater in the surrounding aquifers got polluted severely. The levels of toxic elements in soil, water and air exceeded the permissible limits drastically.

After understanding the severe pollution problems from the Industries, the Central Effluent Treatment Plant (CETP) was commissioned in 1994 for treating the industrial wastewater with a capacity of 7000 m3/day. The CETP was not equipped to treat the different types of effluents produced by various chemical and pharmaceutical companies. After the treatment from CETP, the treated effluents are directly discharged in to the nearby streams. Actually, the treated effluent is still not safe to discharge into any of the open drains or streams. The tests carried out showed that the treated effluent has a Total Dissolved Solids (TDS) concentration of 4000 – 5000 mg/L. Due to the effluent discharge, the streams have become perennial. While carrying the effluents, the streams act as diffuse sources for the underlying aquifers all along its course. Also from the unlined tanks and ponds loaded with the effluents, seepage occurs to the subsurface. The pollutants reaching the groundwater systems further migrate through advective dispersion process.

In 2003-2004, a detailed field investigation has been carried out to test the groundwater quality in the study area. After the monsoon period, a large number of groundwater samples in different areas were collected and analyzed for various parameters such as TDS, colour, pH, electrical conductivity, turbidity, fluoride, chloride, total hardness, nitrate, alkalinity, sodium, potassium, sulphate etc. All the groundwater samples collected in the area showed severe pollution and the analyzed parameters limit were much above the permissible limits. As per the Water Quality Index analysis, the water can be categorized to very bad to bad. The analysis showed that the groundwater in the area is not useful for drinking, domestic purpose or even irrigation purpose.

During the field investigations, it was observed that: many groundwater wells have pungent/foul smell and brownish black colour, food cooked using the groundwater in the utensils cannot be stored beyond 4-5 hours and utensils showed the effects of corrosion, water even after boiling leaves a yellowish residue at the bottom of the vessel and the agriculture in the area is affected severely, with a significant reduction in crop yield. Now the drinking water for the people in the area is supplied through tankers and pipelines from far distance.

This study shows the effects of rapid industrialization and the effects of unsustainable developmental effects and non-action on the water resources systems. The development without environmental concerns makes the surrounding area not suitable for living of the human being, flora and fauna due to the pollution problems to water, soil and air. The paper further discusses various aspects of the groundwater pollution problems with data analysis, computer modelling and interpretations.

Common Effluent Treatment Plants: Concept and India's experience

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Presentation of the Project / topic and analysis of the issues

The small scale industries (SSIs) covering a wide spectrum of industries occupy an important position in Indian economy accounting for 40% of the industrial production, 35% of exports and employment to 16.7 million in about 3.2 million units. However unplanned and uncontrolled growth of these industries has resulted in the problem of pollution in several parts of India. Rivers, streams and lakes are getting polluted due to discharge of untreated wastewater from these SSIs. Due to small operation, lack of technical skills, capital, space and other constraints operation of individual effluent treatment plant (ETP) in SSIs is not techno-economically feasible. In order to tackle with pollution from SSIs, one of the significant measures taken by Government of India is to promote concept of common treatment. The government has appreciated the fact that the provision of ETP by each individual SSI would not only be immensely expensive as regards to the capital and operating costs but would also not ensure guarantee of performance by individual industries. Realising the efficacy of the concept of common treatment, and the associated problems of the small entrepreneurs, Govt of India instructed pollution control boards and other agencies to explore possibility of establishing of common effluent treatment plants (CETP) in various industrial estates based on criteria of pollution load, toxicity of pollutants and number of industries covered in a cluster and whether the project could be self-sufficient to meet O&M costs.

Extensive public interest litigation and numerous verdicts by the Indian Courts provided a major impetus to construct CETPs at an accelerated pace. Govt of India and State Governments provides financial grants upto a total of 50% of the total cost of construction of CETP. Rest of the money is obtained through bank loans and contribution from member industries. Till date Govt has promoted around 130 such CETP schemes out of which 70 plants are functioning and rest are under various stages of construction. The CETPs in India can be classified into plants catering to similar type and categories of industries e.g. tanneries, textile and those catering to dissimilar type of industries, where member industries have different categories – pickling, electroplating, dyeing, engineering, etc. Depending on the design they can be broadly classified into biological and physico-chemical treatment.

CETPs main objective is treatment at low cost, which is borne by individual member units on a collaborative basis. Nutrients, dilution and composite characteristics on account of the diverse nature of wastewater from member units of CETP make the otherwise complex industrial wastewater amenable for degradation. The important issues that merit consideration are aspect of ownership, conveyance system, cost of the treatment, criteria for cost sharing & plant design.

Presentation of the results / findings

Performance of CETPs depends on several factors like Pre-treatment at individual member unit, segregation of toxic / hazardous effluents (recovery of useful products like ferrous sulphate from spent acid in pickling industries), collection and conveyance system, ownership aspects, flow of funds for O&M, accepted cost apportionment formula by all the beneficiaries, plant design, trained manpower, infrastructure available, etc. CETP management also has to adapt to changes in the wastewater characteristics due to industries either shifting / closing or changing their operations. Handling of hazardous chemical sludge generated at CETP is another significant issue of concern. Choice of mixing of sewage is another issue to be discussed. It makes treatment amenable and allow to achieve prescribed discharge standards.

Design will depend on effluent characteristics, treatability studies, bio-degradability, segregation of wastewaters, pre-treatment provided, cost of treatment, affordability, etc. Choice of technology is significant in order to provide treatment at low cost. In order to minimise on electrical costs, the possibility of substituting bio-energy could be explored to reduce operational costs. Various cost-sharing formula are available but their application varies according to local conditions, industry types, data available, level of surveillance required, practicability, etc. e.g. In Delhi, CETPs cost sharing is based on consumption of municipal water supply, ground water use, number of workers, plot size and type of industry.

Conclusions and Recommendations

It is observed that the SSI units collectively pose a potential threat to the environment. In this background, the concept of common or shared treatment is gaining ground in India. The concept of common treatment based on feasibility should be part of the new industrial estates as essential component of infrastructure. In fact, the location of industries should always be such that units with compatible nature of activity are located in a cluster, which in turn can facilitate in providing common treatment. Segregation of hazardous / toxic industrial wastes conveyed to CETPs should be done so that treatment costs are minimised. Pre-treatment standards at individual industries will help achieve the desired environmental results from CETPs. Proper infrastructure including trained manpower lab, chemical, standby power, etc should be available to management of CETP. Improved collection and conveyance system is the need of the hour.

Use of treated effluent is possible wherever tertiary treatment has been provided. It can be used for irrigation or for industrial purposes. The use of treated effluent in an urban environment requires focussed thinking, which can result in more secure water resources future. There is need to recycle the treated effluent so as to limit the demand growth for potable water and also to reduce the extraction from the aquifers.

Wellhead Protection – Strategies for Drinking Water Wells

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Key Words: Wellhead Protection; Drinking Water Wells; Hazardous Substances; Precautionary Strategies; Lessons Learned

Groundwater based public water utilities are a common feature in the developing world and many new groundwater based water utilities are under development particularly for small to medium size towns. Production wellfield siting, if carried out with foresight and planning, can result in a sustainable source of potable water. The lessons learned from two cities in New Jersey, USA provide some contrasting results. Both are old industrial cities located along New York Harbor. In the late 1800s, both Cities needed to look for additional sources of water supply as many of their municipal and industrial water supply wells had become impacted from salt water intrusion and contamination from surface spills and poor land use. Both Cities purchased undeveloped watersheds (around 1,000 hectares) and developed new wellfields within these areas which were designated as a "Water Reserve". Post World War II growth in the new wellfield area for one city resulted in increased pressure on water supplies and the need to abandon some deeper wells in the Water Reserve due to salt water intrusion. As a result, the City became increasingly dependent on a shallow water table aquifer. This shallow aquifer system was supplemented with artificial recharge. In the late 1960s, two industries located in the watershed proximate to and upgradient of this City's wellfields. By 1971, the City had to shut down 6 wells and by 1973, 24 wells due to contamination from heavy metal constituents and volatile organic compounds (VOCs) associated with disposal from these two industries. In addition, an illegal dumping episode in 1977 of polychlorinated bi-phenyls (PCBs) materials within the wellfield area resulted in the entire wellfield being shut down for a short period. The second City was more engaged with land use development and protection issues proximate to its Water Reserve and as a result for over 100 years the wellhead protection strategy of purchasing land and creating protection buffers around this city's wellfields has resulted in the sustained supply of potable water to over 100,000 people for the past century.

The lessons learned from these problems point to the need for water supply utilities to: (a). curtail access to public water supply wellfields; (b). be involved with local land use controls to avoid detrimental land use changes in a water supply watershed; and (c). recognize that a Water Reserve, in and of itself, may not offer the optimal level of protection for water supply wellfields.

