PROCEEDINGS

Mar del Plata

20 YEAR ANNIVERSARY SEMINAR

STOCKHOLM, August 16, 1997

Water for the next 30 years
Averting the looming water crisis

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MAR DEL PLATA ANNIVERSARY SEMINAR

Analytical summary

by Malin Falkenmark

Although much has happened since the Mar del Plata Water Conference in 1977 in the field of water resources management, the creeping water crisis has been a recurrent issue in conclusions from past Stockholm Water Symposia. The ever increasing water pollution has become a major problem throughout the world, including groundwater aquifers and coastal waters. There have been repeated expressions of alarm over the slow rate of progress towards the sustainable use and development of water resources for health, food production and income generation. The warnings culminated at the 1996 Symposium with its call for nothing less than a Freshwater Revolution to bring about the necessary pressures on the political systems, needed changes in attitudes and behaviours, and to mobilize public opinion.

An internationally produced and recently completed Comprehensive Freshwater Assessment (CFWA) was submitted to the CSD in April 1997 and to the UN General Assembly's Special Session in June 1997. It clearly demonstrates the extent to which continued mismanagement of water resources can become a major obstacle to social wellbeing and economic development. The General Assembly called for the highest priority to be given to the serious freshwater problems facing many regions, especially in the developing world, and called for a dialogue among governments aiming "at building a consensus on the necessary actions, and .....consider initiating a strategic approach for the implementation of all aspects of the sustainable use of freshwater for social and economic purposes....".

The Mar del Plata Anniversary Seminar used the occasion that twenty years have now past since the 1977 UN Water Conference. The aim was to analyze the impact that the Mar del Plata Conference has had on improving water management, and in what way ensuing thinking has continued to change our water perception, and to address the main issues of the next 30 years. The Seminar was to build a bridge between on the one hand successes and failures of past decades, and on the other the conceptual development, efforts and strategies needed for the next thirty years, and policy options available to avert the looming water crisis. This introductory article gives an overview over the contributions to the Seminar and an analysis of the results.

THE PREDICAMENT

Mar del Plata Action Plan - an excellent road map in a changing landscape

Twenty years after Mar del Plata we are more concerned than ever about the possible consequences of misuse of water resources. P Najlis and J Kuylenstierna, United Nations, summarize the lessons learnt during the past twenty years. The fact that water mismanagement has continued to deteriorate on many fronts does not mean that the framework provided by the Mar del Plata Action Plan is faulty or that the implementation has been a failure. Most of its principles remain valid today. The Conference i a defined the need for taking an integrated approach to the development and management of water resources and to its vulnerable and finite nature. Though overtaken by the rate of population growth, the efforts launched through the 1981-90 International Drinking Water Supply and Sanitation Decade significantly accelerated the provision of safe water and sanitation in many developing countries. Several countries have established national water authorities, and some countries river basin authorities. Many countries have carried out revisions of their legislative frameworks and a number have taken measures towards the control of pollution.

Despite such progress, many of the issues addressed in Mar del Plata remain unsolved, although the Conference did start a process of changing our perception about water as an unlimited resource clearly acknowledged by the UNCED Conference in Rio. In fact, the Mar del Plata Action Plan provided an excellent road map but we have not succeeded to follow that map to any significant extent since the efforts have been overtaken by the rate of population growth, urbanization and industrialization.

Challenges for the next 30 years

An overview of the present water resources predicament in different world regions is given by G Björklund and M Falkenmark, Sweden, both involved in the CFWA preparations. The paper shows that the different regions of the world can be characterized as falling into five distinct regional clusters in terms of respectively technical and demographic water scarcity. Major driving forces of change shaping the next few decades include besides population expansion, growing expectations in terms of improved living conditions and improved nutrition standards. This will put new stress on limited water resources. Since water constraints may impose unforeseen and unwanted limitations to economic development, food self-reliance, health, industrial development, etc such constraints will influence social and economic development realities. The paper indicates the huge scales of the remaining water supply and sanitation development needed to reach full coverage of the entire population by 2025 AD, clarifies future water-scarcity related constraints in terms of food selfsufficiency, and suggests that in view of expected pollution loads and their dilution needs, the human appropriation by 2025 will have reached 80 percent of the total accessible water in rivers and aquifers.

A number of challenging management efforts are identified in order to reach a more desirable future for our children and grandchildren: in terms of aversion of conflicts, pollution, land fertility degradation, urban water supply collapses, and crop failures.

Evidently, major shifts in both policies and conceptual approaches to water are called for in order to limit calamities that can otherwise be foreseen. A number of goals should help in defining the strategies to be selected in different regions.

TWO BURNING ISSUES

The food security issue

In many developing countries, particularly those situated in the semiarid tropics, food security and water management are closely related. Some lessons learnt from the recent past when food insecurity has been linked to lack of income rather than lack of water are summarized by W Klohn and B Appelgren, FAO. Basically, food self-reliance is ensured through a mix of crop production and import - both hampered by poverty and stagnation. In dry regions, irrigation is a key factor in stabilizing yields but is energy-intensive and often pressing against hydrological or economic limits.

The need to ensure urban supply and industrial activities, for which water has no substitute, collides with the large quantities of water needed for agriculture. When competition sharpens, agriculture is often the loosing sector, since it cannot bear a water price as high as can the urban and industrial sectors. There are significant regional differences in water development and management practices. Asia has the largest number of large-scale irrigation projects where water productivity is low due to poor management. In Sub-saharan Africa on the other hand most agriculture is rainfed and demographic growth has outstripped growth in food production. At the same time much of the water resources remain untapped. Technology transfer can be a key driving force to bring about a spontaneous expansion of small-scale irrigation.

Economists have difficulties handling water conceptually

Water shortages may impose severe constraints on socio-economic development. In traditional macroeconomic analysis, as explained in the paper by P Rogers, USA. water like other natural resources, is not mentioned as a cause of economic growth since it is assumed that labor and capital can substitute for the resources needed. Water's multiple functions makes it difficult to handle it conceptually since it belongs to both categories of natural capital: critical natural capital (natural, irreplaceable) or other natural capital (renewable or substitutable). Efforts done to integrate water into macroeconomic analysis have been rather unsatisfactory: attention has gone into allocation principles, neglected sources, return flows and quality problems.

Linking impacts of water resources management decisions with macroeconomy

In a second paper, P Rogers, USA, discusses how to get water into national economic planning. A promising approach is to build on the theory of Input-Output analysis to examine the flows between the water sector and the economy that could highlight the impact of water policies to the national output and the evaluation of the value-added as a guide to water decision-making. The paper illustrates the construction of a water Input-Output model through the integration of both the economic account, as the

traditional input-output table, and the country wide water account, including the water cycle. Attention is paid to the inter-sectoral allocation, water usage and the shadow price of water to determine, in value term, the return flows (recycling, drainage and infiltration) from the different users. This theoretical framework is applied to water thus enabling determination of the economic value of water, shadow prices, overall demand curves, subsidies, strategic sectors impacted by water policies, and generally examines the impacts of water resource management decisions on the macroeconomy and vice-versa. It can be used to evaluate the broad macroeconomic setting of water issues, and is innovative in examining a new kind of linkage of the river basin approach to the national macroeconomic planning through the Input-Output model.

KEY POLICY IMPLICATIONS

For countries to be able to apply measures within a strategic framework, adequate coping capability is crucial, encompassing five main components: access to professional manpower, good enough understanding of the actual predicament, adequate institutional framework able to handle complexity, access to locally acceptable technology, and access to financing. The CFWA, in examplifying regionally based policy components divided the world into just four main regions, according to differences on the one hand in availability of additional water (water rich as opposed to water poor countries) and on the other in coping capability, using per capita income as a proxy (above or below 2 896 US dollar per person and year). Table 1 gives a somewhat more elaborated background in terms of the water stress categories to which the four selected case countries discussed at the Seminar belong.

Table 1. Population in water stress categories and position of selected case countries

COPING CAPABILITY	low stress < 10 %	medium low stress 10 - 20 %	medium high stress 20 - 40 %	high stress > 40 %
low	1349 - i a Brazil	1552	1123 - i a Morocco	376
good	367 - i a Canada	528	319 - i a Spain	83

Stress indicators given as use-to-availability ratio in percent. Population in million by 1995. Data from CFWA.

Large scale policy challenges in water rich countries

High income countries with low water stress are indeed a fortunate category in terms of future water issues as illustrated by D Davis, Canada. This select group of countries withdraw for use less that 10 percent of the renewable water resource available within the country and have a per capita income over almost 9000 US dollar per annum. The population of these countries represents two percent of the world's population, and will not change significantly by the year 2025, largely because a new cadre of countries with rising GNP per capita will replace developed countries that enter into water stress. These countries tend to have mature economy, high level of industrialization and generally low population growth rates. Water diversions have often been used to increase supply, and the use of hydropower is significant. They generally have the knowledge base, skills and resources needed to achieve sustainable water resources management objectives, but the political will may be lacking. Short-term policy option should focus on pollution reduction and control, pollution remediation, appropriate water pricing, increased efficiency of use and protection of the natural aquatic environment. In some cases transboundary agreements should be negotiated. In the longer term these countries must work towards sustainable and integrated water and related resource management, and bridge the artificial barriers that now exist in terms of legislation, policy and administration. These countries must also play a larger role in global initiatives and assist their less fortunate neighbours.

Key challenges in *low income but water rich* developing countries are illustrated by J Kelman, Brazil. Regions with low water stress are not necessarily free of water problems. If they have low coping capability, they very likely will have water management problems related to the urbanization process. The most important are water supply for large cities, pollution control, and flood control. The explosive growth of urban centers over the last 25 years continues unabated and is creating escalating water supply problems. By 2000 there will be 18 megacities with more than 10 million inhabitants in the developing countries alone. Streams that cross the poor outskirts of big cities are almost entirely composed of wastewater, domestic and industrial. Storms that in the past caused minor problems now cause major problems due to occupation of the flood prone areas by the poor and clogging of rivers and channels with garbage. The paper describes some lessons learnt in the process of trying to apply the Dublin principles with the purpose to pinpoint bottlenecks. Since public companies have large problems in expanding water supply and sanitation quickly enough, private companies may be an alternative. Addressing the causes of floods by involving stakeholders in the selection of solutions may be more economical than consequence-focused engineering works.

Large scale policy challenges in water-poor countries

J.M.Mendiluce & Pérez del Rio, Spain, present the case of a *water-stressed high income* country with a long history of settling water disputes including the famous Valencia water tribunal. The country has been a forerunner both in terms of user associations and river basin organizations, and is now in the phase of introducing controled water markets to improve water use efficiency. Good water management has to be supported by four basic columns: a proper legislation, an adequate institutional organization. an integrated and comprehensive water resources planning, and an economic sound basis for water tariffs. The most recent law gives big importance to public participation in

water planning, creating river basin water councils for regional basin-level planning and the National Water Board as advisory body to the government.

M. Ait Kadi, Morocco, provides an example of a *water-stressed low income* country. By the end of the 1990's, Morocco will have reached the end of the infrastructure-oriented phase of water resources development since most of its available water resources will then have been captured. Emphasis is therefore shifting to the more difficult task of ensuring socially and technically efficient allocation - an ever more complex task in view of high population growth, rapid urban migration and great variability in rainfall with frequent droughts. Endeavours towards holistic freshwater management strategies are serious, integrating sectoral water plans and programmes within a framework of national and social development policy. A new water law provides a mechanism to implement the transformations required. It includes a National Water and Climate Supreme Council and River Basin Agencies. Water is seen as a public good, subject to charges for all users, dischargers and polluters.

CONCLUDING REMARKS

New security threats

A.Biswas, Mexico, in his final comments, stressed that although the Mar del Plata Action Plan provided an excellent road map, we have not been very successful in following it to any significant extent. Very few people have realized the importance of unconventional security threats from new factors like population growth and the associated impacts such as depletion and degradation of natural resources, especially water, and environmental degradation. These new and emerging factors are a serious threat to future national, regional and global peace. Even fewer have a clearer understanding of where, how and when such threats could affect peace and security issues. Consequently, in many areas we are now worse off compared to 1977.

At present ecosystems are not everywhere considered to be legitimate users of water. Moreover, there has been very little debate on where we want to go now, and how to get there. The developments during the last 20 years have taken place to a large extent in developing countries like Brazil, China, India, Mexico and Turkey. There is very little South-South transfer of experience however. We thus need to change our mindset and learn from the rapid advances made by such countries. Similarities in climatic, economic, social and environmental conditions often mean that South-South experience transfer could provide better results than the existing North-South knowledge transfer.

Analysis and final observations

The set of presentations give a snapshot of the current key problems in the world as they are now perceived. Although the challenges for the future were exposed for only one country from each category, some differences - although of course incomplete - came out nicely as shown in Table 2.

Table 2. Key issues under different water resources predicament

coping capability	*low water stress*	*high water stress*
good capability	*Canada* * pollution reduction * water pricing * ecosystem protection	*Spain* * water resources planning * reservoirs * river basin councils
poor capability	*Brazil* * urbanization -- water supply/sanitation -- mitigation of flooding	*Morocco* * water = public property * more cohesive legal framework * more food import

Unfortunately, the Seminar did not come very far in addressing the main issues for the next 30 years. It became evident, though, that the task of providing safe water supply and sanitation and of solving the food security issue, especially for the poorest, often water short countries with stagnated economies constitute massive challenges: of the order of 300 000 p per day for water supply and 600 000 p per day for sanitation. A particularly serious dilemma , also closely linked to the life support base in developing countries, is evidently the observation that food production to meet basic needs for food can seldom compete for water in an economical sense. Since the very low agricultural yields typical for rainfed agriculture in the dry climate regions where population expansion is particularly rapid, can only be increased if root zone water security can be attained, the Seminar pointed to a fundamental dilemma that has to be addressed in the near future.

A few final observations should be made. The Seminar tended to concentrate more on what we accomplished rather than what we did not accomplish. The final discussion stressed the lack of a sense of urgency towards the escalating water pollution especially in developing countries. It was felt that, if a new aggressivity is not developed in the battle against water pollution, the world may in fact be moving towards a hydrocide. The water quality issues of developing countries have not yet been properly tackled but in administrative circles met with an attitude of rejection. Since their is no substitute to water in many of its uses, water pollution may indeed make the water unusable.

It was furthermore stressed that the developing countries have to be brought out of their isolation in order to get easy access to good ideas and guidelines for effective action. Internet may open a new potential here. In fact, as stressed by A. Biswas, the most immediate and most serious threat to national and regional peace is likely to come not from climate change but from the lack of good quality water. This is a fact that has been mostly neglected in recent global discussions.