Precautionary (Protection) strategies and policies in regard to wellhead/drinking water source protection can result in significant cost savings and sustainability for drinking water utilities. Protection strategies are developed to protect drinking water sources from contamination from industrial discharges (synthetic organic compounds, heavy metals, hydrocarbons and the like); wastewater discharges onto the land; agricultural impacts (pesticides and fertilizers), and other non-point sources of pollution. Non action can result in costly alternatives such as prolonged and expensive treatment of water pumped from contaminated aquifers; developing new sources of water supply at a distance from existing sources; or buying water from a neighboring water utility.

Not enough consideration has been given to watershed and groundwater quality protection and as a result many groundwater aquifers have been impacted. In a response to this, there has been a variety of local approaches to watershed and water quality management and protection in the Europe, the United States and other parts of the world. In recent years, there has been an increased initiative by water utilities to retire or purchase lands over prime aquifers within water supply watersheds and wellhead protection areas.

The creation of wellhead protection areas on the basis of a tiered delineation is an approach that has become increasingly applied to water supply utility wellfields and has a technical and regulatory basis in certain countries. Wellhead protection is a practice and policy that involves the delineation of Wellhead Protection Areas (WHPAs) around drinking water wells/wellfields and the adoption of protective land-use restrictions to varying degrees in the WHPAs. A WHPA is "The surface or subsurface area surrounding a water well or wellfield, supplying a public water system, through which contaminants are reasonably likely to more toward or reach such water well or wellfield".

Quantitative approaches have been developed to delineate wellhead protection areas/zones and develop land use restriction policies on the basis of the travel time of contaminants to wellfields. The most protective/restrictive zone (referred to as the Tier 1 zone) protects for impacts from bacteria and viral contamination. A Tier 1 zone has a travel time in the range of 200 days to 1 year. Tier 2 and Tier 3 zones are developed to protect against impacts from synthetic organics, hydrocarbons, heavy metals and other pollutants and generally involve travel times in the range from 5 to 12 years to the wellhead. These longer travel times allow for some form of corrective action to be applied to the contaminant source(s) before they can reach a water supply wellfield.

WHPA approaches can be viable if supported by local ordinances with enforcement capability. Difficulties in implementation relate to land use practices already in place that may be detrimental to groundwater quality, existing zoning codes; and private property land use issues.

Managing water quality risks from already existing environmental legacies of hazardous substances

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Current water pollution by toxic and persistent organic pollutants (POPs (such as polyaromatic hydrocarbons (PAHs), chlorinated hydrocarbons (CHCs), BTEX compounds, halogenated organic solvents, such as TCE and PCE, coal tar, creosotes, PCBs and certain pesticides) and other hazardous water pollutants may stem primarily from environmental legacies of the past, rather than from considerably more regulated ongoing/new industrial and other activities. POPs are frequently found at contaminated land sites, causing groundwater contamination, which may in turn contaminate downstream surface and coastal waters. About 40,000 potentially contaminated land sites have been identified in Sweden alone, with an estimated cleanup cost of SEK 25 billion for the most prioritised sites. In Europe, such contaminants constitute a large part of presently 33 identified priority substances within the EU Water Framework Directive, which sets ambitious objectives for all waters in a catchment (groundwater, as well as rivers and lakes) to meet good chemical and ecological status by 2015. In the United States, cost estimates for groundwater clean-up from such contaminants by liable parties are of the order of $3-5 billion per year for around 15 000-25 000 sites with most severe industrial groundwater pollution, leading to clean-up life cycle costs of $50-100 billion for use of currently common clean-up technology. These estimates were recently made by an international expert panel (including the present author), charged by the U.S. Environmental Protection Agency to identify key research issues for guiding efficient and sustainable remediation strategies.

Contaminated land and groundwater sites constitute continuous and diffuse sources (in the meaning of being more or less spatially spread with highly uncertain mass distribution) of pollutants for downstream water environments. Pollutant mass from contamination source zones is released to the mobile water phase by dissolution, desorption and physical mass exchange from immobile zones, and may also move as a fluid itself. This pollutant mass is then carried downstream by groundwater (and possibly also its own) flow along variable subsurface pathways, yielding a subsurface pollutant plume where both mass transfer and biogeochemical transformation processes (such as adsorption, degradation, chemical reactions) occur and attenuate pollutant mass from the mobile aqueous (and possible pollutant fluid) phase. Process equilibrium and kinetic rate relations determine how much pollutant mass is removed from the mobile plume phase by natural attenuation processes and whether or not this mass removal is sufficient for immobilizing the plume and thus protecting downstream water quality, human health and ecosystem status; if natural attenuation is not sufficient, active remediation should be necessary, such as source zone remediation by commonly very costly mass removal technologies, or/and plume control by relatively less costly but continuous and maintenance-demanding pump-and-treat, reactive barrier and/or enhanced attenuation technologies. However, critical questions here are: what is sufficient mass removal by natural attenuation, how should such sufficiency be regulated, and how shall the decision be made for how and how much to remediate the contamination source zone, versus controlling the downstream pollutant plume?

Application of the precautionary principle to these questions has to be quite different from the more commonly considered application to the question of whether or not to permit new activities, developments and uses of hazardous substances. In the latter case, there exists a real option to avoid risk to water quality, health and ecosystems from new potentially hazardous substances or activities, by simply not permitting them if there is significant uncertainty about how to assess and quantify this risk. In the former case, however, this option of a relatively easy way out simply does not exist. The water quality, health and ecosystem risks of contaminated land and groundwater cannot be avoided by a simple non-action policy. If the risks are considerable, society will pay the costs of not recognizing and not acting to mitigate them sooner or later, in one way or another (for negative health effects, associated economic losses, decreased human benefits of harmed ecosystem services, and possibly also for the remediation that was neglected but could have saved other costs if done earlier). If we want to efficiently manage water quality risks and avoid harm to health and ecosystems from such already existing environmental legacies, we have therefore no choice but to use best available knowledge for explicitly assessing and quantifying these risks, uncertain or not. In addition, we must continuously aim to decrease the uncertainty in our risk assessments, which requires considerably increased research and monitoring support for closing essential knowledge and data gaps on water flow and pollutant transport processes along the highly variable coupled subsurface-surface water pathways in a catchment. In this process, we must finally also develop new concepts for interpretation and application of the precautionary principle to management of already existing potentially harmful environmental legacies, because the simple option of non-action is here the least precautionary one, in contrast to the non-action option of not permitting new potentially harmful activities and substances.

Disposal of Wastewater Effluent to Land: Fate of Heavy Metals and Nutrients

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Wastewater appilcation to land is considered a cost effective, easy, and useful disposal method by which land treatment capacity is utilized. However, this method may contaminate the ground water with toxic substances such as heavy metals and some organic compounds and may enter human food chain if crops are grown nearby.

The aim of this study was to examine the fate of some heavy metals and phosphorus after wastewater effluents applied to sandy soil. For this purpose, secondary wastewater effluent was applied to sandy soil column at a rate of 3 m3 /m2.d-1 for ten months. The column was 2m in height, 0.25m in diameter and contained 0.75 m sand of an effective size of 0.56mm The sand bed overlaid a 0.25m graded coarse gravel as a support.

Results showed that application of secondary effluents from exclusively domestic origin poses little risks for contamination of ground water. However, long-term application must be controlled since mobility of some heavy metals and phosphorus was evident . In particular, the study suggested that this practice should be avoided on Karstic or sandy formations overlaying active aquifers. Further research on limitation of shortest distance that must seperate field crops from effluent disposal sheds was recommended, as well as effects of this practice on other soil types.

Is there a real danger of radionuclide contamination of irrigated soils and crops of South of Ukraine by the Dnieper River waters?

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The main way of contamination and distribution of radionuclides in hydrologic system of the biosphere within huge territories of Ukraine, Byelorussia, Russia and other countries during active phase of the Chernobyl NPP accident was an aerosol transfer. At that on the watershed of upstream part of the Dnieper River, especially its main tributary the Pripyat River (on which the Chernobyl NPP is located) and water area of Kiev reservoir, have fallen about 2.5.1015 Bq of 90Sr, 1.7.1016 Bq of 137Cs and 2.6.1013 Bq of 239Pu as a solid radioactive fallout. In future the transport and redistribution of radionuclides in surface waters depends on hydrodynamics process in aquatic ecosystems, landscape, geochemical and hydrometeorological conditions of radioactive washout form the watershed territories as well as state of fission products and their evolution.

The Dnieper River, crossing north and south of Ukraine, rolls its waters to the southern steppe regions that are less radionuclide contaminated and where irrigation is widely used in farming. Due to irrigation there are an essential changes in a water mode of soils, which can result in increase of radionuclide mobility and their increased availability for root systems of plants. In these conditions the intake of radionuclides by plants can occur on such chains of migration, which are not present in usual non-irrigated, so-called "dry-farming land" agriculture, namely: the radioactive transfer in productive organs of plants directly from the contaminated irrigation water. In particular such favorable situation for radionuclide intake arises at overhead irrigation (95% of land under irrigation in Ukraine irrigates in such way) of crops, which has the productive organs formed on aboveground parts of plants.

Thus there is a real danger of secondary radionuclide contamination of the soils and, eventually, the crops. Directly after the accident this problem attracted attention of experts in field of radioecology and hydrology. However, relatively low water contamination level, registered in the first five years after the accident, did not constitute a serious problem. Nevertheless, taking into account a constant incoming of radionuclides from the catchment basin of the Dnieper River and its tributaries as a result of rain-wash, snow melting and floods (the Pripyat River amounts to 40% of the Dnieper River radioactive flow), the problem of possible radioactive contamination of crops in the South of Ukraine is not to be ignored.

The field research carried out during 1996–2001 in Kherson region showed the decrease of water contamination by 90Sr from 0.32 to 0.17 Bq/l and by 137Cs from 0.34 to 0.09 Bq/l. Although, before the research started in 1996 the soil 90Sr contamination was 6–9 Bq/kg and 137Cs – 10–11 Bq/kg, the systematic overhead irrigation with Dnieper River waters during 6 years, being normal 1,200–2,400 m3 per hectare, resulted in the increase of radionuclide content in soil in 1.3–1.5 times. Consequently there was insignificant progressive growth of both radionuclides in all the studied crops: 90Sr – from 0.9 to 1.3 in cucumber; from 0.8 to 1.1 in tomato; from 3.2 to 3.5 in pea; from 7.0 to 7.9 in blend of fodder grasses (sudan-grass and lucerne); from 2.0 to 2.4 in grain of winter wheat; from 2.1 to 2.6 in winter barley; from 2.1 to 2.3 Bq/kg in corn and 137Cs, respectively, from 0.8 to 1.3, from 0.7 to 1.1, from 3.8 to 4.4, from 8.5 to 9.8, from 2.0 to 2.4, from 2.1 to 2.4, and from 2.0 to 2.5 Bq/kg. The concentration factor varied from 0.13 in tomato to 0.79 in grasses for 90Sr and from 0.09 to 0.75 for 137Cs in these crops (soils black and chestnut earths, sandy-loam and loamy granulometric structure).

Generally these levels of radioactive contamination in productive organs of crops can be considered insignificant, starting from the limits of admissible state standards (white straw crops – 5 and 20 Bq/kg, vegetables 20 and 30 Bq/kg for 90Sr and 137Cs respectively). However, if the 137Cs contamination in several times lower than the state permissible levels, the 90Sr contamination is near to the maximum limit. It is necessary to emphasize that radionuclide content in crop production within territory of Ukraine during pre-accident period due to global radionuclides amount to 0.14–0.18 Bq/kg for 90Sr and 0.18–0.25 Bq/kg for 137Cs.

The analyses that have been carried out per last years have shown that the level of water contamination in comparison with 2001 practically has not changed though it is possible to note the natural tendency to its decrease. However the 90Sr contamination of crop production continues steadily to grow. At that its accumulation by plants occurs by higher rates, than in soil. The increase of concentration factor values practically by all species of plants is evidences of it. Most likely it is connected with increase of quantity of the free mobile forms of 90Sr due to destruction of nuclear fuel particles, released during accident, which are the basic carrier of 90Sr. The content of 137Cs was stabilized on the defined value, that specifies an absence of increase of quantity of the soluble forms of radionuclides in soils and, apparently, is the consequence of so-called "ageing" – linkage of cesium by minerals of soils.

Presented data points the necessity of regular monitoring of 90Sr migration in all links of the trophic chain, especially under the conditions of irrigation of agricultural lands relatively free from radionuclides and development of techniques connected with reduction of radionuclide intake in plants. In particular we have shown that change of irrigation mode owing to decrease of quantity of watering during maturing of production at preservation of irrigative norm, and the main – the replacement of overhead irrigation by surface-ground watering, results in reduction of radionuclide accumulation in a grain, cucumbers, tomatoes and other crops in 2–3 times. The increase of norms of potash and phosphoric fertilizers promotes decrease of radionuclides intake in plants.

Gender Conflicts in Water Resource Governance
A Case Study: Districts of Mukono, Jinja, Luweero and Mpigi around Lake Victoria Basin in Uganda

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Uganda is in great need to development and natural resources have the potential of making significant contributions to the social economic well being of communities around lake Victoria catchment areas. Uganda has lake catchments endowed with high diversity of plant and animal life and therefore the conservation biodiversity is critical. However, the current basin resources uses and practices of basin resources are not promoting sustainable development and in many insistences, conflicts in uses have arisen with displacement and denial of user rights of catchment people.

We are all aware of the common conflicts between tourism development and community villages as well as between large-scale fishing and small-scale fisher folk. Catchment resources are dwindling at an accelerated rate and the diversity of life is diminishing. The live hood of catchment community is at great risk.

For many centuries the people around lake Victoria have lived in harmony with their environment. The forests were seen as part of communal heritage that provide food, medicine, fibre, and shelter. Today, the scenic/land scape characteristics of our natural resources make them potential tourists destination. Our natural resources are shrinking rapidly as the population and demands on resources have increased, daily agriculture, industrial logging, and fuel wood collection. This has left devastating social and ecological implications on our society. Because the man owns land, he markets the produce from land and decides how the proceeds are spent. There is little or no collective decision making regarding income from the proceeds.

Objective of the study:
The study presents an evaluation of the role of gender in management and conservation of lake Victoria catchment area, with the purpose to identify common elements in the approach as well as success factors and weakness so as to get alternatives on sustainable use of water resources. The majority of people in the four Districts live and earn their livelihood in the agricultural sector, which is predominantly rural, where they are engaged in crop production, livestock and fishing.
The research result shows on gender; agriculture, environment and water, land tenure system and land policy. The study was conducted in areas of environment (sites of severe erosion, recurrent drought shared waters/resources and actual potential conflict areas: (where conflicts have occurred and are about to occur where there are tensions).

The research was carried out in participatory rural appraisal, considering the following sub-topics: -

- Gender, agriculture and environment
- Land tenure system and Land policy around the region.
- Effects of conflicts on women and men towards resource management and use.
- The growing fishing industry and its impacts on families.
- Women and indigenous knowledge around Lake Victoria catchment.

Findings: Lake Victoria catchment
It is clear that the core of environment degradation in the lake basin it lack of cooperation in gender balance and environmental issues at play.

Gender conflicts activities has resulted in increasing degredation as development activities are undertaken. This is caused by men who owns land, and where by time comes for products selling, women are not allowed to sell the products, and even harvesting like trees and do fishing. So what happens, women and children just go and harvest all/ clear-cut every plant / green cover. This results into: -

- Degredation has been caused by over-exploitation of resources for short-term benefits. This has resulted in: Land degradation, water pollution, disappearance of biodiversity, destruction of vegetation cover and deforestation.

- Poor farming practices, overstocking of livestock and inappropriate application of agricultural chemicals lead to loss of topsoil and release of nutrients and other agrochemicals into water bodies.

These have brought problems of;

- The amount of flash flows and floods has increased in resent years possibly due to destruction of soil cover, which has interfered with infiltration.
- The waters are turning more turbid with time, indicating increase in soil erosion in the catchments of this Lake basin.
- Environment management is still not being taken as a priority as it should be.

Challenges:

- Dependency syndrome and don't care attitude to the environment.
- Bad behaviour relating it to culture, that a woman is to be accessed to land but not owning it.

Recommendations: - Collaborative efforts should be put in place with relevant authorities to address the problem of catchment degradation by improving soil cover and reducing soil erosion through reforestation programmes and promotion of proper agriculture practices. The practices will include; sustainable agriculture through agro forestry and better methods of farming with emphasis on gender perspective.

- Community awareness and participation of all gender groups should be encouraged in behaviour change towards environmental conservation and sharing during harvesting and selling of products.
- Environmental restoration programmes such as a forestation, soil conservation should be actively done.
- Everyone should know his/her responsibility for the environment and should act accordingly.

Alternative: There should be encouragement to all stakeholders to participate in the conservation of the existing resources and manage these resources in a sustainable way with particular emphasis on water resources.

One of the main conclusions from the paper is to give a voice to women in policy and decision making which will go a long way to ensure that water resource management goal is met.