It is clear that the water management profession is likely to face a challenge in the next century, the magnitude and complexity of which no earlier generation has had to face.The only possibility to meet these requirements is by building capacity to deal with complexity and to apply a fully integrated approach when undertaking concrete action.

OPENING OF ”MAR DEL PLATA 20 YEAR ANNIVERSARY: WATER FOR THE NEXT 30 YEARS, AVERTING THE LOOMING WATER CRISIS, AUGUST 16, 1997

Anna Lindh, Minister of the Environment, Sweden

Ladies and gentlemen,

First of all, I´m very pleased to be here with you. Those of you visiting Sweden for the first time, I can assure we always have this beautiful weather, and this fascinating mixture of popular festival and scientific symposium at highest level. So, welcome back!

As a politician, I think this seminar is a very important one, because water will be on top of the political agenda the coming years for at least four reasons:

First, water scarcity threatens peace, within countries or between countries. Clean water is the key to development and wealth. The one who controls the water has power over many peoples' life and wealth.

Second, water scarcity threatens food supply.

Third, water scarcity threatens health. Diseases are spread through polluted water. An estimated five million people perish every year in diseases caused by bad water quality.

So, the limited supply of drinking water is one of the world's most serious problems, today and tomorrow.

But, four, the problem is not only a matter of water quantity but also of water quality. Water pollution by hazardous chemicals affects human health and the biological diversity, all over the world. In Sweden we face the problem with eutrophication and acidification. Far away in the arctic, where you think environment is cleanest in the world, PCB levels in mother's milk are the highest in the world.

It is often said that we are at a cross-roads. Often that is to exaggerate, but when it concerns the issue of water the coming years will be decisive. The water crisis is creeping closer. The world population will continue to grow. In 1-2 generations we will be somewhere around 9 billion inhabitants on earth. That is twice as many people to supply with water and food as today. In addition, the number of very poor people is increasing. At the same time, more countries than ever before are lifting themselves from poverty. There is a strong economic growth in some of the developing countries. We have to meet both: a growing population and growing needs.

The social and economic development thus means both menace and hope. Menace, because it will lead to a higher pressure on the global resources, including fresh water.

Hope, because the economic development could provide the necessary resources for a basic change of society towards an ecologically and socially sustainable development.

My vision is that we in one generation the coming 25-30 years will reach a situation, where economic growth will be linked to management of resources and ecological understanding. We must get a much better eco-efficiency in the use of natural resources, in many cases by a factor 4 to 10. That applies to water management as well. New technologies must reduce water consumption and give us more efficient. Water and sewage especially in the new mega-cities of the world. Agriculture's irrigation systems must direct the water so that it gives most profit to the plants and does not wash away the nutrients from the soil. The use of different synthetic chemicals must decrease. The very hazardous substances should be phased out within one generation.

To get there five steps have to be taken:

We have to acknowledge the obvious:
Water should not be thoughtlessly spent, only borrowed. Fresh water has a price. There are costs for supply, there are costs for treatment. That does not mean water should be traded and sold on a market just like other products; water is essential to life and should be handed under democratic auspices. I read an interview with Eagleson, the Stockholm Water Price winner this year, saying that you should know the price of water to be more careful. I think that is right.

We must prevent pollution and water degradation not only to treat afterwards. Processes and products should be clean from the beginning, to avoid different dangerous substances.

To do this political action has to be taken. Strong environmental legislation, with an integrated approach to pollution abatement, and economic incentives should stimulate water savings and water management and phasing out of hazardous substances.

Information and education are maybe the difference between failure and success. It is as important in rich as in poor countries. Companies, agriculture, households - information and education on how to use the water in the most efficient way - what substances to avoid - is as efficient many times as legislation, and has to be combined with legislation. These four steps - water has a price, prevention instead of treatment, strong legislation and economic incentives, information and education, might sound simple. They are obvious. But not easy. Tradition is strong. Economy often too week. Lobbying from chemical industry very heavy.

That makes a fifth step necessary.

If we are going to avoid a water crisis, we must co-operate on an international level. The first steps towards an international strategy were taken at the UN Conferences in Stockholm 25 years ago and Mar del Plata 20 years ago. Pollution abatement and water treatment were in focus. The Earth Summit in Rio five years ago represented a broader perspective.

To meet the needs of existing and future generations it is necessary to create a balance between man's activities and the environment, a balance between water supply and water consumption. Today, it obvious that lack of fresh water can be an important cause of economic stagnation and prevent economic development.

Sweden actively pressed on the water issue before the Rio Conference and participated in the preparations of the Global Water Assessment. At the Special Session in New York in June, the availability of fresh and clean water was one of the main topics. Sweden has taken an active part in the development of EU proposal for action called "Water 21". I was happy to find that there was support for the conclusions. But even if the conference was a step forward we are still only at the beginning. Now the real work has to start:

- to get a strategic approach, maybe an action program for the implementation of a sustainable use of fresh water,
- to formulate and implement policies and programmes for integrated water shed management,
- to strengthen regional and international co-operation for technology transfer and the financing of integrated water resource programmes and projects.

Also for water issue the reform process of the UN is absolutely necessary. In Sweden, we have a long experience of water savings and pollution abatement. We have seen it is possible.

25 years ago, at the UN Conference on the Human Environment in Stockholm, Stockholm could hardly live up to be "the city on the water". If the delegates had taken a closer look at the water, they would have found it muddy and stinking. But during an intensive period, thousands of e treatment plants were built, emissions from industry were reduced, the amounts and the properties of the chemicals and raw materials were scrutinised. An example: The amounts of chlorinated organic compounds from bleaching of pulp has been reduced by more than 95 % since the beginning of the 1980's. It is thanks to both external pollution control, recycling of water and the fact that elementary chlorine no longer is used for bleaching.

The results are visible in the environment. Seals, otters, eagles have recovered.

But more efforts are needed. Still, the emissions of nutrients cause problems. Still, hazardous are diffused in the environment. But it is no longer the point sources which are the major contributors. In Sweden today, the total load of nutrients, heavy metals and hazardous substances from point sources often accounts for less than 20 per cent. Instead, air deposition and land use are the most important sources of impact on water quality.

Now we are developing the new instruments to cope with this new situation. A modern legislation, an environmental code, will be introduced to Parliament during the autumn.

We have launched a programme of six billion Swedish crowns for 3 years to facilitate the transition of Sweden to an ecologically sustainable society. In order to stimulate the development of technology and investments, grants are given to different local projects. Water use and water treatment are often important elements of these projects.

Sweden has also taken the initiative to elaborate an Agenda 21 for the Baltic Sea Region. Last October the Ministers of the Environment around the Baltic Sea decided on this initiative. This is the first time that a number of countries form a common programme for sustainable development. In focus is, of course, the Baltic Sea environment but the programme comprises the whole catchment area and stresses an integrated approach with sector responsibilities and broad public participation in all the countries. An Agenda 21 for the Baltic Sea is to be adopted at high political level in the beginning of 1998.

Our experience the past 25 years tells us it is possible to achieve a lot the coming 25-30 years. But political will, and political action, is needed.

At the opening of the Stockholm Conference, 25 years ago, the Swedish Prime Minister at that time, Olof Palme, expressed his conviction that the future is in our hands. He said: ”There is no reason why we should surrender to anonymous powers, nor to predestine development towards an inevitable catastrophe. The catastrophe, if it comes, is a result of wrong political decisions or of no political decisions at all. ” Let us take his words as a guidance for our coming efforts to bring clean water to all people on earth.

Thank you.

SECTION 1

The predicament

TWENTY YEARS AFTER MAR DEL PLATA - WHERE DO WE STAND AND WHERE DO WE GO?

By Pierre Najlis and Johan L. Kuylenstierna

In March of 1977, the Mar del Plata Water Conference adopted policies for the further development and efficient utilization of water with the basic objective of promoting the level of preparedness needed to avoid a water crisis of global dimensions within the next few decades". The Mar del Plata Action Plan of the United Nations Water Conference , 1977, aimed at providing a framework for action at national regional and international levels needed to avert such a crisis. Twenty years later the recently completed Comprehensive Assessment of the Freshwater Resources of the World (1) clearly demonstrates the extent to which the continued mismanagement of water resources can become a major obstacle to social well-being and economic development. We have now reached a point in time where action can no longer be delayed if a series of crisis are to be averted. This article assesses the impact the Conference in Mar del Plata has had on improving water management, and in what way ensuing thinking has continued to change our perception on this issue.

WHAT HAS BEEN ACHIEVED SINCE MAR DEL PLATA

The action plan from Mar del Plata can be regarded as a road map, that, if followed properly, could provide the way toward sustainable water management. As a map, it can provide necessary guidance and help to the reader (in this case the policy makers, planners etc.) to find the best way forward, but it does not always dispense all the necessary information by itself. A map is a static document, that will need revisions, since the environment is going through constant changes. A map is also, to a varying degree, a generalization of the reality, which means that surprises and obstacles not foreseen can be encountered along the way. The reader of the map will also need to have some basic knowledge on how it should be interpreted, and how to transfer the information in the map into reality. This means, in summary, that just because there is a good action plan, it does not always necessarily transfer into proper and efficient management.

In 1991, a report to the Committee on Natural Resources entitled "Water Resources: Progress in the Implementation of the Mar del Plata Action Plan", dealing with strategies and measures for the implementation of the Mar del Plata Action Plan in the 1990s (2) stated that there has been a further deterioration of the situation in regard of quality of life, poverty and hunger and the conservation of the environment in many

regions of the world. The report argued that the failure of improving the situation in socio-economic development could frequently be linked to the failures in programmes for water-associated development and management.

Despite the fact that actual results have been meagre in relation to the increasingly alarming nature of the problems, the Action Plan from the Mar del Plata Conference did mark the beginning of a process that has, indeed, brought our perception of water management issues forward. It succeeded in raising public awareness on the importance of water resources and the Action Plan provided a basic framework, not only for actions at the national level, but also for all the following policy discussions in various intergovernmental fora. It has, in fact, become a living document which has evolved through time, finding its latest expression in Chapter 18 and other relevant chapters of Agenda 21 of UNCED and ensuing discussions of the Commission on Sustainable Development.

Most of the principles enunciated in the Action Plan remain as valid today as they were 20 years ago. In particular, the Conference defined the need for taking an integrated approach to the development and management of water resources and to its vulnerable and finite nature. Though insufficient in the light of the rates of population growth, efforts launched through the 1981-1990 International Drinking Water Supply and Sanitation Decade succeeded in significantly accelerating the provision of safe water and sanitation in many developing countries. Many countries heeded the call for the establishment of national water authorities and co-ordinating bodies for the management of water resources at the national level; some countries have established river basin authorities. A number of countries have carried out revisions of their legislative frameworks and others, albeit few, have taken measures towards the control of pollution and the rehabilitation of rivers.

WHY IS THERE A LACK OF PROGRESS AND FURTHER DEVELOPMENT ?

Despite progress in some areas, many of the issues that were addressed in Mar del Plata remain unsolved. Progress has mostly been painfully slow and, undoubtedly, has been negatively affected by events in the ensuing decades.

External factors

Decreasing economy

The economic optimism of the 1970s and the concomitant belief that additional financial resources from national and international sources would become available was soon replaced by economic recession and decreases in the flow of financial resources, including Official Development Assistance (ODA) expressed as a percentage of GDP (see **table 1, 2 and 3**). Over the period from 1975 to 1984, the annual growth rate of ODA (in 1993 prices and exchange rates) was 4.69%, as compared to 1.39% over the period 1985-1994 (United Nations/DESIPA, 1996, (3)). In addition to this, most developing countries have been facing an increasing debt burden. An effect of this is that

Table 1. Economic and demographic indicators for the period 1980-1995

Region	Growth of GDP (annual percentage change) Exchange rate basis (1988 dollars)		Growth rate of population (annual percentage change)		Population (millions)		GDP per capita Exchange rate basis (1988 dollars)		
	1981-90	1991-95	1981-90	1991-95	1980	1995	1980	1995	Average yearly % change
World	2.9	1.4	1.7	1.6	4 392	5 636	3 548	3 900	0.67
Economies in transition	2.0	-7.7	0.7	0.2	361	391	4 823	3 693	-1.56
Developed economies	2.9	1.5	0.6	0.6	753	834	14 984	19 665	2.08
Developing countries	3.1	4.8	2.1	1.9	3 278	4 424	780	988	1.77
Latin America	1.2	2.7	2.1	1.9	353	475	2 182	2 092	-0.27
Africa	2.0	1.6	2.9	2.9	448	686	765	657	-0.94
Sub-Saharan Africa	1.8	1.0	3.1	3.1	255	401	380	304	-1.33
West Asia	1.3	2.3	4.0	2.9	90	153	5 736	3 328	-2.80
South and East Asia	6.0	6.0	2.1	2.0	1 322	1 802	464	817	5.07
China	9.0	11.3	1.5	1.1	999	1 221	202	664	15.25
Mediterranean	2.1	-0.9	1.8	1.4	67	86	1 716	1 573	-0.56

The table shows that not all regions had growing economies during this period, both as total growth of the economy, and especially as growth rates per capita. The drop in GDP per capita in Africa and West Asia is particularly significant and is due to low economic growth, or even negative growth, and rapid population increase. It is interesting to note that the GDP per capita in developing countries, as a total, display a significant increase (1.77% as a yearly average), which clearly demonstrates the influence of the Chinese and South Asian economies on the total value. It is therefore important not to deal with developing countries as a single, homogeneous, group. The growth rate of the Economies in transition were largely negative during the first years of the 1990s, but has increased over the last few years. Due to their low population increase, their GDP per capita is likely to increase. The growth rate in developed economies slowed down during the first half of the 1990s, which, in part, explains the drop in ODA, now at levels below 0.3% of GDP in average.
Source: United Nations/DESIPA (3).

developing countries paid more in interest rates ($72.0 billion) than what they received in ODA ($58.2 billion) in 1993-94. Even so, the situation now is an improvement from the early 1980s when the interest payments were more than twice as high as the net ODA (3).

Table 2. The ratio of external debt to GNP (in %) for developing countries

Region	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995[a]
All countries	40.5	44.1	47.0	49.3	43.8	40.1	39.1	39.5	38.1	37.5	37.0	31.6
Latin America	57.4	62.2	63.7	65.7	56.7	50.1	44.9	45.5	42.7	40.0	37.1	39.6
Africa	51.5	57.8	66.7	72.8	72.0	73.6	70.4	72.4	69.7	71.0	76.4	65.0
Asia	22.8	26.0	28.6	30.4	26.3	26.6	27.2	27.8	27.9	28.6	28.5	26.8
Sub-Saharan Africa	67.1	75.9	77.7	87.0	68.9	91.3	98.9	103.0	108.3	114.2	135.8	120.9

a) Preliminary estimate.