Water Quality Aspects of Agricultural Developments in Bangladesh

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Bangladesh is an overwhelmingly agricultural economy. This sector directly contributes nearly 32% to the gross domestic products (GDP) of the country and absorbs about 70% of its labour force. Over the last few years the has been an emphasis to increase the acreage of rice, by cultivating high yield varieties (HYV) rice, which replaced traditionally adopted resistant varieties. This bias towards HYV rice increases the use irrigation water and agrochemicals – both fertilisers and pesticides.

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 60 percent of the net cultivable area of Bangladesh are now under irrigation facilities and most of these lands are irrigated with groundwater that are drawn through shallow and deep tubewells. It is apparent from Bangladesh Agriculture Development Corporation (BADC) survey that a total of 865,213 shallow tubewells and 23,182 deep tubewells were used for irrigation purposes during the 2001 boro season. Shallow tubewells irrigated about 2.3 million hectares (about 61% of total area under irrigation) and deep tubewells accounted for about 0.54 million hectares (about 14% of total area under irrigation). The contribution of surface and groundwater sources to total irrigated area in Bangladesh has changed considerably over time. The contribution of groundwater to total irrigated area has increased from 41% in 1982/83 to 71% in 1996/97 and to 75% in 2001. The contribution of surface water has, therefore, declined from 59% to less than 25% over this period. 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. Hence, 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. Therefore, 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.

Application 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. Again, the use of pesticides, which is an integral part of modern agriculture, is increasing over time. The uses of these chemicals are not effectively controlled in Bangladesh and toxic persistent pesticides such as DDT, although banned for agricultural use, are reported to be imported illegally and are being used for the protection of rice crops. The presence of DDT in tested water samples (10 ppb to 35 ppb) indicates slight to moderate pollution from Organo Chlorine residue in different parts of Bangladesh. The tail-water runoff from such agricultural fields can cause surface water pollution, while deep percolation can cause groundwater pollution. It is estimated that about 25% of the total used pesticides reach coastal water, so about 500 tons of organo-phosphorous and 250 tons of DDT has reached into seawater in 1984/85. This study is aimed to assess the use of water in general and groundwater in particular for agricultural development in Bangladesh. An attempt is also made to assess the amount of different minerals that are being recycled through the environment for their possible environmental consequences that are encountered due to huge abstraction of groundwater for agricultural uses. Then a number of management options are critically discussed and recommendations are made for better planning of agricultural development in Bangladesh to minimise the degradation of the quality of water and the environment.

Hydroecological situation assessment in Southern Aral Sea Region, Central Asia according to last 15 years ecotoxicological data

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Due to the fact that in Central Asia the irrigation activities are directed mainly to the growing of cotton, the production of meat and fish still has been widely neglected (Karimov, 1995; Karimov and Lieth, 2004). It is worth noting that the irrigated area mainly used for cotton growing in the Aral Sea basin was two million hectares in 1900, 3,2 in 1913, 4,3 in 1933 and about eight million in the 1990s. Within the Syrdarya River Basin main cotton growing areas are situated in the upper and middle reach. Amudarya River waters are used for cotton culture within its whole length. Fore countries of the region: Kazakhstan, Tajikistan, Turkmenistan and Uzbekistan are involved in cotton agriculture.

It is well known that cotton agriculture requires use of large assortment and quantity of different hazardous chemicals. Huge quantities of pesticides was used on cotton plantations and in orchards in the region during second half of last century, which lead to their high concentrations in soils, from which the agrochemicals were washed away into rivers. The hydroecosystems of both of Khorezm region and Karakalpakstan republic of Uzbekistan and Tashaus region of Turkmenistan, which all are taking water from the lower Amudarya River, have been exposed to high doses of agrochemicals for over 40 years. It is expected that the same agrochemicals will be concentrated in the compartment fish. The worst concentrations expected in the fish in terminal water bodies, which are maintained by collector-drainage waters from irrigated fields. The situation is known to be critical especially on the lower Amudarya Reach, where only in agriculture about 20 various pesticides are used in 2002, including carbophos, Bi-58, basagran, etc.

Regular large-scale an "ecosystem level" ecological and toxicological investigations on quality of water and various abiotic and biotic components of natural ecosystems of the Amudarya River delta were for the first time initiated by group of scientists of the Central Asian scientific research institute of Irrigation (SANIIRI) in 1987. One of the primary goals of the research, where one of the senior authors participated, was the investigation of the ecological and toxicological situation in lakes and residual reservoirs in the Amudarya Delta region that had not been covered within the network of OGSNK (Nation-wide service of supervision and the control over a condition of the surrounding natural environment). For some years we received a unique data set (Karimov, Borodin, 1990, Karimov, 1995, et. al.), giving detailed information on the level of pollution of various components of water ecosystems. This research was continued later within the framework of «UNESCO Aral Sea Project" during 1992-1996 (Borodin, Karimov, et al., 1998). However, after the end of the mentioned projects the study of ecological and toxicological parameters of water ecosystems in the delta and their influences on aquatic organisms have been practically stopped; first of all for the lack of financing. At the same time it is necessary to take into account the missing relevance of the data for modern hydroecological situation because of the change of environmental conditions.

Since 2002 we resumed such investigations within the present, INTAS 1039 Project. The main objectives of the investigations were: to investigate hydrochemical parameters and biocide pollution rate of water, bottom sediments, plants and main commercial fish species and evaluation of modern environmental conditions and ecotoxicological situation, to compare obtained results with retrospective and to enter obtained data into the data bank on hydrology, hydrochemistry and hydroecotoxicology for the Amudarya Delta Region with further integration into GIS.

The results of conducted hydro-ecotoxicological investigations allow us to conclude that the present concentrations of most environmentally dangerous pollutants such as chlorinated pesticides in main ecosystem components: water, bottom sediments, plants and fish are sharply declined and near to the detection limits or not detectable. Thus, the epoch of high pollution risk of aquatic ecosystems in the Delta Region of Amudarya River with chlorinated biocides of agricultural origin (until the beginning of 1990-s) is probably ended. It can be explained by decrease of the volumes of used pesticides since 1980-s more than 10 times. However, this reduction does not come from any ecological concern or reasonable behavior of agriculturists, but rather financial and penury reasons.

Based on stated fact present hydroecological situation in the Region may be estimated as favorable for terrestrial and aquatic ecosystems and wildlife conservation. Ecosystems in the delta region underlie high variability. Their hydrochemical regime is directly dependent on the level and stability of river flow. So, in the future water quantity and flow regime are often more important than water quality. The main principle of integrated water resources management (IWRM): all users of water in the drainage basin are closely interrelated, should be realized more effectively not only in the lower reach of Amudarya River, but also within the whole river basin. We emphasize that because water quantity and quality requirements of lake and river fisheries and fish-farming still often neglected in water plans in basin States. Further investigations on ecotoxicological assessments should be minimized and carried out according to the special needs, e.g. they should include used presently new pesticides and industrial biocides. Main scientific investigations and financial resources should be directed to the conservation of biodiversity and bioproductivity, development of ecologically sound agricultural technologies and aquaculture systems.

Causes and consequences of water quality degradation in the upper Kafue river, the Copper belt Province, Zambia

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River water is used as drinking water supply in many developing countries. Further, river systems often harbour rich and divers ecosystems. However, rivers are often used as recipients for contaminant discharges deriving from a wide variety of human activities. Contaminant sources commonly include industrial processes, as well as waste water and sewerage. This implies a conflict of interest between two different types of use, and necessitates careful consideration of river systems´ capacity for receiving contaminants discharge, and the possible effects on human health and aquatic ecosystems that is related to such discharges.

This poster presents the results of comprehensive environmental investigation in the upper parts of the Kafue river system in Zambia. The investigations comprised water quality monitoring, and investigations of impacts upon aquatic ecosystems and biota, and the results provides a good example of the cost of non-action. The Kafue river system is receiving discharges from extensive Cu and Co mining and processing operations, as well as sewerage and waste water deriving from urban areas. It is shown that the main concerns with regards to human health impacts is that of microbiological contamination, caused by inadequate and degraded systems for sewage collection and treatment, and inadequate management of municipal and other types of solid waste. This contamination makes the river water unsuitable for drinking, or any other type of human use. Conversely, the main concern with regards to impacts on aquatic ecosystems is the contamination arising from mining activities. In downstream areas, these manifest themselves as elevated levels of dissolved metals, and suspended solids. This type of contamination has negatively impacted aquatic biodiversity over a stretch of river of some 150 km. The most serios contamination is that related to elevated levels of Cu, as these exceed existing standards established for the protection of aquatic life. The impacts on aquatic biota are considerable more serious in the dry periods.

It is shown that the Kafue river in its natural state carries low levels of dissolved metals and very little suspended sediments. The reason for the latter is a combination of the area's low relief, coupled with the existence of extensive wetlands, and densely vegetated river banks which prevent erosion. The naturally low capacity of the river to carry suspended sediment has two important consequences for the mining activities. First, the area is naturally resilient to erosion, which greatly facilitates the management of mine and processing waste facilities, as the risk of material eroding and escaping from such facilities is comparatively low. Second, the fact that the Kafue river carries very little suspended sediment, makes it important for mining operations to avoid discharging tailings and other waste into the river. This follows as the aquatic ecosystems in the area are adapted to low concentrations of suspended sediment.

It is shown that contamination related to discharges form active mines is the most important source for pollution, whereas old and abandoned facilities represent a much smaller problem. From this follows that if the mining operations in the Copperbelt where to adapt internationally acceptable standards of environmental management, with adequate storage and disposal of tailings and process related waste, then the water quality in the Kafue river would improve both considerably and rapidly.

With regards to sewerage, waste water and solid waste, it shown that the in former times well functioning systems for collecting and treating these have deteriorated dramatically. The reasons are lack of investments in modernisations and upkeep, as well as poor management of existing facilities. It is concluded that rehabilitation ff the existing systems for managing sewerage, waste water and solid waste are urgently needed, and that any further mismanagement and/or non-action would further exacerbate an already serious situation.

Water Quality Degradation caused by agricultural practice: case study from Ukraine

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Agriculture occupies 70 percent of Ukrainian land with an extraordinarily high average of 81 percent of that land being cultivated. Agricultural activities are estimated to cause 35 to 40 percent of total environmental degradation in the country. These activities result in increased soil erosion, contamination from fertilizers and pesticides, and other surface and ground water contamination.

Agricultural runoff is the second leading cause of surface water pollution in Ukraine. This situation is aggravated by inappropriate manure storage, leaks from livestock farms and cattle breeding areas together with direct discharges of wastewater from the households. Bacterial pollution of water resources in rural areas is a very serious problem and is primarily caused by inadequate treatment of domestic wastewater. Despite the dramatic reduction in the use of pesticides and fertilizers in last 14 years, nitrate concentrations and pesticide residues remain high in water bodies. In some locations, surface and ground waters are severely polluted by inappropriate storage of obsolete pesticides at sites located throughout rural areas in the 24 districts and the Crimean Republic. The total amount of obsolete and unusable pesticides is estimated to exceed 22,000 tons.

We have monitored surface and ground water quality close to two stockpiles situated in Poltava district (typical agricultural region) in 2003-2004. Results obtained have detected sometimes 2-3 times higher concentrations of DDT and its metabolites in surface water close to the obsolete pesticide stockpiles.

Other places suffering from deteriorating surface and ground water resources by pesticides or fertilizes are the “dacha” territories. A dacha is out-of-the-city house with small piece of land, approximately 0.06-0.1 hectares. Dacha territories primarily lie in the rural areas and suburbs surrounding large and medium-sized cities. These areas do not have adequate water or wastewater treatment systems. Approximately 40 percent of Ukrainians own dachas, which serve as a place for a weekend outings and vacations. Some retired and low-income people also use the dacha for growing fruits and vegetables for their own needs, and sometimes for market. Taking into account that dacha territories are small land areas with very intensive agricultural practices and a high concentration of people, particularly in warmer seasons, discharges of pollutants from houses and agricultural practices in these areas substantially exceed the established permissible levels. Because dacha territories are not under monitoring or environmental control of state or local authorities, contamination problems are exacerbated. In addition, lack of knowledge regarding appropriate environmental and agricultural practices contributes to deterioration of water quality, loss of freshwater and marine ecosystems, and poses threats to public health. Very often dacha’s owners don’t have enough agricultural knowledge and cases of pesticides misusing have been reported.

We have monitoring one dacha’s territory close to Kyiv city and detected a high concentration of pesticides. Also high nutrient concentrations at number of small likes situated in studied region have been fixed. Agricultural sources of nutrient contamination include (1) inorganic fertilizers (inorganic nitrogen and phosphorus); (2) animal manure (organic nitrogen and phosphorus); and (3) nitrogen deposited from atmospheric sources. Nonagricultural sources include poor quality septic systems, leaking sewers, and discharge of untreated wastewater.

Contamination of water sources by nitrate (the most common nutrient in ground water) is a health concern. Ingestion of nitrate in drinking water by infants can cause low oxygen levels in the blood and may lead to a potentially fatal condition. Results indicate that nitrate was detected in 48 percent of groundwater samples, and concentrations were relatively stable throughout the monitoring period. Groundwater samples have shown an average nitrate concentration over 100 milligrams per liter, which is more than two times higher than the Ukrainian standard. Shallow groundwater (typically at a depth of five meters or less) beneath agricultural land has the highest median nitrate concentration, followed by shallow groundwater beneath urban land. Deeper groundwater in major aquifers contains the least concentration. In Poltava region nitrate was fixed in concentrations 30 to 40 percent higher than Ukrainian standard.

A survey of 50 women in childbearing age was accomplished at Poltava region to investigate the extent to which women understand the influence of water contamination by pesticides and nitrates as well as pesticides exposure to potential impacts on their health. All interviewed women apply pesticide application on the family farms. The questionnaire indicates that women are not strongly concerned with pesticide exposure which is routine and little attention is paid to occupational risk factors after drinking a contaminated water or using untreated water in daily activities. There is a high necessity of increasing awareness of local communities and dacha's inhabitants regarding water quality and water management at the local level. Also communities' members have to be educated and to be trained in water quality degradation aspects and prevention measures.

Irrigated agriculture and the formation of high fluoride groundwaters in India

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Irrigated agriculture covers about 70 M ha in India. About 10 % is currently affected by salinisation and alkalinisation. This depresses the yield and restricts the choice of crops. Another effect, less recognised, is that alkaline conditions in the soil zone tends to mobilise fluoride in the groundwater. Currently about 65 M people are affected by fluorosis, dental and skeletal (Andezhath et al., 1999). Dental fluorosis is endemic in 14 states and 150 000 villages in India (Pillai & Stanley, 2002). Also soft tissues such as muscles and ligaments are affected by fluorosis debilitating the affected individuals. The number of people affected by fluorosis in increasing, partly due to the increase in population in sites with high fluoride groundwaters but also due to the increasing areas affected by soil alkalinisation.

Fluoride is abundant in soil and rocks present in hydroxyminerals like pyroxene, hornblende and biotite and in fluorapatite. There is no direct relation between the amount of fluoride present in minerals in soils and rocks and the concentration in groundwater, this is rather governed by chemical equilibria between the aquifer and the groundwater. Elevated fluoride concentrations are found in soft groundwaters with a high pH. The fluoride solubility is governed by the solubility of calcium fluoride. In alkaline soils the calcium is removed from solution through the precipitation of calcium carbonate leaving place for the fluoride concentrations to increase (Jacks & Sharma, 1995). The relation between irrigation and increasing fluorosis was seen long ago (Krisknamachari, 1976) however without explaining the geochemical mechanisms behind the observations. The extent of saline and alkaline soils is increasing in India. Normally development of alkalinity is a slow process but in the Indira Gandhi Canal irrigation area Jaglan & Qureshi (1996) found an increase in pH of 0,5-1 unit over a period of three years. In recent years the state of Haryana has experienced an increasing degradation of soils with water logging of about 60 % of the cropped area (Sing, 2000). This means that in Haryana only, more than 2 M ha are in the process of being degraded through salinisation and alkalinisation. Water logging is found also in many small irrigation projects (Meena, 2001).

The reasons for the increasing degradation of irrigated soils are mainly two, the absence of proper drainage (Meena, 2001) and overirrigation. The construction of drainage is expensive as the digging of drainage canals requires more of soils to be moved than the construction of irrigation canals. In many projects proper drainage has not been provided as it does not pose a problem initially when the groundwater level is low. Overirrigation is common, a major reason is that the irrigation water is often provided free of charge. In cases where groundwater is used for irrigation the electricity or the fuel is highly subsidised. Irrigation areas have often been established gradually. In such cases it is customary that the older schemes have priority to the water resulting in overuse and water deficiency in the newer schemes.

Flouride removal by treatment has not been a success story due the inherent difficulties in the process irself and due to lack of infrastructure in villages such as reliable supply of electricity. In alkaline irrigated areas it makes sense to take steps to improve drainage and soil conditions to provide both a good groundwater and sustainability in crop production (Datta et al., 2000).