In Latin America, the ratio has decreased substantially over the period from 1984-1995, while it has increased in Africa, particularly in sub-Saharan Africa. It is, however, interesting to note the estimated sharp decrease in the ration in Africa between 1994 and 1995 (11%). The total debt burden of developing countries has decreased with about 22% over the period from 1984 to 1995, but it continues to be high, especially in sub-Saharan Africa.
Source: United Nations/DESIPA (3,4).

Table 3. Value of ODA and total debt service payments of developing countries

Region	Total ODA (billions of dollar)		Debt-service payments (billions of dollar)		Total external debt (billions of dollar)		
	1983-84	1993-94	1984	1994[b]	1984	1994	% increase
All countries	30.6	58.2	123.9	173.8	886.6	1603.1	81%
Latin America	2.9	5.5	53.5	63.4	398.3	562.4	41%
Africa[a]	10.4	22.0	25.5	25.0	180.1	313.2	74%
Asia	6.9	14.1	31.8	71.1	224.6	604.0	268%

a) Does not include the Mediterranean region.
b) Preliminary estimate.

It clearly demonstrates that the net transfer of financial resources are from the developing countries to the donor countries. Interest payments alone in 1994 is estimated to 72.0 billion dollars (total for all developing countries), and only Africa receives more in ODA than they pay in interests (10.2 billion). The total external debt continue to increase, and so will total interest payments, which will cause further constraints on financial resources allocation to other sectors, including water supply and sanitation and other water related developments.
Source: United Nations/DESIPA (3, 4).

The lack of more international financial support, the increasing debt burden and economic recession, has refrained many developing countries from investments into water resources development and management. The result is that many development

projects never have been implemented. In addition, economic constraints are likely to have had a negative impact on the quality of many projects, not least in regard of environmental evaluation of, for example, irrigation projects, but also on technical standards such as efficient drainage systems to lower the risk of salinisation and water logging etc.

Increasing population

The economic development in Africa and in West Asia has been particularly troublesome. In Africa, GDP per capita (in constant terms) has decreased with 15% over the period from 1980-1995, while in West Asia, the decrease, although starting from a higher level, is as much as 42% over the same period (table 1). This latter region has the fastest population increase which, in part, explains the decrease in per capita GDP, but the economic growth rate as an average has, in addition, been negative over the period from 1981-90. What is maybe surprising is that the Latin American region also experienced a small decrease in per capita GDP from 1980 to 1995, despite the rapid economic growth lately in some of the countries of the region. In addition, the developed economies experienced a growth rate over the period 1991-1995 that was only about half of that experienced during the 1980s (3). During the same period, the level of ODA, as a percentage of GDP, has decreased and is now at an average level below 0.3% of GDP. In part, private investments have compensated this loss in the 1990s, but most of these investments benefit a limited numbers of countries, especially in Asia and Latin America.

Conflicts

Wars and civil unrest that have afflicted so many regions of the world, all but negated the possibility of progress, often destroying institutional structures and the social and economic fabric of societies. This continue to be a major obstacle in many regions, not least lately in the Central African region. A downward trend during the 1990s can be discerned, with 34 major armed conflicts in 1993 being reduced to 27 in 1996 (5, 6). Although only one of these conflicts were between two different states, also civil unrest are affecting neighbouring countries through refugee flows, often causing tremendous pressure on local infrastructure and the natural environment. Food production, so critical in many developing countries, is also directly influenced by civil unrest. An example is Somalia, where per capita food production, as annual growth rates, fell with -19.6%/year over the period 1989-1993. This should be compared with the period 1980-1989, when food production fell with only -0.4% annually (7). This clearly demonstrates how other factors influence food security, apart from the limitations set by available land and water resources.

Rapid urbanization

The consequences of rapid urbanization has been especially severe in many cities of developing countries. In 1950, there were 83 cities world-wide with a population above 1 million (34 in developing countries), while in 1995 this figure had increased to 280, with almost all the increase taking place in developing countries. Already in 2015, this figure is expected to double, and about 93% of the expected 2 billion people increase in urban population between 1995 and 2020 is expected to take place in developing countries (8). The result will be that by 2015, an estimated 5 billion people are

expected to live in urban areas (9). Among the 15 biggest cities in the world at present, 11 are in developing countries. The rate of urbanization has been steadfast in all regions of the world since the mid 1960s, and even in Africa, the least urbanized region, the percentage of urban population to the total has increased from slightly over 20% in 1965 to about 35% in 1995. This figure is expected to continue to increase and reach about 55% in 2025 (9). The Mar del Plata conference did not foresee this development and did not include specific recommendations for urban water supply and sanitation services and sewage treatment. The results have been constrains in providing these services and to handle the large amount of municipal sewage that is produced. The rapid urban population growth has not necessarily lead to a decrease in the rural population, since population growth in those areas, in general, has kept paste with the migration (2).

Internal factors

Water pricing

Although appropriate pricing policies, that promoted the reflection of the real economic cost of water, were encouraged in Mar del Plata, the concept of water as an economic good has continued to be a major issue of debate in all conferences since then. Even though the Action Plan of Mar del Plata underscore the fundamental aim and high priority to the satisfaction of basic human needs, with particular attention to the lowest income group, the problem has continued to be how to develop a suitable balance between pricing policies and the recognition of water as an social good, and the relationship it has to poverty issues. In the report of the International Conference on Water and the Environment in Dublin, the fourth principle state that ”water has an economic value in all its competing uses and should be recognized as an economic good” (10). This principle has often been criticised for focusing to much on the economic aspect of water use, but in the ensuing text, it is stated how important it is to ”recognize first the basic right of all human being to have access to clean water and sanitation at an affordable price”. Since past and present failures to recognize the economic value of water has led to wasteful use, not least within irrigated agriculture, it is crucial to reach a general agreement on how pricing policies should be developed and implemented. Not least the provision of water supply and sanitation in the growing urban areas is dependent upon some degree of cost recovery in order to maintain the services and expand necessary infrastructure. The same is valid for the treatment of sewage.

Integrating land and water management

In the Action Plan, land and water management is mainly dealt with in the context of agricultural water use, primarily to ensure the productivity of agricultural lands, both rain fed and irrigated. River basin plans were suggested as a mean to complement national master plans in some regions. However, the Action Plan did not stress the more comprehensive linkages that exist between land and water management, as not only relating to agriculture. The prevailing, conventional management approach still means that land and water are managed separately in spite of the close interlinkages of these media. Falkenmark (11) argues that the development in the Sub-Saharan area (the Sahel region) has been seen merely as a poverty and soil degradation issue, thus failing

SECTION 2

Key policy implications

to address the underlying water scarcity problem. Present management models therefore fail since they take this narrow approach to water, focusing on water at project level and not applying an integrated approach to land, water and waste management as part of a long term action plan of a country or a river basin. In addition to integrated land and water management, there remains further the need for policy makers to include water into over all socio-economic planning.

Sectoral integration

The importance of providing water for food production has continued to overshadow all decisions on water allocation in regard of other users. It has been crucial to rapidly increase agricultural production, often with a high cost for the environment, to feed the fast growing population. National water subsidy policies frequently promote wasteful use of water for irrigation, making it difficult for other users to compete for the limited resource.

World grain production has indeed increased, from 1,319 million tons in 1977 to 1,841 million tons in 1996 (but with large year to year variations). At the same time, however, per capita production reached a peak in 1984 with 342 kg of grain and has then, more or less, declined to only 319 kg in 1996 (although this was substantially better than in 1995 when production was down to 299 kg due to bad weather, the lowest since 1972). The world grain harvested area has also decreased from a peak of 732 million hectares in 1981 to 696 million hectares in 1996 (although this is an increase from 679 million hectares in 1995). In addition, the per capita area world grain harvested areas has almost constantly decreased from 0.23 hectares in 1950 to 0.12 hectares in 1996, *i.e*. with almost 50%. The carryover stocks (a measure of food security) was down to 51 days in 1996, its lowest value since measurements began in 1961, and only half of what it was in 1986 and 1987 (12 and sources therein). To achieve this dramatic food production increase, the use of fertilizers have increased dramatically, from 95 million tons in 1977 to 128 million in 1996. Also the total area of irrigated land has increased from 198 million hectares in 1977 to 249 million in 1994 (25%). Despite that, the global irrigated area has shrunk from a peak of 47.3 hectares/thousand people in 1978 to 44.1 hectares/thousand people in 1994 (almost a 7% decrease) (Brown *et al*., 1997, (12)) and sources therein). According to Shiklomanov (1997, (13)), the water consumption for agriculture increased by 15% between 1980 and 1995, and is expected to increase an additional 22% to the year 2025. The water use per capita in agriculture will drop over the same period (**table 4**), further emphasizing the needs of developing measures for more efficient water use, especially within agriculture.

Water quantity and quality aspects

The Mar del Plata Conference recognized that more knowledge on water quantity and quality was needed to improve water management and planning. However, mainly core data on precipitation, surface and groundwater resources and what potential there was to water resources uses were stressed in the Action Plan. In response to that, networks have been developed to provide better data, such as the Global Environment Monitoring System (GEMS) and various programmes initiated by the World Meteorological Organization. In addition, some countries did indeed develop and strengthen their water resources assessment programmes in the late 1970s, but the trend has reversed due to

economic stringency, which gives cause for concern (United Nations, 1991, (2)). What was further lacking in the Action Plan was recommendations to develop integrated information systems that incorporated socio-economic information and hydrological data. The main reason for this is most probably that Geographical Information Systems did not yet exist.

Table 4. Water consumption per capita in various sectors 1980, 1995 and projected for 2025

Sector	1980 (m^3/year)	1995 (m^3/year)	2025 (m^3/year)
Agriculture	394	353	286
Industry	14.3	14.4	17.6
Municipal needs	9.7	10.4	9.7

Note the substantial decrease in agricultural water consumption per capita (more than 25%) projected for the period 1995 to 2025. The total consumption is, however, expected to increase from 1952 km^3 to 2377 km^3. This highlights the problem policy makers are facing. Total water consumption will continue to increase, while the total consumption per capita will decrease (except for industry)due to population growth and the current, already stressful in many regions, situation will prevail if not water resources are used more efficiently.
Source: Calculated from figures provided in Shiklomanov (13).

Local participation

Although not totally omitted in the Mar del Plata Action Plan, local participation in solving local water management problems was not addressed as a key issues at this conference. An example is the resolution on community water supply, dealing with the provision of water supply and sanitation to all during the 1980s. It emphasises mainly the role of Governments and the United Nations agencies in the achievement of this goal. In the Plan of Action, local community participation is mentioned; ”communities [...] must be motivated and involved as appropriate at every level of the programme, including the planning, construction, operation, maintenance and financing of services, and the monitoring and safeguarding of the quality of the water supplied” (14, page 68). Even so, actions are proposed to be initiated mainly at the national level, through national revolving funds and the establishment of appropriate institutions. Massive national information campaigns were also encouraged, to mobilize public opinion and knowledge on basic sanitary services.

RECENT PROGRESS

Local participation emphasized

As stated above, the outcome of the Mar del Plata conference should not be considered a failure. The problem has not been the lack of good ideas, but rather the lack of implementation, partly due to some of the factors discussed in this paper. There has been a continuous evolution of thoughts, that can provide new impetuous to the rate of implementation of necessary actions. The emphasis on local participation, made in recent conferences, constitute a substantial shift from the prevailing ideas of centralized solutions in the 1970s and 1980s. In Mar del Plata, centralized solutions where Governments should be the main actor, was encouraged. As such, Governments were supposed to have the primary responsibility for providing water services and also for protecting water resources from quality degradation. The shift means that Governments are more considered as the providers of an enabling environment in which private initiatives can function and in which community participation, *i.e.* local level involvement, is strongly emphasized. This shift has enabled and encouraged new thinking on how water management problems can be addressed and solved and, in addition, strengthened indigenous participation and knowledge in the process.

The International Conference on Water and the Environment in Dublin (10)), as well as Agenda 21, underscore the importance of local participation, not least through non-Governmental organizations and major groups (especially women). The Dublin Conference expressed the view that centralized and sectoral approaches to water resources development and management are insufficient when addressing local water management issues and therefore stressed that governments should actively seek the involvement of local actors, including the private sector. This approach was also fostered at the Ministerial Conference on Drinking Water and Environmental Sanitation, 1994, that declare in the Action Programme that there should be community management of services that should be backed by measures to strengthen local institutions. This is well in line with what was already stated in the Global Consultations on Safe Water and Sanitation in New Delhi, 1990, and in Agenda 21, that further action is needed in capacity building through human resources development and overall community participation. Private sector investments are also more actively promoted as an additional source of knowledge and financing, not only for water supply and sanitation services but also in improved irrigation practices and other water related services. The lack of public and local participation, and the fact that most actions have been initiated and implemented at a centralized level, is probably one of the main reasons why not more has happened since Mar del Plata. The trend lately has been toward more local participation, as well as promoting decisions at the lowest appropriate level.

Integrated information systems

As discussed above, information systems have not been sufficiently comprehensive and integrated to provide necessary information for integrated water management. A strategic approach has been lacking, leading to overlaps in some areas and gaps in others. There is a tendency, however, that a shift in thinking has begun to emerge. More and more countries do recognize the importance of integrated information management,

and also that information need to be available at various spatial levels. Integrated water shed management will be easier to conduct in the future, if this trend continue. An important development is that of Geographical Information Systems, that facilitates integration of socio-economic data and environmental data for planning purposes.

Urban problems are gaining in importance

Degrading water quality close to urban centers is presently recognized as a major environmental problem. A recent study by the Economic Commission for Latin America and the Caribbean (15) shows that many countries in Latin America treat less than 20% of the waste water, a figure that is even lower in many other developing countries around the world. Mar del Plata emphasized that increased efforts should be given to the question of water pollution, within the over-all context of waste management. But it is evident that the efforts so far has not been enough, especially in the context of the fast increasing urban population, not least in the poorly planned slum districts of many cities. This lack of coping capability is significant for almost every city in the developing countries. New efforts with private companies have been promoted recently, but it is yet to early to determine the outcome of such ventures.