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Water pollution with pesticides in Africa

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Presentation of the topic and analysis of the issue: In order to achieve the Millennium Development Goal to reduce by half the number of people lacking adequate water conditions in year 2015, it is necessary to focus not only on the quantity of water but also on the quality. One of the most important parameter affecting water quality in many developing countries is pollution by pesticides. Hundreds of pesticides are used in the struggle to increase food production, protect harvested food, and control vectors of diseases, and large amounts of these pesticides have been identified in water, sediment, soil, food, air, aquatic fauna and biota. It has been verified that the organochlorine pesticides have severe negative characters such as toxicity, persistence, bio-concentration and bio-magnification. Still these pesticides have often been used in developing countries, mainly due to that they are inexpensive to manufacture and effective in pest control . Also other pesticides are hazardous, then mainly due to their toxicity alone. Besides pollution through application of pesticides in food production, food conservation, and for vector diseases control, pollution also occurs when pesticides are used for fishing and when leakage occurs from obsolete pesticides storage sites. Also severe, is the poisoning of farmers in countries where the farmers suffer from low level of awareness of safe pesticide handling and protection, this is however out of the scope of this paper. Due to practical and financial limitations, pure monitoring studies cannot fully describe the distribution of pesticides in the natural environment. This constraint is even more pronounced in countries where the analytical laboratories with capacity to perform pesticide and pesticide residues analyses are scarce or totally lacking. A complement to monitoring studies is then to do theoretical modeling of the pesticide distribution. Previous studies have identified a variety of parameters affecting the fate of pesticides, but few have paid attention to the special circumstances prevailing in tropical regions, where high temperatures and varying rain-falls has to be addressed. Moreover, many developing countries have additional point sources of pesticides. This presentation deals with the environmental fate of pesticides in Africa. It compiles results from monitoring studies and compares the results with physical, chemical and biological character of the compounds. The most significant distribution patterns are identified as well as important pollution sources. The paper also addresses challenges facing scientists in Africa.

Sources and distribution pathways: Point-sources of pesticides include direct application in order to control agricultural pests and vector diseases and for conservation of food. Due to limited training of farmers, applied amounts are sometimes more than the amount necessary, and both cypermetrine and deltametrin have been found in vegetables and cereals in Burkina Faso . The pesticides are often transported away from the application site as a result of spray-drift, wind erosion, and run-off during heavy rainfalls , thus DDT, HCH, endosulfan, heptachlor, tetrabuthylazine and atrazine have been found in water sources close to agricultural areas in Benin, Tanzania and South Africa . Sources of pesticides also include pesticides used for paralyzing fishes during fishing activities4. Both DDT and HCH have been found in fish in Burundi, even without using these substances for fishing . Leakage from obsolete pesticide stock storage is another important pollution source, and surface soil samples from Tanzania have been found to contain 28 % total DDT and 6% total HCH . Other source include effluent from waste-water treatment plants and landfills , as well as atmospheric deposition.

Comparing pesticides identified in environmental compartments with compound character: The distribution of organic compounds in the environments is governed by sorption, dissociation, volatilisation and transformation , and in the case of pesticides also plant-uptake. The fate of a specific compounds is determined by the character of that compound in terms of Kow, pKa, Henry's law constant and t1/2 biological degradation and chemical transformation, as well as, external factors such as application methods, soil and plant structure, wind speed, particles in the atmosphere, water transport, colloids and suspended particles in water, surface layers of water bodies, rain-fall and temperature. Semi-volatile pesticides have been found to be atmospheric transported and deposited6, degradation products of degradable compounds have been found in water and soil6. Hydrophobic pesticides have been found to be sorbed to suspended organic particles and colloids , in excess amounts in the soil around obsolete pesticide storage sites8 and in surface layers of open water bodies . The importance of pKa is demonstrated in a study where the Koc of a pesticide was found to four-fold in environmental water samples, when the pH-level was increased from pH 5 to pH 8 . Processes have also been found to be time-dependent and longer pesticide–soil contact times have resulted in enhanced non-extractable pesticide-humic compound formation .

Challenges facing researchers in Africa: In order to reach the Millennium Goals, scientific research on water related issues has to be intensified in developing countries where the need for improved water conditions is large. Unfortunately the infrastructure promoting research is not always well established in these countries, and authors recommend increased collaboration with, and support to, researches from developing countries addressing the issues of the threatening water crises.

Conclusions and recommendations: It is concluded that the contamination level of pesticides in water, soil and food in African countries often is high. Thorough surveys must be undertaken but the basic infrastructure in Africa is sometimes weak. Field monitoring should be supplemented with theoretical distribution estimations, which have to include a large number of parameters. These parameters affects each compound at the same time and to various degrees. It can be concluded by comparing results from field monitoring studies with compound specific characteristics that distribution models can be developed. Special attention must be taken to increased temperature, occasional water scarcity and variations in rain-fall intensity when developing models suitable for Africa. It is also concluded that the scientific capacity in Africa must be strengthened in order to meet the Millennium Development Goals.

Small-scale Mining in the Pungwe River – A threat to sustainable water Management and Development in the Bi-national River Basin

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The Pungwe River is a bi-national river, born in Eastern Highlands, Zimbabwe. It flows eastwards through the Mozambican provinces of Manica and Sofala, reaching the Indian Ocean at the City of Beira. Gold extraction in the Manica province has a long history, but during 2003 and 2004 the activities have spread, leading to extreme sediment concentrations in the Pungwe River, and locally very high mercury concentrations in bed sediment. The gold mining activities are mainly informal, with only a few small-scale industrial gold mines in the region.

Presently there is joint effort of the Governments of Mozambique and Zimbabwe to develop an Integrated Water Resources Management Strategy for the Pungwe River. The process, which is supported by Swedish International Development Cooperation Agency (Sida), is driven by the regional water authorities, ARA-Centro in Mozambique and ZINWA-Save in Zimbabwe. In line with the national laws of both countries these two implementing agencies are para-statal bodies with the responsibility of managing the river basins under their jurisdiction without economical support from the central Government. This means that the regional water authorities must generate their own income through e.g. water fees, water levies or through consulting services.

The deterioration of the Pungwe River water, caused by the mining activities, has therefore become a threat to the regional water authorities, especially ARA-Centro, and thereby also to the implementation of the IWRM strategy. The major water users in the basin refuse to pay for the water, which seriously affects the already poor institutional capacity of ARA-Centro. Despite their large effect on river water quality there is no direct way for the water authorities to intervene with the mining activities since these are under the umbrella of the Ministry of Mines. The newly established Pungwe Basin Committee, consisting of stakeholders in the basin, cannot either solve the problem since the miners are mainly informal (illegal) and thus have no juridical power.
To map the present problem and to identify possible mitigative solutions a detailed survey of the mining activities and their impact was therefore conducted in 2004 as part of the Pungwe Project, supported by Sida.

It was found that informal gold mining activities are mainly poverty-driven and that the miners often have a nomadic existence. The informal miners are both Mozambican and Zimbabwean citizens working on both sides of the border. Gold mining activities take place directly in or by the river, with gold extraction from the alluvial deposits, or from the surrounding mountains. Severe soil erosion combined with washing the soil by the river results in high sediment concentrations in the rivers. Measurements showed up to 13 g/l of suspended solids in the river streams. Furthermore, the suspended sediment was found to be mainly clay and silt that have very low settling velocity. Therefore, particles brought into suspension stay suspended all the way to the Pungwe estuary.

The mining technique used by the informal miners is mainly panning. Mercury is added to make the small gold particles flocculate into bigger ones (amalgamation). The conducted fieldwork showed, however, that the use of mercury is mainly a health problem to the miners themselves and high mercury concentrations were only found locally in the bed sediments of the mining areas.
To mitigate the environmental and social problems both hard solutions, e.g. construction of settling or tailing dams, and soft solutions, e.g. organising and educating the small-scale miners have been assessed. The conducted survey and information gathered through interviews with stakeholders indicate that, although technical solutions may help temporarily, soft solutions must be implemented to solve the problem in the long term. Since the mining activities are poverty-driven removal by force is not possible.
Coordination between countries and between different ministries is essential. Deficiencies in the policies regarding informal gold mining activities, i.e. insufficient coordination and cooperation between affected

authorities, make it difficult to fulfill monitoring programs etc. both due to economical and practical reasons (mining sites are often located in remote areas) and political reasons (miners and mining area are bi-national).

The main proposal is to organise and educate the informal miners. A possible way to achieve this is by initiating so called small-scale miner's associations. Apart from environmental advantages, economical benefits will arise through this solution, mainly from tax income. Furthermore, the social situation of the miners could improve. As of today, alcoholism and prostitution, as well as health problems, are abundant in the mining villages. A pilot project has been conducted by the Department of Small-Scale Mining

Exploration in the adjacent Revue River basin, giving assistance in creating a small-scale miner's association. This has resulted in environmental, social and health improvements. However, due to lack of funds, the project was never fully implemented. This indicates that support must be long-term to guarantee a sustainable solution.