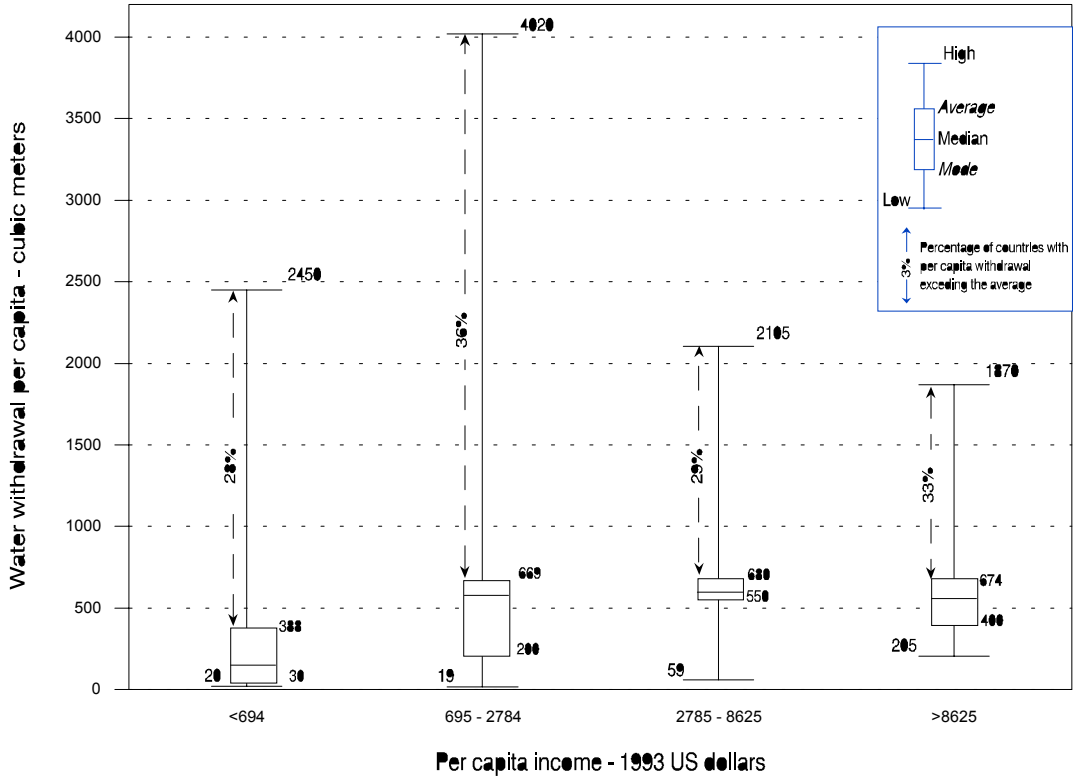
Food self sufficiency need to be transferred into food self reliance

In the Comprehensive Freshwater Assessment (1) the issue of food security is discussed in a slightly different manner than what has commonly been the case. The assessment does not question the validity of global food security, but it recommends that countries facing water shortages allocate water to other uses than irrigated agriculture, uses that will provide more benefit to a majority of the population in the long run, and thus enable them to purchase food from the world market. Water scarce countries have development options, since there are no evident relationships between the degree of economic development and per capita water use **(Figure 1**).

Initiation of an Intergovernmental dialogue

One of the recommendations from the 5th session of the Commission on Sustainable Development, 1997, and later by the United Nations General Assembly Special Session in June 1997, was to ”call for a dialogue under the aegis of the CSD, beginning at its sixth session, aimed at building a consensus on the necessary actions and in particular, on the means of implementation and tangible results, in order to consider initiating a strategic approach for the implementation of all aspects of the sustainable use of freshwater for social and economic purposes....” The Commission also stressed that ”This intergovernmental process will only be fully fruitful if there is a proven commitment by the international community for the provision of new and additional financial resources for the goals of this initiative.” This recommendation can be seen as a starting point for new, firm political focus on freshwater, a focus that aim at developing and initiating implementation policies rather than solely continuing discussions.

Figure 1. Statistical distribution of per capita water withdrawal by Member States of the United Nations based upon per capita income



This figure shows that there is no clear correlation between per capita income and water use. Other factors are more important, such as degree and type of agriculture (irrigated or rain-fed), the stage in industrial development, life style issues, etc. It also demonstrates that economic development can take place even with limited water resources. Economic and social planners need to take water resources into consideration and chose a development path accordingly.
Source: Economic data from the World Bank.

CONCLUSION - WE NEED TO ACT NOW!

There is no doubt about the pressure on the world's water resources will continue to increase in the foreseeable future. Many factors will contribute to this, such as population growth and the need to provide food for the growing population, technological development resulting in changing consumption and production patterns, trade policies, socio-economic development since the economic and social development will have a large influence on countries ability to address emerging water stress and scarcity and demographic trends in urban and rural development. In addition, the lack of acceptance at the political level for the concept of water as an economic good, continue to inhibit development toward less wasteful water use practises, and the allocation of water to users that in the long run could benefit more people within a country (*i.e.* from

agriculture to industry).

Twenty years have past since Mar del Plata and progress in the implementation of generally agreed principles need to be accelerated. Perhaps many of the efforts we can see emerging today are a result of Mar del Plata. This Conference, together with those that followed, did start a process, which initially was inevitable slow, of changing our perception about water as an unlimited resource. But the present situation, as highlighted in the Comprehensive Assessment of the Freshwater Resources of the World (1) does not give us the luxury of waiting to implement firm and concrete actions another twenty years. We can no longer afford another twenty years of gradual adaptations. Time has become a limited resource in itself! Past experience shows that the situation is continuing to deteriorate in many regions. It is therefore time to make sure that the principles of Mar del Plata, Agenda 21 and any of the other major conferences that have taken place over the past 20 years, find a real consensus in rapid implementation at the local, national, regional and global levels. Even though it has been difficult to translate technical and scientific knowledge into national policy making and implementable projects, the efforts of doing so must increase. Table 3 clearly demonstrates how water availability per capita in the agricultural sector will decrease over the next 25 years, and thus, how important it is to use water more efficient if world food production shall keep pace with the growing population. This can serve as one of many issues that will need further attention in the next couple of years, and where firm and urgent action is now needed.

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WATER RESOURCES

Challenges for development under different predicaments

by Gunilla Björklund and Malin Falkenmark

The authors show that the water resources predicament varies considerably around the world where the different hydroclimatic regions, when seen from a water stress perspective, tend to form five clusters. The article highlights the main challenges for the next thirty years and what kind of strategy is needed in the different regions to address the future. Attention is paid to coping capability differences.

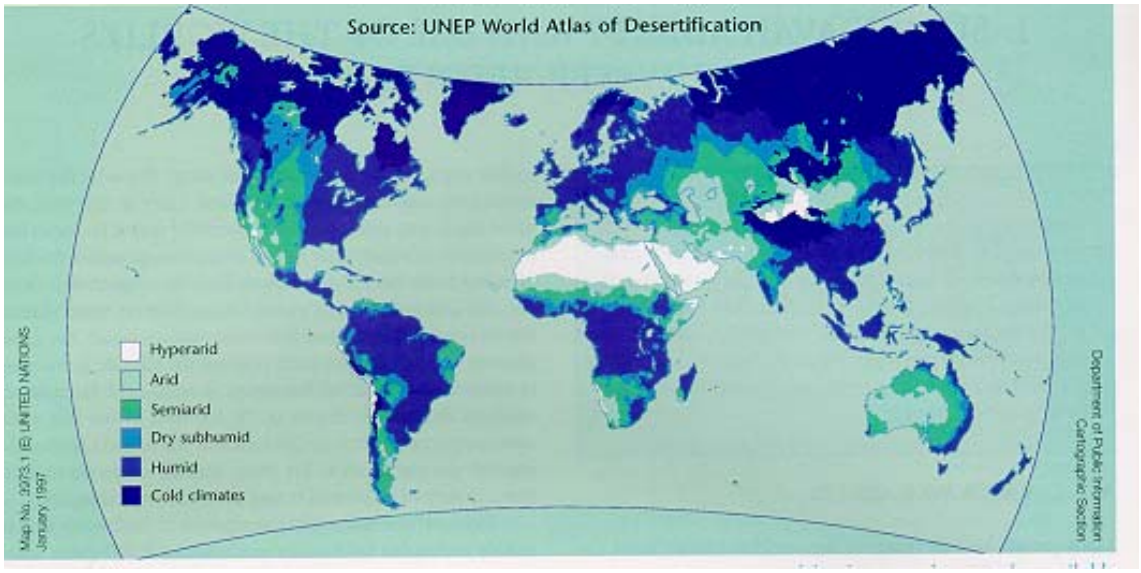
The world is presently struggling with widespread symptoms of past mismanagement of land and water, and at the same time undergoing an almost explosive expansion of its population. Widespread expectations for improved quality of life and generation of income puts new stress on limited water resources. Since water constraints may impose unforeseen and unwanted limitations to economic development, food self-reliance, health, industrial development etc. such constraints will influence social and economical development realities and will therefore have to be entered into national planning. New strategies and urgent action of a new type is needed to secure that water's deep involvement in both environment and development issues can be properly addressed.

This paper will give a short overview of the present situation in the world in terms of main water-related problems, indicate main challenges for the next 30 years, and give some indications of the main policy options in regions with differences in terms of water resources as well as coping capability. When discussing water scarcity, it will distinguish between three different modes:
* *natural water scarcity*, related to aridity, implying scarcity of soil water for plant production with implications for the potential of rainfed food production
* *demographic water scarcity*, i e demographic pressure on available water as an indicator of degree of competition for water between individuals, sectors, and subbasins with implications in terms of dispute proneness and proneness to water pollution
* *technical water scarcity,* i e use-to-resource (withdrawal-to-availability) ratio which is an indicator of the difficulty to meet increasing water needs by further water resources development.

THE PRESENT PREDICAMENT

Large parts of the world are characterized by natural water scarcity. **Figure 1** shows a world map where such regions can be identified as regions with hyperarid, arid, semiarid and dry subhumid climate**.**

Figure 1. Naturally dry zones of world



Dry climate regions where natural water scarcity may imply problems for rainfed agriculture. Data from UNEP World Atlas of Desertification. From CFWA (1).

Figure 2 exposes fundamental regional differences in terms of per-capita water withdrawals (diagonal lines), demographic water scarcity (population pressure on available water, horizontal axis), and technical scarcity (use-to-resource ratio, vertical axis). It has been based on data from a recent overview of water availability and use (1), in which the world was regionalized into 26 different internally rather homogenous regions. By 20 % on the latter scale, the costs and efforts needed for water resources management start to be large in the national economy (reservoirs, pipelines, transfers). The 26 regions tend to concentrate into five clusters with distinct differences in terms of both water abundance/scarcity and per-capita withdrawals, the latter basically reflecting predominance of irrigation:

* A: dry climate region with high population pressure and high dispute proneness. Use-to-resource ratio is high in spite of moderate to low per capita withdrawals. Potential in terms of unused water is low (N Africa, W and S Asia);
* B: temperate zone regions with low to moderate population pressure. Use-to-resource ratio is high due to highly wasteful water use. Potential in terms of unused water is low (USA, M Asia/Kazachstan, Caucasus);
* C: a climatically mixed region with moderate levels in all respects: in population pressure, in per-capita water withdrawal, and in use-to-resource ratio. Good potential in terms of unused water (C and S Europe, S/FSU, SE Asia and N China;
*D: water-rich regions with low water needs and therefore low use-to-resource ratio. High potential in terms of unused water (S America, N Europe, N North America and C Africa);
* E: dry climate regions with erratic precipitation and moderate population pressures. Use-to-resource ratio remains low due to lack of irrigation. Theoretically a high potential in terms of unused water but the water is difficult to mobilize from ephemeral or international rivers (dry parts of Subsaharan Africa).

Figure 2. Fundamental regional differences in water scarcity predicament

Figure shows characteristics in terms of demographic and technical water scarcity respectively for Shiklomanov's 26 global regions. Diagonal line shows per capita water withdrawal referred to later in the text.
Data from Shiklomanov (2).

CHALLENGES FOR THE NEXT THIRTY YEARS

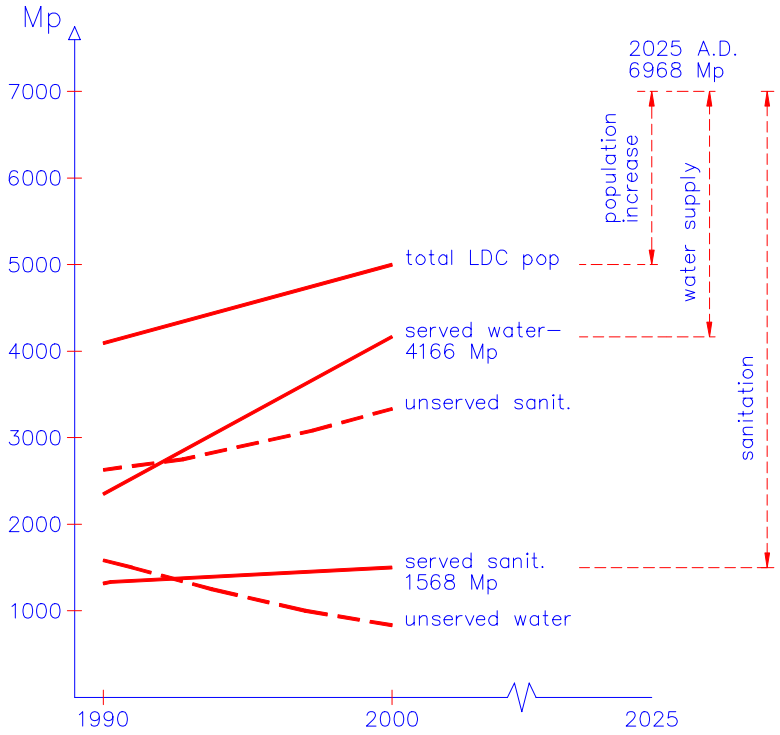
Urban scale and water supply as a precondition for health

Urban growth is more or less out of control in many Third World regions, exacerbated by the rural exodus of poor population strata from marginal areas where it is not considered possible to make a dignified living. Municipal authorities have increasing difficulties to supply the infrastructure needed to provide safe water and sanitation. Many systems carry water only a few days per week. There exists exaggerated expectations on the government to supply the household water. The water supply systems are often in bad shape, highly cracked with large-scale leakages, allowing pollutants from equally cracked sewage pipes to enter the drinking water distributions system.

In spite of massive efforts to remedy the public health situation during the International Drinking Water Supply and Sanitation Decade 1981-90), large deficiencies still remain in terms of supply of safe water and sanitation to the Third World population (3). The result is high mortality due to water-related diseases. The huge size of the remaining task (**Figure 3**) makes several regions threatened by continued deficiencies - even in the medium term perspective. Sanitation development has turned out to be even more

difficult to achieve. It in fact more or less came to a standstill during the 1990's. The challenge has more dimensions than just technique: public understanding, cultural habits, social dimensions etc. If the coverage is to be 100 percent by 2025, there still remain 5.4 billion people to serve, or 450 000 additional individuals to be served every day for thirty years.

Figure 3. Water supply and sanitation in developing countries



Development of water supply as well as sanitation 1990-2000 and the challenges remaining up to 2025, assuming that every person should by that time be secured safe water and safe sanitation close to the home.Data from ECOSOC (3).

Food production constraints

Since water is one of the key building stones in plant growth, water scarcity acts as a constraint on crop production in dry climate countries. FAO estimates that for a diet of 2700 kcal/p yr (2300 vegetative, 400 animal based) some 1600 m^3/p yr of water has to be available as "green water" in the root zone to allow self-sufficient food production. In *humid* climate the rain provides enough green water. In *arid* climate all the water has to be provided by irrigation with water from aquifers or rivers ("blue_water"). In *semi-arid* climate maybe some 50 % may be provided from naturally available green water, while blue water has to contribute the remaining 50 %. Irrigation has however to compete for blue water with households and industry. In the semiarid case the per capita need of water may therefore add up to some 1000 m^3/p yr.

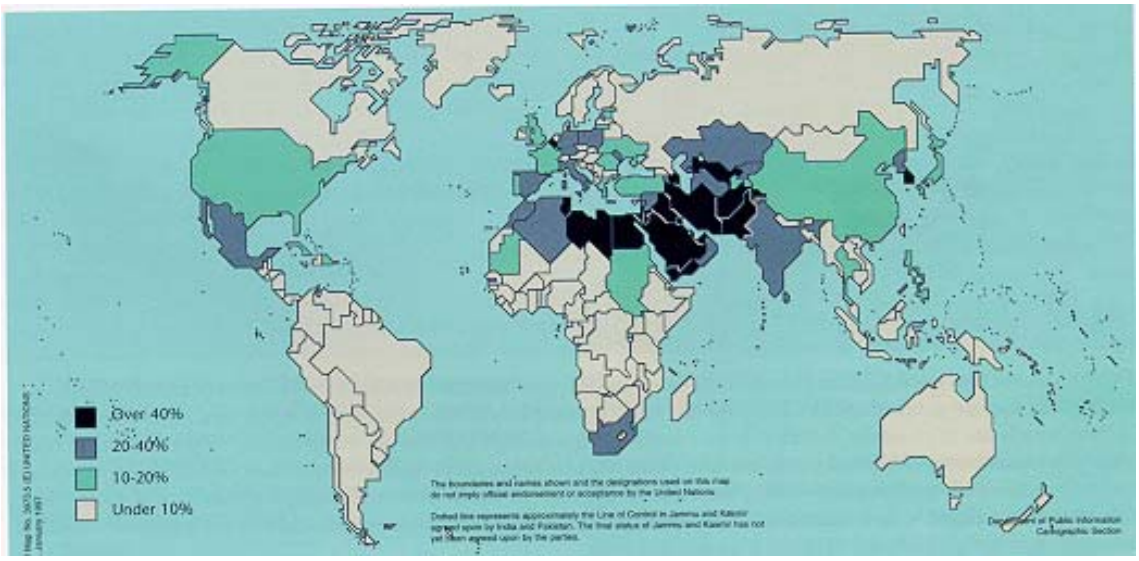
The diagram in **Figure 2** suggests two types of constraints: on the one hand the needed change may be too rapid for society to manage due to limitations in coping capability; on the other the mobilization level might be too high to be realistic in view of the evaporation losses from reservoirs needed to make the water available when needed.

In another paper the author has shown that water constraints may be severe for a around 55 % of the world population by 2025 AD (4). If dry climate countries cannot be self-sufficient in food production the food has to be imported from elsewhere. The considerable time delays that may be expected in a possible adaption to major market changes makes it urgent that the global community assesses the implications of this fundamental dilemma. The considerable gap between the optimists' and the pessimists' conclusions - as analyzed by Mc Calla (5) - regarding future global food export volumes indicates a gap between a doubling of the present export volume and a quadrupling in only 30 years.

Water for income generation and economic growth

Major driving forces of change shaping the next few decades include the ongoing rapid population expansion, growing expectations in terms of improved living conditions, rapidly growing food needs and improved nutrition standards. **Figure 4** shows the impact of population growth alone.The analysis leading up to the final report on the Comprehensive Assessment of the Freshwater Resources of the World (1) included different scenarios regarding the amount of (blue) water needed to secure income generation and economic growth (including irrigation).

Figure 4. Use-to-resource ratio by 2025 AD assuming constant per-capita-demand.



From CFWA (1)

Alt 1 studied the plausible results if IPCC's economic assumptions would play out as assumed (6) The world becomes progressively more integrated both economically and culturally. Water requirements were calculated based on a detailed sectoral end-use

analysis considering changes in both efficiency and management. The water needed for irrigation assumes a 10 percent expansion of irrigated acreage. The scenario indicates that the gross global water withdrawals would rise from 3700 km^3/yr in 1990 to some 4500 km^3/yr in 2025, i e with some 20 % in the next 30 years.

However, since the IPCC model pays no attention to possible water constraints, the result must be seen as quite conservative . The model also assumes little restrictions on free trade.

Other scenarios may be equally plausible. Alt 2 starts from how water withdrawals have been changing over time in the recent past (2). Agricultural needs were estimated from a predicted expansion of irrigated land by 75 Mha (as based on existing plans). Attention is also paid to evaporation losses from reservoirs. The scenario suggests that the gross withdrawals would rise from 3 700 km^3/yr in 1995 to almost 5 200 km^3 in 2025, ie by some 40 %.

Alt 3 , finally, involved an analysis of the increase in water consumption needed to feed the expanding world population based on the earlier indicated FAO-approach. Most of that increase is expected in dry climate regions. One of the keys to yield increases is root-zone water security to protect to the plant from yield reduction due to droughts and dry spells. The additional water needed just for food production would amount to some additional 2 500 km^3/yr, implying that direct water needs would increase by almost 70 % in only 30 years.

There are evidently considerable differences between the three scenarios, indicating severe lacunes in our basic understanding of the role water plays in vital life support systems.

Water quality and habitat deterioration

Water quality problems are widespread due to a) bacterial or microbiologic contamination responsible for a huge scale spread of diseases all around the developing world, and b) pollution from toxic substances, i e chemical contamination (metals, synthetic and industrial organic pollutants and radionuclides) posing cumulative and chronic health risks to humans and to aquatic ecosystems.
While the North has been able to address these two problem categories sequentially, implementing control measures gradually, the developing countries in the South are meeting the two distinct threats to water quality at the same time. Chemicals have already lead to contamination of water on a regional scale, in a few cases even on the global scale (7). Main pollution sources are from agriculture, industry and households but also deposition of long-range transboundary transportation of pollutants contributes. A huge legacy also exists in terms of hidden chemical time bombs, stored in soils and sediments, inherited from human activities in the past (8). Such hidden pollutants can get re-mobilized by land use change or climate changes.

Although half of the world population depends on groundwater for their supply, groundwater pollution, which is practically irreversible on a human time scale, has been allowed to spread without control through pollution from agricultural chemicals,

disposal of untreated effluents from industrial and mining operations, contamination from hazardous waste disposal, and salt water intrusion. Dominant approaches to waste production and management suggest that also the pollution loads will continue to increase.
As the competition for limited resources increases with expanding water use, and pollution loads increase, water quality will deteriorate further and maintenance of ecosystem productivity be even more compromised than at present. With growing industrial activities will come growing industrial pollution loads, although industrial modernization, increasingly, will involve waste-water treatment and growing water use efficiency. A more than 15-fold increase of the pollution load has been projected for the dynamic Asean economies (9). In the most optimistic alt 1-scenario the amounts of water needed for the dilution of the waste loads to "acceptable" water quality levels would demand some additional 8 000 km^3/yr to be added to the direct water use, increasing the human appropriation of accessible (blue) water to some 12 000 km^3/yr, i e to more than 80 % of the total accessible freshwater.

International security threatened

After considering these three alternative scenarios for the next 30 years, i e the life time of our children and grandchildren, we may draw a number of conclusions:
1) water problems are partly a wellfare issue, but much more so a development and socio-political issue;
2) the international security system will be stressed in a world where deepening resource scarcities and environmental disruptions can contribute to conflict. Tensions would be particularly complex if environmental degradation in various areas would stimulate additional migration to richer areas;
3) the massive water requirements for increased crop production means that huge amounts of river water would leave to the atmosphere, not available for reuse, leaving less water to dilute pollution loads;
4) what cannot be locally produced in terms of food has to be imported. This implies growing demands for food transfer from better endowed regions where a surplus can be produced.The expected vulnerabilities of dry climate countries with rapid population growth makes it important to ensure a stable, safe and fair environment for trade;
5) almost all accessible water would be appropriated already by 2025, leaving only limited reserves for the following generation;
6) water scarcity can never be overcome by wellfare programs, but by use of ingenuity, skills, concerted efforts, etc.;
7) the huge pollution loads to be expected from the ongoing urbanization and industrialization in a world that has a very poor record in terms of waste load reduction may lead to widespread collapse of aquatic ecosystems.

THE FUTURE WE WANT

The overall conclusion to be drawn at this point is that major shifts in both policies and conceptual approaches to water are called for in order to limit the calamities that can

otherwise be foreseen. The alt 1 scenario showed that our present policies, technologies, and institutions are likely to lead to a future we won't like. The alt 3 scenario has given an indication of the herculaean effort involved in securing global food supply.

In order to find out a better way to craft future water resources strategies we have to complement with a backcasting approach to visualize where we want to be. Our long-term vision is an environmentally sustainable society with the ability to endure and flourish. There is no undermining of the natural resource base, i e both land and water productivity are well protected from a long-term degradation. Upstream/downstream disputes regarding water sharing and water pollution are skilfully averted. International consensus has been achieved on a joint code of conduct based on a basic water ethics. Poverty eradication involves at least three components that are directly or indirectly water-related:

* morbidity reduction through health-protecting activities (safe water supply and sanitation)
* security in access to food either through achieving national self-reliance through water-consuming crop production, or through purchasing of food which depends on access to a secured family income
* family income which depends on employment opportunities in sustainable industrial or cash crop production, both water-dependent.

Aversion of the different water-related threats hindering poverty eradication and sustainable economic development will demand a number of challenging management efforts:

* conflict aversion: water sharing strategies and regulations, based on a universally accepted water ethics
* pollution aversion: proper management of waste (liquid and solid) and of water soluble agricultural chemicals
* aversion of land fertility degradation: integrated soil/water/nutrient management
* aversion of urban water supply collapses: development and maintenance of the urban water/sanitation infrastructure
* aversion of crop failure: simple drought proofing technology based on rainwater harvesting or local runoff collection.

WHAT KIND OF STRATEGY IS NEEDED TO ADDRESS THE FUTURE?

A strategy to address water problems, existing as well as future can consist of very different types of factors, of different levels of detail and with different approach. It may be implemented at few or several stages. But to be effective the overall approach has to be integrated.

Regional differences

Category A regions

An integrated approach has to be applied to water- and water related problems in region A, as defined above (for instance Morocco). This is a really water scarce region,

experiences *natural water scarcity,* dry climate where potential evapotranspiration exceeds precipitation, *demographic water scarcity,* a limited amount of water per capita (less than 1000 m^3 per capita per year), and *technical water scarcity*, a high ratio of water use to water availability.

In this kind of area the issue of sharing the small amount of water between its competitive users, both in terms of people and in terms areas of use is the main problem. In doing so demand has to be adjusted to supply, *demand management* has to be applied. It will be necessary for countries of this category not just to adjust their demands to existing supply but also from a national perspective to try to diversify the demand so that it would also include possibilities to trade in order to secure basic needs, in particularly for food security. This is in particularly true for poor countries.

Category D regions

For *water-rich* (precipitation exceeds evapotranspiration) countries with *low water needs* (high amount of water per capita per year) and thus *low use-to-availability* ratio (category D), such as Canada, Sweden or central Africa, it might appear to be no water problems as water is abundant. This may, however, sometimes be the root of the problem, especially in rich economy countries and water-rich rapidly growing economies such as in south-east Asia, where industrialisation has lead to a rapidly increasing pollution of water and land. Even though ground water abstraction may not be a main problem in these areas, less amount of available *clean* ground water may be the result of pollution affecting also the ground water.

An integrated approach to land-freshwater-coastal zone problems is needed to apply both in the rich countries, in rapid industrialised countries and in poor countries. This is particularly the case where land-based sources of pollution, including from agriculture, is the main water problem. An evident example is the action programme for the Baltic Sea, shared by several countries.

Category E regions

Countries of category E, *natural water scarce* countries, due to the erratic precipitations appearing to have *low water needs* and thus *low use-to-availability* ratio, such countries in Sub-Saharan Africa, seem today not to have severe water problems. This, however, is as described above partly due to relatively sparse population, low rate of irrigation and difficulties in mobilising from ephemeral rivers. But partly it is also an effect of those countries are too poor to be able to develop their resources. Unfortunately, the population growth when drought is not a limiting factor is high. There has been a tendency to implement activities on single-project basis, in some parts to be able to survive. This is a non-sustainable solution and will in the long-term perspective not result in an increased capacity to cope. The economies are not likely to improve, as a result of such short-term activities and the countries will remain dependent on development assistance.

To be able to escape the economic trap it is necessary for these countries to shift development of water use into sectors that would create employment and generate income with which to buy food from water-rich countries or from areas within the country where access to water for food production might be less scarce.

Category C regions
Countries belonging to category C, *climatically mixed* regions with moderate population pressure today and *moderate use-to-availability* ratio is a very mixed group, where it is difficult to define common problems. Some of those countries, Central Europe are today relatively rich countries with relatively low population growth where the main problems today are linked to water pollution. Others, such as parts of South-east Asia and Northern China are partly rapidly growing economies with rapidly growing mega-cities where provision of potable water and different kinds of water pollution linked to industries and the mega-cities. The water problems might therefore be regional but may have an effect on the economy of the nation.

The approach that needs to be taken for all countries of this category is an integrated one as any measures linked to water in one sector would have an effect on water available for other sectors. In a regional perspective there may of course be differences as the regions can vary in types.

Category B regions
Countries of category B in the temperate Zone where the *potential evapotranspiration* is relatively low and the *population pressure* also is relatively low would be assumed to experience little water problems. Examples are USA, the countries in Middle Asia etc. These countries cover often vast areas, including arid and semi-arid areas. In some parts of the countries the use of water is exceeding the available amount, sometimes due to that the available amount is small, sometimes due to wasteful and unsustainable water use, sometimes to a combination of both.