The conclusion of the assessment of gold mining activities in the Pungwe River is that water management must be fully integrated. The water authorities must take water quality aspects into consideration and in doing that must cooperate and coordinate with other sister authorities that are responsible for the source of the pollution. The cost of not including other disciplines may lead to that the corner stones for water management, in this case the possibility of putting a prize on water, will fall. The example of Pungwe River further shows that when the problem is poverty-driven soft solutions are necessary in the long-term. Gold mining will continue in the river basin as long as people living there has no other alternative to get food for the day.

Environmental Guidelines for the Safe Reuse of Drainage Water in Irrigation

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The reuse of drainage water is already practiced on a large scale in several countries. In Egypt, the reuse of drainage waters in irrigation is an important component of present and future water management strategy.

Drainage water contains human wastes, including pathogenic microorganisms, industrial effluents that might include toxic organic and inorganic chemicals and pesticide residues. Soil and crop productivity, animal and human health could be adversely affected when reusing this drainage water. Because of the potential risk that can be associated with the reuse of drainage water, guidelines for the use of drainage water for land reclamation has been developed.

This paper presents the proposed environmental guidelines for the drainage water reuse in irrigation to suite the characteristics of newly reclaimed lands in Egypt. The proposed guidelines determine the conditions under which drainage water could be used in irrigation without adversely affecting the environment. The objectives of the environmental guidelines include mitigation of human health issues associated with the reuse of drainage water and determination of appropriate cropping practices. Also they assess the suitable methods for environmental protection of reclaimed agricultural lands and adjoining areas of ecological importance.

Based on the national and international reviews, the environmental guidelines suggest the limits of each parameter in soil and water beside the essential mitigation measures for the drainage water reuse in irrigation. The proposed numerical values in the guidelines are based upon the best available scientific evidence including the monitoring results of the pilot areas in the newly reclaimed lands and are in conformity with the requirements of Egyptian laws and regulations.

SIWI Seminar for Young Water Professionals:

Water Demand Management – An Effective Strategy That Incorporates Both Soft and Hard Solutions?

Navigating the Learning Curve: the State of Water Demand Management in the Front Range of Colorado, USA.

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This paper will outline the progress made in water demand management in the Front Range of Colorado, USA. In particular, events of the last five years will serve to illustrate the many dimensions of current demand management programs, including descriptions of programs that include both hard and soft approaches at demand reduction. This review will give young professionals an overview of the development, and implementation, of demand management strategies in the field.

Context

The activities described here take place in the Denver, Colorado, metropolitan area and other cities up and down the Front Range of Colorado, a stretch of semi-arid land roughly 250km long, receiving an average of 38cm of precipitation per year. This area of Colorado is home to nearly 80% of the state's 4.3 million people, but only 20% of its' native waters. The Front Range has experienced rapid growth in the past decade and is expected to add another 2.5 million people by 2030.

In the late 1990's there were water demand management programs in most of the larger cities in the Front Range, with several smaller cities (<100,000) having one single, or one part-time person devoted to conservation. Program delivery was primarily in the areas of education and information (soft approaches), with little funding directed at equipment replacement, process efficiencies, or regulation (hard approaches).

2002- The Big Drought

In 2002, Colorado was in the middle of a 6+ year climatic drought cycle. Tree-ring studies have shown that this year was one of the driest in the pas 300 years. Until this year most water providers had been able to meet demands through system management and stored water. In 2002, nearly every urban water provider in the Front Range had reduced water availability and was forced to implement water use restrictions. These restrictions, directed primarily at outdoor watering, proved effective in the short run, saving millions of gallons of water and allowing utilities to continue to provide most of their essential demands.

The restrictions worked because most providers had previously established a conservation education program, and the majority of customers recognized the need for shared response to a natural occurrence. However, while the restrictions were effective in the short run, many believed that the mechanisms used were too blunt, and too generic to respond to the broad array of customers needs, and left most indoor water uses unrestricted.

Due, in part, to the low state of water use efficiency in outdoor water delivery systems at that time, users had little ability to differentiate and prioritize uses; when inefficient systems were allowed to operate for only short periods, many outdoor uses were not adequately served, and many community landscape assets suffered. For 2002, the good news was that the necessary water (and more!) was saved. The long term lesson was that there is more work to be done to make urban water system more resilient, at both the utility, and customer levels.

Post-2002

As in most cases of post-drought in the United States, the response in Colorado has been a mixed one. Many, many water providers and large users (such as the landscape industry) have largely gone back to a business-as-usual approach. However, many people in the water provider, and landscape, sectors, have developed long-term approaches to more efficient water use in their communities.

Since the year of the Big Drought, there have been regulatory, political, and industry programs developed to foster, and maintain, a more water-efficient ethic and proactive approach to water management in Colorado. Many practitioners have realized that meaningful, and successful, long-term water demand management involves a better understanding usage patterns and norms, and the refocusing of urban water providers on water services and away from a focus on unit consumption. Samples of area programs will be presented to showcase the state of the practice of water demand management in Colorado.

The author has directed the water conservation program in the City of Boulder, Colorado, (population 100,000) throughout the periods described above. Specific demand management tools and processes used to respond to City of Boulder citizens before, during, and after the drought of 2002 will be presented, and compared to those implemented by other water providers throughout the region.

Resolving Conflict Issues in Watershed Development Programmes for Water Demand Management in Districts of Madhya Pradesh and Maharashtra in India

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Approach of Watershed management
Watershed development Programmes follow an interdisciplinary approach with concern for environment, productivity, gender and equity to achieve soil and water conservation, agricultural production, income generation through means of different techniques of drainage line treatment, artificial recharge, tree plantation, crop management, water management, land management, market linkages, micro-enterprise (SHGs), community institution and other benefits.

Water demand management in a watershed
Water demand management involves different strategies in different scenarios. It primarily involves subjective and objective evaluation of available water resources, water quality, and distribution in surface and groundwater jurisdiction followed by the assessment of the development and consumption in different sectors, future demand in different sectors; concluding with assessment of available resources and their sustainable development through integration of artificial recharge and other conservation schemes. The most efficient strategy to manage water demand management is through watershed as a unit. The successful completion of any watershed development programme should also culminate in water demand management. Whether the implementation of the Watershed Programmes has been able to ensure water demand management proves to be its impact indicator.

Interlinkage of Watershed Development Programme and Water Demand Management
Impact evaluation of every activity in a watershed development Programme shows close interlinkage with water management. Water being the prime input resource for agriculture, forestry development, enterprise development, domestic consumption its proper management and availability is the driving force of any watershed development programme. It has been experienced that drought conditions and water scarcity for a short period can initiate the complete failure of a watershed development Programme which may has been in progress for a long time leading even to disintegration of institutional framework established. Thus there is an urgent need to resolve the conflict issues arising in a watershed to ensure undisputable, equitable, continual, sustainable solutions to water demand management and watershed development on whole.
Detailed evaluation studies of completed WDPs have been performed in the districts of Madhya Pradesh and Maharashtra, India. It has been observed that lack of water resources is not the limiting constraint in the water demand management but the lack of proper management of the available resources and the conflict issues arising thereof.

Further, one of the important components of Watershed development is women empowerment and poverty alleviation, which can again only be achieved once the water demand in the area is met as the women in a watershed are the sole managers and large consumer group of water and without involving them and providing them with water, poverty alleviation can not be ensured.

Watershed development projects in Madhya Pradesh and Maharashtra The watersheds in villages of Jhabua and Satara districts of Madhya Pradesh and Maharashtra respectively were facing many problems viz. the management and utilization of the resources was lacking leading to adverse effects like drought, ecological degradation, migration of tribal people, increased soil erosion and poor socio-economic conditions. Thus, the water demand management was the urgent need in the watershed lest the ecology of the watershed is deteriorated to irreparable extent. The watershed development programme implemented in the villages involved activities for soil conservation measures, water conservation measures, plantations, horticulture, fodder development and social development. The water conservation measures included construction of water harvesting / conservation structures to ensure availability of water for irrigation and to increase agricultural production levels through increased soil moisture / fertility. The programme also incorporated training and awareness components for the development of groundwater and conjunctive use for irrigation purposes. Further community involvement was propagated through formation of users groups, watershed development agencies, watershed committees, women groups, Self Help Groups (SHGs) which ensured capacity building of the community in the watershed and sustainability of the project.