To be able to reach any sustainable solution on water issues it is absolutely necessary to apply an integrated approach, both from an area and an issue perspective. As the situation also can vary very much in different parts of the countries, the necessity to adjust the demands to existing, and future, supply is necessary. To reach best available benefits in the region even inter-state and/or inter-national agreements should apply an integrated approach.

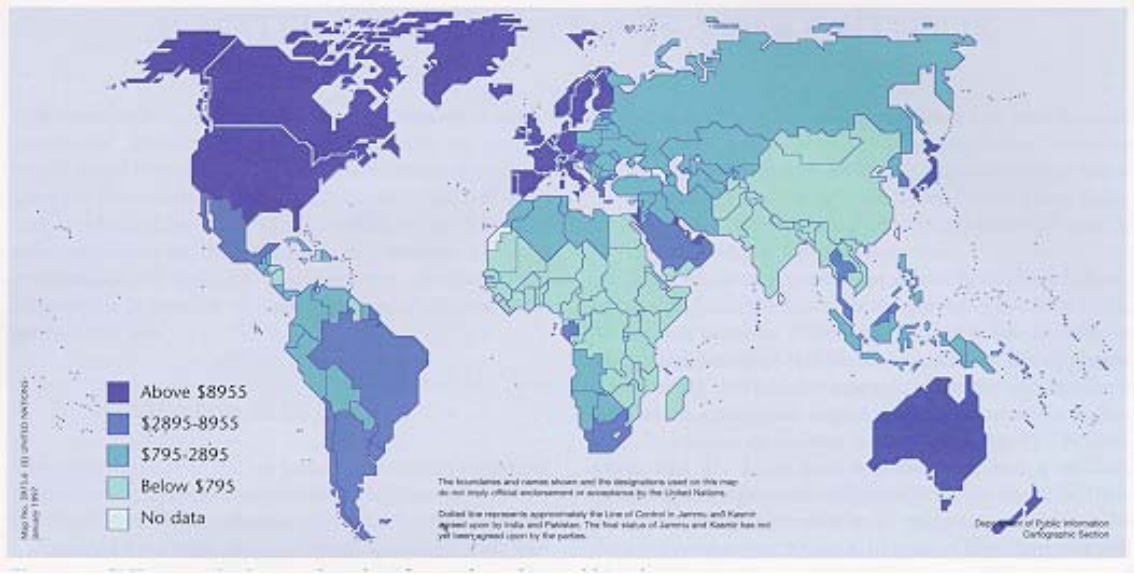
Coping capability differences

For countries to be able to apply measures within a strategic framework, a coping capability is needed in terms of economic, technical and knowledge capacity. As can be seen from the five categories presented above, categorisation per regions for different water related problems is very difficult. Categorisation when it comes to coping capabilities is not more easily applied and the results when applying a multi-variety of parameters are not increasingly reliable. A figure that can be used to roughly estimate the coping capability of a country, and that is accessible, is the current per capita income, where the World Bank four categories are used (< $795, $796 - $2,895. $2,896-$8,8955, >$8,956) for CFWA. To apply these different income categories to the five "water categories" related to climatic conditions is theoretically difficult as the categories sometimes are composed of countries with different preconditions, differences both between them and inside them. As those differences refer to both

natural preconditions and to socio-economic ones (that is in particularly true for categories C and D) it is not
possible to suggest any common strategic approach, except for that it needs to be integrated and adjust demand to supply even in a future looking perspective.

To be able to come up with some kind of regional approach in applying strategies and policy options, the Comprehensive Freshwater Assessment therefore used only four regional categories, countries with low annual per capita income (<$2,895) and countries with high annual per capita income (>$2,896), countries using >20% of the available renewable water resources (=water poor countries) and countries using <20% of the available renewable water resources (=water rich countries). See **Figure 5**. The two criteria are then combined. Evidently this categorisation is very rough and thus the suggested policy options are sometimes vague. To present more detailed suggested policy options and action plans it would be necessary to, for each and every country and/or region try to decide its current as well as future status concerning *natural wateravailability (*precipitation - evapotranspiration), *population pressure, use-to-availability*, *annual income-per-capita, access to technology* and *level of in-house knowledge.* Even if we are considering all these, partly independent but interacting parameters a country can make a peculiar performance, depending on being a large country where the first and the third parameter can vary across the country.

Figure 5. GNP per capita in 1994



Annual income per capita 1994, used as a proxy for coping capability. Based on data from the World Bank. From CFWA (1).

The regionally based policy suggestions of the Assessment are based on the four categories Water rich/economically wealthy, Water poor/economically wealthy, Water rich/economically poor, and Water poor/economically poor.

Local as compared to international strategies

In considering strategies and policy options in integrating water management driving forces resulting in the present and future conditions must be defined. The main driving forces are population growth, changing production and consumption patterns, economic growth and changing trade systems. These and their level of details of course vary, in particularly between different levels of society. The policy options will therefore have different character at local level compared to at international level.

The strategies at national level should have the following goals, to (i) secure basic food availability, (ii) secure water for drinking water supply and sanitation, (iii) reduce water pollution to protect human and ecosystem health, (iv) increase co-operation over transboundary waters, (v) clearly demonstrate the need to consider water as an economic good, (vi) build human and institutional capacity, and (vii) secure access to reliable data. The different preconditions of course imply different policy options, at international as well as at local level, but to be able to suggest detailed options, there is a need for a clearer diversification in accordance with the real preconditions. This is a real challenge for future work, but for a near future as measures urgently need to be taken to secure a future where enough water is available.

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WATER AND FOOD SECURITY

by Wulf Klohn & Bo Appelgren

Based on lessons learnt from the recent past, the authors agree that food insecurity is dominantly linked to lack of income rather than lack of water. Food self-reliance is ensured through a mix of crop production and import - both hampered by poverty and stagnation. In dry regions, irrigation is a key factor in stabilizing agricultural production and often pressing against hydrological or economic limits.

INTRODUCTION

The bells of alarm have been rung about an impending food crisis owing to population increase, a dwindling amount of land and water per person, exhausting fossil energy supplies and environmental degradation. The authors believe however that the global capacity to produce food can match population within the foreseeable future. Based on the discussions at the recent World Food Summit (Rome, 13-17 November 1996), food security does depend on water, land and other factors which need to be globally articulated and addressed. These include the socio-political and economic environment, population growth and food requirements, international trade and food aid, available options for increasing food production, processing, marketing and distribution, and agricultural research and investment strategies. Establishing food security is a continuous and often long term process that represents an important element of development strategies, especially in poor rural economies.

The Right to Food

There is a trend for an international recognition of a human right to food. The sources include the 1948 Universal Declaration of Human Rights, the 1966 International Covenant on Economic, Social, and Cultural Rights, and, for armed conflicts, the 1977 Protocols to the 1949 Geneva Convention. While the right to food as humanitarian aid in the case of disaster or war is generally accepted, there is growing agreement that no nation has the right to starve its people (1). Few governments are however prepared, or have the capacity, to secure access to food of poor and undernourished citizens. At the World Food Summit, a debate raged in which some argued that increased trade, obtained cutting the global market free from government intervention, will result in greater food security, while others reasoned that food is a basic human right which national governments, not the global market, have a primary responsibility to make accessible. The following compromise statement was included in the Rome Declaration on World Food Security:

"We pledge our political will and our common and national commitment to achieving food security for all and to an ongoing effort to eradicate hunger in all countries, with an immediate view to reducing the number of undernourished people to half their present level no later than 2015".

Access to adequate food is increasingly being seen as a human right. To allow access to food for the poor and undernourished populations, today about 800 million people, is a problem of distribution and access to available supply. The challenge is rooted in the lack of progress on food production in countries with low nutrition levels, low income, prevalent poverty and inadequate growth. Production constraints in such countries represent a major obstacle to food security and cannot be overcome by trade only: affirmative action is required to increase income, growth and food production where poverty and undernutrition is prevalent.

FOOD SECURITY - A COMPREHENSIVE VIEW

Dietary energy

Food intake is usually measured in energy requirements as calories per day and person. The minimum level of energy requirements for individuals, allowing for only light activity, ranges from 1720 to 1960 calories/day/person (2). Food security is defined as a state of affairs where all people at all times have access to safe and nutritious food to maintain a healthy and active life (2). For a household to enjoy food security, it is necessary that its members have the resources to buy food, or in the case of self-sustaining farmers, to produce it according to the household's needs. Food insecurity at the household level is almost invariably associated with poverty. But poverty is complex and only after its causes are examined can solutions be developed.

As shown by history, food insecurity at the household level is most often associated with failing rainfall or agricultural pests resulting in crop failure, war events resulting in disruption of agricultural activities (recruitment of farmers and agricultural labour into the armies, devastation of the countryside, displacement of people) and of foodstuff trade (blockade, siege), and changes in the economic and social environment (terms of trade, employment, demography) resulting in critical financial weakness of families. In a situation of insufficient food supply, household members may have unequal access to food to the detriment of the weaker members of the group, usually women and children. The current hunger map of the world flags firstly and foremost countries stricken by war. Millions of land mines buried in the fields during armed conflict prevent cultivation and take a terrible toll on rural people for a long time after the war is over.

Available food supplies, measured through the average dietary energy supply (DES) in calories, are unequally distributed within a country: experience shows that, for countries where the average DES is close to the nutritional threshold, the majority of individuals are undernourished, while for countries with DES at a level of 2700 calories the number of undernourished individuals is small. Thus, a country DES level of 2700 calories per person per day is used as a threshold separating a barely satisfactory food situation with an unsatisfactory situation. The DES in rich countries is significantly higher than the 2700 calories threshold but there are limits to what people can safely eat and few countries drive average food consumption and wastage beyond 3500 calories per person per day.

Food self-reliance: a mix of production and trade

National governments have a political motivation and at least a moral responsibility to guarantee minimum access to adequate food supplies for all citizens. Food self-reliance is usually ensured through a mix of domestic agricultural production and international trade; in certain situations, however, countries strive for food self-sufficiency, relying essentially on domestic production and on food storing to ensure food security at food prices that are accessible to the poor. This is not only the case when there is a threat of war and disruption of trade, or in the absence of an adequately large market to bridge the country over years of drought and crop failure, but has also been used as a consistent element of long-term economic development strategies.

A necessary but not sufficient condition for food security is that an adequate and stable level of food supplies to feed the world population is reached overall. However, global food supplies are poorly distributed between a few exporting countries and regions of the world that have become dependent upon imports. In practice, in the same way as poverty may prevent families from ensuring adequate food intakes for every member, countries with a weak trading position may be unable to buy in the international market the food needed to ensure every citizen is adequately fed. Indeed, widespread hunger and starvation can occur even when food is available, if large numbers of people lose the ability to purchase, exchange or receive food.

Low-income food-deficit countries

Most of the world's hungry live in 86 low-income food-deficit countries LIFDCs, over half of them in Africa. They do not produce enough food to meet their needs and may not have sufficient foreign exchange to make up the shortfall by purchasing food on the international market, especially when faced with loss of crops and livestock caused by disasters of natural or human origin, with exceptionally high international food prices or with exceptionally low prices for their export commodities. Moreover, massive urbanization is changing the character of diets towards higher quality cereals and livestock products. At the limit, food assistance can prop up a food-deficient situation, but owing to its temporary nature does not provide real food security. LIFDCs need to produce food at the best conditions accessible to them.

THE WATER CRISIS AND FOOD SECURITY

2,5 billion more to feed in 2025

The current world population of 5.8 billion people continues to increase at a rate of some 90 million people per year and it is projected that by the year 2025 there will be 2.5 billion people more, for a total of 8.3 billion. Between 1950 and 1990, when the proportion of hungry people declined, some 2.5 billion people were added to the world population. The decline took place primarily in China and Southeast Asia, while hunger in absolute numbers has risen in Africa, Latin America and South Asia. By 2025 it is expected that over 80 percent of the world's population will live in developing countries, and over 60 percent of these people will live in cities.

Irrigation needs pressing against hydrological limits

Since the early nineties, concern has been expressed from various quarters about unsustainable trends in water use, in particular agricultural water use, and an impending water crisis (3, 4, 5). Between 1950 and 1990, water use tripled owing mostly to increased reliance on irrigation for food production. Nowadays, irrigated agriculture, which makes a large contribution to food security, accounts for the lion's share in water abstraction: some 70 percent world wide, and over 90 percent in some developing countries. Globally, over 50 percent of all economically accessible water resources have already been appropriated (6). The demands for water are pressing against hydrological limits. The world as a whole is not running out of water but, as population increases, the quantity of economically accessible freshwater per person and per year is decreasing. More water is available, but at a steeply increasing economic, social and environmental cost.

Food security and water: diversity of situations

The relation between food security and water is complex and manifold. The water crisis scenario is based on global total and average figures and on extrapolating past trends. According to these trends, all the economically accessible water could be committed by the year 2025 (7), by when the cost of water development projects would have steeply increased. Therefore, well before any absolute resource limits are reached, the costs of water resources development become high and few projects remain feasible and bankable to attract financial resources. This would not necessarily detract from food security in countries that can afford higher prices. In reality, there is a diversity of situations in individual countries, ranging from still abundant water resources to severe water crisis under way. In many countries, water policy is changing and adjusting towards a more sustainable form of water use, through less wastage, protection of water at the sources and adjustments in the patterns of agricultural trade to ensure security of food and water. The supply of water turns out to be always a local or, at the most, a regional issue.

Irrigation - key stabilizing factor

Plant development and the production of biomass, including food, requires that soil moisture, naturally provided by rainfall or added by irrigation, be available at the root level. Unlike most other water uses, water applied as irrigation is largely evaporated in the process and not any more under control for other uses and for the environment. Moreover, intensive agricultural and livestock production requires the management of nutrients and pests. Agrochemicals applied to this end can be heavy polluters of water and the environment, to the detriment of other users, including agriculture itself and fisheries. Some food-processing factories can be among the worst environmental offenders. As water becomes scarce, agriculture is constrained to pollute less and to use the limited resource more efficiently. Conversely, agriculture can use domestic wastewater, however under stringent limitations owing to health consideration.

Irrigation is a key factor in stabilizing food production. Intensive, reliable production under irrigation offsets the limits set to horizontal expansion and yield increases in agriculture that is dependent on the vagaries of rainfall. Irrigation minimizes the effect

of insufficient soil moisture on plant growth and reduces the risks farmers take in their seasonal investment. Crop yields on irrigated land are typically two to three times higher than average yields on rainfed lands and may be better in quality and opportunity, thus resulting in higher revenue for the farmer. However, agriculture is in competition, both for water and for investment funds, with other sectors which more often than not are economically stronger. Making water available for agriculture requires investments in infrastructure, which also needs to be maintained and managed. Moreover, agriculture dependent on pumped water can be energy-intensive (8, 9).

Income of the poorest has to grow faster

Market demand, partly driven by the position of countries on food security, is expected to induce agriculture, in particular irrigated agriculture, to grow the bulk of food needed for a growing population. How this food will be priced is a disputed question. What is clear is that the number of food insecure people will decrease if the income of the poorest people grows faster than the price of food, whereas increasing food prices and stagnating economies mean more hungry people: hunger will recede if the income level of the poor is raised above the hunger level. In rural areas where there is still undeveloped water, advancements in irrigation technology, resulting themselves from the pressure of water scarcity, are likely to also benefit the generation of income, and therefore to support food security. A caveat, though, is that capital is always a critical resource: the promise to improve the food situation is borne by robust, appropriate, low-cost technology.

Water - too little or too much

A number of food-stressed countries under semiarid climate conditions find themselves in a situation where poverty, the cause of food insecurity, prevents agricultural and water development to increase production and income and also perpetuates dependency on insecure food imports on concessional terms. Such countries need capital and technology assistance, and probably also price protection, to overcome the agricultural production straits. A different set of food-stressed countries is found in the humid tropical region. These countries still have reserves of rainfed land and a potential for productivity increases. Their problem is not water or land scarcity, but often is composed of agronomic problems and the absence of a consistent approach to food security policy.

MACROECONOMIC AND SECTORIAL POLICY FOR FOOD AND WATER

Shift towards market oriented strategies

National food security is embedded in the macro-economic and agricultural policy environment. In the recent past, the failure of interventionist approaches in developing countries induced a shift towards market oriented strategies, often adopted in the context of structural adjustment programmes. When countries with a weak economy become exposed to external stress from open international trade, they attempt to maximize gains and minimize immediate losses from the integration into the world

economic order. The policy measures taken by these countries need to be consistent, with, for example, crop pricing policy reforms and changes in macro-economic and foreign exchange rate policy. This has not always been the case.

One of the phenomena often associated with structural adjustment of the national economy is large scale migration of labour from rural areas to cities. Better income opportunities in the more dynamic urban economy spill over to rural areas through remittance of funds. Migration is not without problems because urban areas are not ready to receive the migrants, but has proved beneficial overall when accompanied by rapid development in the manufacturing and services sectors. Nevertheless, because of a concern about rural poverty and household food security, many developing countries subsidize agricultural inputs and support agricultural prices, sometimes while these very measures are undermined by overvalued exchange rates and price distortion between crops.

Breaking the circle of stagnation

Countries normally embark on policy reforms to address national indebtedness and balance of payment problems. However, policy reform has also proven necessary to reorient development strategies in order to provide a suitable environment to address problems of employment, poverty alleviation and appropriate resource management, all necessary elements to enhance food security. When low prices disincentive agriculture, the countries which do not produce enough food to feed their people, and cannot afford to bridge the gap with imports, remain below subsistence level. Inconsiderate food help and food dumping, while bridging over a food scarcity episode, can be ruinous for local farmers. Channelling scarce investment funds into, for example, finance-intensive irrigation development projects in an adverse economic environment is poor business and cannot break the circle of stagnation.

Policy reform - a necessary element

Macro-economic and sector policy reform is therefore a necessary element to address food security and scarcity of land and water resources. There is a need to identify critical issues and draw lessons from policy approaches and processes in those countries that have been successful, and also from those which have failed to establish an adequate level of food security. Generally, to sustain food supplies and support local food security, it is important that the necessary incentives, including producer prices providing improved purchasing power and reduced risks to agricultural production, are established to motivate farmers to activate production (10, 11, 12).

Successes and failures in National Food Security

During the last decades, many countries have succeeded in raising per caput food supplies and also many have failed. The raise in food supplies was generally associated with above average economic growth, increased food imports, reliance on global agriculture and a trend of declining food self-sufficiency. In the case of some large rural economies, improved rural income formed the base for economic development in other sectors. While improvements in per caput supplies could be sustained only for limited periods of a decade or so, the durability varied in the countries depending on the commodity cycles. In the more durable cases, food supplies were integrated as part of the socio-economic transformations.

China, with 21 percent of world population and 7 percent of global runoff, has been able to increase from a low level intake of 1500 calories to over 2700 by the 1990s and to feed over one fifth of the global population through increases in the domestic production, using only one-fifteenth of the arable land of the world. These results were based on incentives and strong institutions that supported agricultural infrastructure and dissemination of technologies. Burkina Faso, following the hard experience of Sahelian droughts, has been successful in improving household food security through a mix of policies including macro-economic policy reform, water and soil conservation and household income generation. Other countries with determined efforts or more recent policy measures towards improved food security include Ecuador and Costa Rica in Latin America and Mozambique and Zimbabwe in sub-Saharan Africa. Policy measures to mitigate negative effects on the poorest and most vulnerable groups contributed to success in these countries.

Countries subject to economic and agricultural stagnation have consistently failed to raise food supplies. As food imports did not increase to compensate for the decline in self-sufficiency, the social and societal costs of declining per caput food supplies have been very high. It is generally agreed that inappropriate food security policies also lead to high incidence of conflict and political instability, with further devastating impacts on national economic development and food security.

FUTURE DIMENSIONS

The fact that food insecurity is almost always tied to poverty suggests that investment capital is a critical factor to overcome constraints to development and ensure access of people to food. Moreover, the fact that there are food-insecure people in the humid tropics with relatively low population density shows that water is not always critical to food security. However, where water is critical, its mobilization and effective management can contribute to economic development, boost real income and, consequently, improve food security, provided that macro-economic and sector policy reform create an enabling environment (9).

There are opportunities for development of new water resources in food-stressed parts of the world, such as semiarid sub-Saharan Africa. The approach to take needs to be practical, driven by the demand of people, targeted to improve employment and income of the poor, and flexible to adapt to local circumstances. Undernourished and weakenedpeople have a limited capacity to work, untrained workers may be unable to

deliver a sophisticated job, and uninformed people will be hard-pressed for success in business.
Overcoming the circle of poverty and malnutrition requires that people have access to sufficient and adequate food at the beginning of the day. Moreover, people should have access to adequate technology and training and timely information on markets and other income opportunities should be available. The local production system can hardly be expected to get into gear if there is no sustainable provision of finance to lift the constraints to development, whether these relate to water, capital, infrastructure or basic services.

Another increasingly important dimension is given by environmental and sustainability concerns. There is only a modest potential for expansion of agricultural land and agricultural intensification is foreseen to be a main factor to improve rural income and create incentives for profitable farming. Intensification is however often associated with resource degradation. Between the needs of the environment and the needs of communities there is an element of competition. The trade-offs between increased production and sustenance to growing populations, on one side, and the preservation of natural resources and ecosystems from degradation, on the other side, include policies to limit deforestation, minimize the use of agrochemicals and generally use freshwater resources more efficiently. There are sometimes formidable constraints and limited capacity to adapt the policy as well as the economic and institutional environment to these requirements and it has been questioned whether market instruments alone can give enough protection to the environment where it is under threat. However, in the perspective of poor countries, long-term environmental concerns have far too much overshadowed the immediate socio-economic development requirements.

A main concern is to initiate and accelerate development in the lowest-income countries, where capital always represents the critical resource. Capital is not forthcoming in a sustainable manner to such countries owing to the difficulty to identify meaningful investment options and limited domestic savings to create the capital lacking for investment opportunities. Records of development failure remain an obstacle and it is hard to find collateral or insurance to shoulder the high risk. The FAO Special Programme on Food Security is a farm-level based approach being introduced in low income and food deficit countries. It is designed to increase and stabilize food production and productivity in a sustainable manner, and aims at providing the farming communities with well demonstrated packages for agricultural production. Its focus is on low-cost water control systems to reduce climatic risks, crop and livestock diversification, intensification to improve rural income, and constraints analysis to identify bottlenecks areas such as markets and credits in order to support the formulation and implementation of conducive policies.

The water control approach under the Special Programme on Food Security

Kenya*:* Even in the higher rainfall areas of Western Kenya temporary drought is common and there is a need for supplementary irrigation and water control to support cropping intensification and diversification for continuous and increased production and reduce the production risks. This is done essentially through approaches to low-cost water control such as integrated inland valley-bottom development including water control and irrigation also using seepage water in the valley sides; careful, controlled development of wetlands; and improved management in small-scale surface water diversion schemes.

Yemen is an extremely water-scarce country where water conservation and groundwater recharge is a necessity for food security. The country has good rainfall in its central highlands, but the runoff is to a large extent lost as floods discharge either to the sea or to inland desert sinks. The approach to water control is focused on water harvesting and small reservoirs that provide temporary supplies for small scale irrigation and also recharge the groundwater to be used in conjunction with surface water.

Water is scarce in the highlands and mesothermic valleys of Bolivia. Moreover, evaporation is high and the river sediment load easily defeats small reservoirs. The water control strategy is based on underground water storage and abstraction, improvement of conveyance structures (canal lining) and more efficient application of water in the field. Water-saving technologies, such as microsprinklers and drip irrigation are gaining increasing acceptance with smallholder farmers.

Landscape with hills in the background in the Mahweet Governorate close to Sana, the capital of Yemen, where the dam is providing 2-3 months of supply and has helped to re-establish the groundwater level within the cultivated area that had declined to 140 meters, to a depth of 14 meters. Photo: Bo Appelgren.

CONCLUSIONS

The establishment of food security is a process that requires appropriate and consistent approaches and the right enabling policy environment. To avoid economic stagnation and social constraints, it is essential to ensure economic growth and improved household income and therefore to support food security as an essential element for socio-economic development in the agricultural sector as well as in other economic sectors. Growth however is often enacted at the cost of further unequity. The need to protect the poor and under-nourished part of the population who do not have the economic capacity and access to food cannot be neglected. With this approach there is also a stronger base for efficient management and use of land and water resources for domestic supply of food and, in the case of resource scarcity, to further support diversification of the economy away from high water demanding but low-yielding economic activities, including irrigated agriculture for low-value crops.

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PREPARING FOR THE FUTURE
HYDROECONOMICS: GETTING WATER INTO NATIONAL ECONOMIC PLANNING

Part I: Why hydroeconomics is important

by Peter Rogers

Water is one of the simplest chemical compounds. It plays a critical role in sustaining biological life on planet earth.. It is also a major natural resource for human use. To appreciate fully water policy options and how they are evaluated it is necessary to understand how economics is used and misused in the water area. This paper motivates the need for a more erudite and focused branch of economics dealing specifically with water. This branch is called hydroeconomics as a parallel to the terminology hydropolitics used by political scientists when discussing the political of water use.

WATER IN ECOSYSTEM SUSTAINABILITY

At a fundamental level water has only two uses: first, and foremost, sustaining the ecosystem; and second as a natural resource for humankind. All other uses can be subsumed under these two.

In discussing water resources much of the literature refers to so-called "surplus" water supplies or "available" water. We should bear in mind that these are entirely anthropocentric concepts. In an ecosystem there are no "surplus" materials. Water is just re-allocated between species. This immediately raises the economic concept of "opportunity cost." What is the opportunity cost for water re-allocated from one ecosystem use to another? An example is when water is diverted from agriculture to industry: the opportunity cost associated with the water is the marginal value of the water in agriculture. We can usually derive fairly good estimates of these marginal values. But what is the opportunity cost of the water when a wetland is drained to provide water for irrigation?

Externalities in the Ecosystem

Without these externalities we would not have a functioning ecosystem. There is no effluent that is not a functional and required part of some other system. All the externalities are, therefore, beneficial ones. Without externalities the system itself would cease to function. The problems arise when *Homo sapiens* overloads the capacity of the ecosystem to adsorb or, otherwise counteract, its effluents and environmental actions.

Property Rights in the Ecosystem

For most humans, it is assumed that all the property in the ecosystem is theirs to dispose of as they see fit. Indeed, many major religions sponsor the concept of humankind subjugating nature. Despite this general assumption, and the problems it causes, humankind sometimes adopts laws and regulations protecting some species for their own purposes, not that of humans, which is a key issue in the UN Biodiversity Convention.

Economics of Sustainability

How has conventional economic approaches to environmental management changed during the last 10 years? Many economists (1) view the environment as a form of *natural capital* that must be preserved. They distinguish three types of capital;

1. *man-made capital*. Factories, roads, housing, machinery, etc., which can be expanded or decreased by human effort;
2. *critical natural capital*. Ozone layer, global climate, biodiversity, wildernesses, Antarctica, etc. which is made up of natural assets essential for ecosystem survival that cannot be replaced (or at least not without great difficulty) or substituted for by man-made capital assets; and
3. *other natural capital* (renewable natural resources and other finite resources that can be partially or wholly substituted for by products of man-made capital assets).

The problems for economic theory lie with how to deal with the *other natural* capital. For the *critical natural* capital category the prescription is clear (even if the implementation has not followed): these are vital, irreplaceable, *beyond price* (1, p. 18), and their preservation should be an absolute constraint on all activities. Is water a *critical natural* resource or an *other natural* resource? Unfortunately, it appears to be both. It is essential for human and ecosystem survival but its use in many activities can be substituted for by *man-made* capital. This dualism causes much confusion in discussing the rational economic development of water resources.

Problem of Defining Objectives

How does one make development sustainable? The suggestions have been many:

- Let future generations have as much access to our resources as we do.
- Do not discount for future welfare.
- Minimize consumption of exhaustible resources.
- Maintain current stocks of renewable resources.

If these were to be truly followed, we would consume no non-renewable resources today as we spread these scarce resources out over an essentially infinite horizon.

The Need for Government Interventions

If the economic impacts of all the pollution and other unaccounted-for externalities to the system defined were really reflected in the prices of resources, then classical economic theory would lead us to a *Full-Cost Pricing* system. In the case of pollution, this can be restated as the *Polluter-Pays Principle* and can be achieved by environmental regulations and economic incentives for pollution prevention. For resource use, the formulation is the *User-Pays* Principle.

OECD has established the following set of Sustainable Development criteria:

- place economic values on environmental costs and benefits (The *User-Pays* and *Polluter-Pays* Principles);
- avoid damage to critical natural capital as far as possible (The *Precautionary* Principle);
- avoid irreversible processes;
- limit the use of renewable natural assets to their sustainable yield; otherwise, include the costs of replacing these assets, e.g. through a "compensatory" project.