Evaluation Study of WDP in Madhya Pradesh and Maharashtra

An evaluation study of implemented Watershed Development Programmes was performed based upon primary data collection through free floating discussion with the farmers, participatory rural appraisal and open ended interviews followed by statistical analysis of the data collected. The activities under this study included physical verification of the water conservation structures, financial assessment, and beneficiary survey especially of village women. The evaluation study has shown number of impacts on various indicators used for the study viz. migration, living condition, income of the villages, ownership of farms, farm size holding, school and education, utilization of modern tools for agriculture, landuse pattern, agriculture, crop productivity (Rabi (December to April) and Kharif (July to December)), ground water, vegetation coverage, irrigation sources, fuel sources, and livestock development. Study has testified the applicability and efficiency of the watershed management approach in the water demand management and overall upliftment of the watershed.

The recharge of groundwater has been done with the intervention of series of water harvesting structures and water levels have been observed through wells located in the study area. Pre programme data of water levels were obtained from the farmers by interviewing them and the monitored data was also collected during field study. The study has thus concluded that the area which once suffered from repeated droughts and acute water scarcity has managed to utilize its resources. In fact groundwater levels have risen from 1 m to 1.25 m. and also the yield in the wells has improved. Total area under different crops in Rabi season has increased by 86.28 % and Kharif by 3.54 %. It has also been observed personal interviews that all the farmers were aware about the increase in groundwater recharge and its impact on agriculture and drinking water. The rainwater stored in stop dams is being mostly used for irrigation. The water storages have also helped in recharging the groundwater, which is indicated by rise in water levels.

Conflict issues in water demand management

Some of the emerging conflict issues in water demand management encountered during watershed development programmes are: Ownership of groundwater resources, Equitable distribution of benefits among downstream-upstream areas, Integrated management of the resources with custodian rights, Sustenance of institutional development in a watershed, Improvement in gender equity in the rural area, Adoption of sustainable cropping pattern by the stakeholders.

The solutions to these issues need to be reframed and incorporated in the framework of operational guidelines, National Policy, rights and duties of stakeholders and powers of Panchayati Raj System to assure their effectiveness.

Water being a resource intimately interlinked with development of all other natural resources should be managed in an agrarian and rural environment best through watershed development approach with various components of water resource assessment, design of water conservation / development structures, maintenance of structure, optimal utilization of the developed resource, involvement of local masses, empowerment of women (rational and prime consumers of water). The study thus presents a soft solution and a methodology for water demand management through innovative approach of watershed development and identified the conflicts that require an immediate attention.

Water Conservation: Towards Sustainable Development in China

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The future of China depends greatly upon the availability of water for the generations to come. Water conservation is one of the surest, cheapest ways that China can insure that future. The paper analyses the connotation of water conservation and water conservation society. Essentially, Water conservation means doing the same with less, by using water more efficiently or reducing where appropriate, in order to protect the resource now, and for the future. Using water wisely will reduce pollution and health risks, lower water costs, and extend the useful life of existing supply and waste treatment facilities. The conservation goal can be met by wise water practices and elimination of water waste.

The paper mainly address from three parts related with water conservation. Firstly, how we use water in China is introduced and what are the objectives China to achieve to set up a water conservation society. Then how to conserve water and use it effectively is analyzed by means of industry structure adjustment, administrative and market control. Lastly, The paper outline the role of water conservation in addressing problems related to water use and water quality, the benefits and driving forces of water conservation is concluded from the context of water use efficiency, cost savings, and pollution prevention.

In the paper, the connotation of water conservation is discussed. We believe that water savings means freeing up water from non-beneficial uses and providing it to another more productive use. In agriculture, this means promoting practices that achieve more output per unit of water consumed by agriculture. In the context of a river basin, this means ensuring clean water for drinking and industry. It means sound allocation between sectors and water users. Also, it means ensuring enough water for environment. We see that water saving has everything to do with helping the environment. It will reduce sewage discharge to the environment.

The strategy to develop a water conservation society is of great significance in accordance with water resources condition and social economic development in China. The sustainable water resources development shall be achieved in the 21st century by enforcing water management, improving water use efficiency, and carrying out adaptive social and economic development pattern that can results in water saving. China’s new water law, which is implemented in 2002, is read that the government shall strictly enforce water conservation and develop water conservation society throughout the nation.

To set up water conservation society is not a new idea; in fact, many other countries in the world now have some type of water conservation program, more than 10 provinces now have water conservation program in China. The task of setting up a water conservation society in China, of course, encapsulates a wide range of problems. These are in the fields of water supply, sewage disposal, pollution of surface water and groundwater, flood control, drought and desertification, on the one hand groundwater, flood control, drought and desertification, are of a social, economic and educational natural on the other. They are all set against a background of a fragile institutional and organizational framework for water, in many part of the world. For these reasons, and others, the development of a strategy for water conservation appears timely and appropriate. In summary, we would think that being a water conservation society has the following characters:

·Improved clean water security for drinking and industry, wise allocation between sectors and uses of water, and enough water for the environment. Improved corresponding industry structure with the water resources capacity.

·Effective water resources management methods, tools, laws, policies and institutional suggestion.

·Improved understanding on the interactive relation of different water use in different scale and the upper catchments and downstream, and its requirement on administrative management. Acceptable water price for local people and the implementation plan to raise water price together with water withdraw monitoring system. And improved awareness of water saving from all levels of people through education.

·Sound water resources management system with advanced science and technologies, including computer science and mathematical models, GIS and MIS techs.

·Water saving shall be carried out both in arid and humid area on the one hand, on the other, flood control shall be one of the key tasks as well.

Reviewing how water is used in China, the second part of the paper is to suggest an approach looking into the variety of disciplines of water resources cycles and helping water conservation management. The paper outlined some measures to improve water use efficiency, industry structure adjustment, administration, and market mechanism. The driving forces of water conservation are also analyzed.

Paradigm Shift :-Stakeholder Involvement in Decision-making in Water Resources Management.

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Presentation of Topic: Water resources management in Zambia has been a highly centralized system. In 1994 the Government of Zambia formulated the National Water Policy (NWP) that would guide developments in the conservation, management, demand and supply of the water resources in the country particularly in view of the changed macro-economic environment in which liberalization and private enterprise investment and community participation were the norm. The NWP provided a direction to reform the Water sector. However, only the Water Supply and Sanitation sub-sector was reformed with the enactment in 1997 of the Water Supply and Sanitation Act and the creation of a regulator for the sub-sector. Water Resources Management on the other hand was not reformed and continued to perform badly and was negatively affecting the development of other sectors of the economy.

It is an undeniable fact that poor water resources management has a significant negative impact on economic growth, poverty reduction and the environment in general. Zambia is entirely within an international basin and, with the growing legitimate interest by many countries in the region to participate in the utilization of shared watercourses, it will become crucial for Zambia to efficiently manage her inland water resources to enable her define her strategic interests in regional shared watercourse issues as well as meet her international obligations.

The management of water in Zambia is carried out by the Water Board, a statutory Body controlling the use, abstraction, diversion and impoundment of all surface water resources of Zambia. It is supported by the Department of Water Affairs as the technical wing. The institutional set-up of water resources management required transformation in order that the water resource is recognized as an important sector for development and to ensure the equitable allocation and utilization of the resources. The Water Board is situated in the capital City with no decentralized structures. It only meets once a month in Lusaka. It at times would meet in the provinces but not very often due to financial resources. The Board comprises mostly Government officials with only two persons from the private sector. It has been criticized as being too rigid and unresponsive to the needs of stakeholders. The decision-making process does not adequately involve stakeholders not does it encourage cooperation because of its impersonal nature.

It became necessary to complete the reform process by adopting a strategy to reform water resources management by creating the Water Resources Action Programme (WRAP). A unit detached (but under) from the Ministry of Energy and Water Development. The WRAP aims at supporting the National Water Policy in the establishment of a comprehensive framework that will promote the use, development and management of water resources in a sustainable manner. Government, through the WRAP has developed a new institutional framework and is now in the process of revising the 1948 Water Act to bring it in line with current international trends, best practices and promote integrated water resources management.

A new Water Bill 2005 has provided for; the establishment of a system that provides for the management of water resources at the lowest appropriate level focusing on stakeholder involvement. All interest groups including traditional authorities, women and children and the private sector will be factored into the decision-making process; an oversight/leadership body at the national level (transforming the current Water Board into a national authority and redefining the functions of the Department of Water Affairs),so as to provide for an effective framework for integrated water resources management; emphasis on the planning of development of water resources at local level and regulation of infrastructure development, planning procedures and principles; coordination with Government's Decentralization Policy which is devolving all power to the District or local level; harmonization with approximately twenty-five pieces of legislation that impact on water resources management.

Outcome of Reform Process: This will create harmony and understanding in the sector. By involving all interests groups entails that Government policy aspirations in the water sector will meet with more success and less suspicion from stakeholders and the resources will be managed on a sustainable basis.