While it is true that market mechanisms may be more efficient than traditional command and control regulations, however, it is not reasonable to expect private profit maximizers working with high discount rates to be entrusted with the responsibility of keeping the welfare of future of future generations in mind. It is possible, however, to let market mechanisms work to implement innovative approaches to environmental management, such as tradeable permits. The problem is that these approaches have limited applications; in addition, the cost of tradeable permits is not easily pre-determined. Effluent charges and taxes would also encourage innovation and efficiency as compared to more traditional regulations, but there would be uncertainty in the amount of environmental improvement achieved. Market mechanisms are extremely difficult to implement in the face of the large uncertainty in the emissions, the standards and the costs, efficiencies, and reliabilities of control technologies. This is where the need for government intervention is clear.

SCARCITY OF WATER

The discussion about scarcity is usually intimately bound up with the concepts of water as a renewable or non-renewable resource. If it is renewable, how can we ever run out of water? Certainly in many arid or semi-arid zones, people are currently experiencing shortages of water, partly due to population growth (2). It is noted that the cost of supplying additional water to water-short areas is increasing (3). As a result it becomes increasingly difficult to supply the same amounts of water to users at the old low prices.

Modern economists define water scarcity slightly differently, the need for water has to be expressed as a quantity and a price. This is called the "economic demand" for water and both quantity and price must be specified. Clearly, if a resource base is fixed and the consuming population increases, something has to give. This will be either the price

or the quantity of the resource used. However, even this system would ultimately be forced to a halt by population or economic growth. The magical ingredient that enables the economic system to continue to grow is the existence, at some reasonable cost, of substitutes for the scarce resource. A paradox arises here because there is no substitute for non-saline water in sustaining human and animal life. But there is an almost infinite supply of sea water, which can be converted at a cost of energy into fresh water; so now energy, or the capital available to access the energy, becomes the limiting resource. Similarly, political boundaries, management skills, or human labor could be the factors which limit the availability of water.

How close are we to reaching the resource limits? For example, in a study for the World Bank, Falkenmark et al, (4)) claimed that some Middle East countries (Israel, Jordan, Saudi Arabia, Syria, and Yemen) were very close to being unable to supply their populations with the minimum needed amount of water (500 cubic meters per capita per year). However, others looking at the same data (5) see many possible adjustment mechanisms, which include recycling, cut-back in agricultural use, changes in population policy, and the reclaiming of additional brackish water.

Has water been a significant limit on economic growth in any of these countries? How will each country address the future of this resource? Has water been priced out of the reach of significant portions of the populations? What accounts for the fact that in many other countries with much larger per capita quantities of available water the per capita water use is lower? On closer inspection the "water barrier" of 500 cubic meters per capita per year does not appear to be a real barrier from all perspective. The idea put forward by many (6) that we are running out of water cannot be true globally, and even in specific water-short countries there is little doubt that water will always be available at some reasonable price, provided those countries follow sensible economic water policies. *The definition of scarcity in non-economic terms is a distraction that can lead to major misallocations of the water resource* (5). The rapid disappearance of the "oil crisis" once limited market responses were allowed to take place should be borne in mind by water planners. In this context Stavins (7) makes the observation -- that the "exhaustible" resources are actually not threatened because their price reflects their scarcity; on the other hand, the "renewable" resources (such as clean water, forests and some biota) are most threatened due to mismanagement of these usually common property resources because they have no price protection!

Allocation of water among the conflicting potential uses presents a major task to governments, regulating access to water. It is difficult to assign unambiguous economic values to many uses, and hence these may be implicitly overvalued, undervalued, or completely ignored in the decision-making process. Rogers (8) gives several examples of the problems that arise from undervaluing water. Many of the problems of valuing water stem from the market failures mentioned above. In particular, the existence of externalities and the lack of mobility of resources make finding the market price quite difficult.

In a perfectly functioning economy envisaged by the classical economic model "price equals value," and the cost of providing a good, after allowing for payments to all of its factors of production, will equal its market price. As a result of this elegant solution

one only has to establish "cost" to establish "value." Unfortunately, many water resources planners forget that simply equating cost with value only holds true in a perfectly functioning market economy. In all other cases (that is almost all cases) care must be taken not to confuse "cost" with "value." What then is the "value" of water? The answer appears to depend upon "to whom" and for "which use." Drinking water is obviously valuable and becomes increasingly so as the amount available decreases.

WILLINGNESS TO PAY AND OPPORTUNITY COSTS

The water is said to have an "opportunity cost" since the continued withdrawal by one user reduces the amount available to another. This lost "opportunity" costs the affected user the amount he values these units of water. At this point the "value" of the water should reflect the willingness-to-pay of the user who is losing water.

Establishing the willingness-to-pay for various consumers of water is a fairly well developed (1) and can be easily adapted in many water conflict situations to establish estimates of the opportunity cost of water for many of the direct uses of water which have marketable properties. Unfortunately, as mentioned earlier it is difficult to even conceptualize, let alone measure, some of the opportunity costs associated with environmental services provided by water. Many economic studies of water use ignore the opportunity cost of water and only reflect the actual costs of obtaining the water itself. If there were well-established markets for water then the market price would itself reflect the opportunity cost of water. However, in most countries such markets do not exist and one is left having to estimate the opportunity cost in indirect ways.

The opportunity cost of water is only zero when there is no shortage of water. In evaluating water investments it is important to remember that *the value of water to a user is the cost of obtaining the water plus the opportunity cost*. Ignoring the opportunity cost part of value will undervalue water, lead to failures to invest, and cause serious mis-allocations of the resource between users. The opportunity cost concept also applies to issues of water and environmental quality.

TOWARDS THE SCIENCE OF HYDROECONOMICS

In traditional macroeconomic analyses, natural resources, such as water, are not typically mentioned as causes of economic growth. They are needed for production but can be substituted for by capital and labor. The assumption of resources as *substitutable* rather than *complementary* lies at the heart of the conflict between the *ecological economics* movement, (9) and classical economics.

The question arises, however, as to how far away we are from the extremes; as we approach the limits substitution becomes more and more difficult. There are also many cases where resources are pure complements to the other inputs. In these cases, the resource must be provided in a complementary amount or no production will take place at all.

PREVIOUS STUDIES

In the first major modern economic treatise specifically on water, Eckstein (10) generally assumed that water was important to the economy and did not see any particular need to explain *why* water was important in the functioning of the economy. Subsequent books by Milliman et al. (11) and Maass et al. (12) also took it for granted that water was an important ingredient of national economic planning. This literature, based upon classical economic growth models, made no real distinction about water other than its nature as a fugitive resource and that significant externalities were generated in the use of water in the economy.

In planning for development of the economy three values are in conflict; allocation of resources to their most productive uses (efficiency); distribution of the outputs of production to various individuals and social groups within the economy (justice); and the scale (the size) of the entire economy (sustainability). The first of these values is the legitimate subject of study by the economics profession, the second is strictly the province of the other social scientists (political scientists, sociologists, lawyers), but economists have been at the forefront in devising analytic approaches to describe the problem, and the third is the realm of the ecologists. All three of these issues are germane, however, to the planning for water use in an economy.

Allocative efficiency is the most developed of these three areas of concern and is amenable to conventional economic analysis; the *distribution* issue is a political problem that can be best dealt with (if it can be dealt with at all) in the context of the Pareto trade-offs between conflicting groups (13); the final issue of *sustainabilit*y is not well defined by any of the sciences and is, hence, left to outsiders to the political process (ecologists) to deal with it. Since the first two issues can be dealt with using modern economic methods, the struggle is to try to get the issue of sustainability defined in such a way that the economic analysis can deal with it along with the other two issues. This, the dream of the economists, is a nightmare for the ecologists!

A Framework for Analysis

Wassily Leontief (14) postulated that economics could be approached in a structural manner through the input-output model (See Part II) and transformed macro-economics to an empirical discipline that could utilize modern data processing technology. This opened up a new window for the study of the complex interdependence within the production system in a modern economy. Input-output analysis examines the flow of goods and services and all intermediate transactions among the producing and consuming sectors of a country or a region.

Traditionally, water resources have seldom been viewed as an integral part of the economy. Many analytical developments are problem-driven.

Despite earlier efforts, the integration of water into the macroeconomy has been rather unsatisfactory. Water does not have a closed cycle in any of the Input/Output studies. The sectoral or spatial aggregation is usually too lumped to be of much practical use in

decision-making. In one model, the water is only considered as a service sector - water supply. The supply sources of water and the return flows and sanitation, and aspects of water quality were ignored. Demands of water were not sufficiently disaggregated (e.g. households ignored). The two-way link of water resources decision-making and macroeconomic decision-making were not explicitly considered. This lack of integration may be puzzling, especially as attempts have been made to examine other scarce resources such as energy in such a linked macroeconomic context. However, one has to keep in mind that much of the energy-economy links took place as a response to the oil crisis of the 1970s. As water scarcity is now approaching crisis situations in many areas, interest has peaked in the better inclusion of water in the macroeconomy.

There are many parallels between the energy and the water sectors: they both tend to be highly subsidized sectors of the economy; they are constrained by existing supply; large important sectors of the economy depend upon them; the demands and supplies can vary widely by region and time period; demands are growing rapidly with increasing population pressures; there is scope for conservation and substitution, and proper planning is essential to manage these scarce resources. Of course, there are many significant differences: energy is more readily thought of as a priced resource, water is much harder to transport than energy, recycling and return flows are to be considered in the case of water and water can be of different qualities. Approaches such as the BEEAM model (Brookhaven Energy-Economic Assessment Model) have been adapted for use in integrating the water sector into the macroeconomic structure in Part II of this paper.

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PREPARING FOR THE FUTURE
HYDROECONOMICS: GETTING WATER INTO NATIONAL ECONOMIC PLANNING

Part II: How to do hydroeconomics?

by Peter Rogers

Input/Output analysis concerns the examination of the flow of goods and services and all intermediate transactions among the producing and purchasing sectors of a country or a region, and contains a wealth of information relating to the overall structure of the economy. It represents economic transactions and offers a valuable tool for both analytical analysis and descriptive explanations. The Input/Output table shows not only the details of the income and the product account, but also illustrates the transactions among producers and purchasers. The use of Input/Output also attempts to capture the impact originating from exogenous stimuli in one or many sectors of the whole economy. This theoretical framework is applied for water thus enabling determination of the economic value of water, shadow prices, overall demand curves, subsidies, strategic sectors impacted by water policies, and generally examines the impacts of water resource management decisions on the macroeconomy and vice-versa.

INTRODUCTION

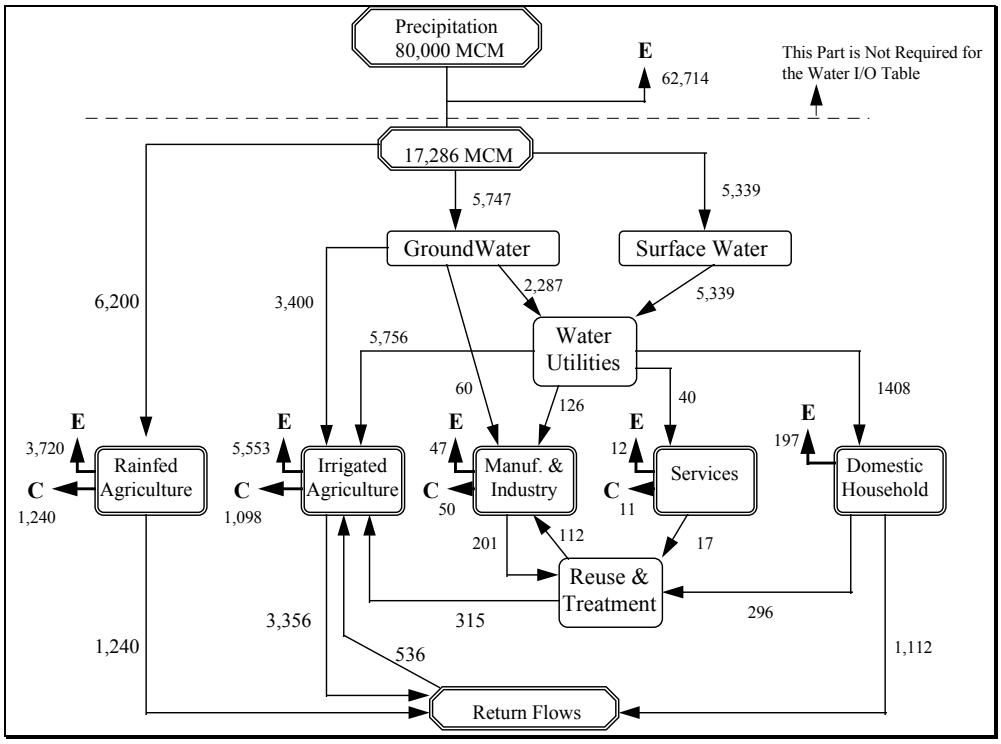
In Part I of this paper we motivated the need for a new way of assessing water in the overall macroeconomic sense. We established the need for a multi-disciplinary tool which highlights the flows linking water and the economy. In this part of the paper we devise such a framework to implement hydro-macroeconomic planning; what we call *hydroeconomics*. We have used the methodology of Leontief's Input-Output Analysis, (1) which is a widely accepted approach to study the interdependence of economic sectors and agents in a nation or a region.

The use of water in the Input-Output methodology highlights the availability of water at the macroeconomic level and the examination of the sectoral value-added provides a reliable guide to water resource decision-making.

ACCOUNTING FOR WATER IN THE ECONOMY

Precipitation, groundwater, rivers, lakes, fresh water, polluted water are all part of the same unitary resource. Yet, they appear in different part of the hydrological cycle, and are often used by different economic sectors. Surface and ground water that has already been been used can be treated and clarified for reuse, while unused surface water can recharge the groundwater for later use. Therefore, the entire hydrologic balance must be considered, not just part of it.

Figure 1: Water Sector Balance for Morocco - 1995



The term hydrological balance refers to the detailed description of the water flows in the hydrological cycle closely intertwined with the economic water-using sectors. The purpose of the compilation of a water sector balance is, besides the fact that it represents a valuable summary of information for water management, it is also the first step to ensure an adequate incorporation of the water cycle into the economy. This includes not only the basic cycle of water in terms of primary sources (e.g.: precipitation, groundwater, surface water, etc.), but also the economic users and the flows back to the hydrological system. **Figure 1** shows such a water balance for Morocco. The hydroeconomic system includes both the hydrological cycle and the national economic system. Water will, therefore, have to be accounted in this newly defined closed system: either in one of its physical forms or embedded in the economic products. In order to capture the characteristics of water, for each sector of the economy, the water balance of Figure 1 illustrates the input to the system, as well as the output in terms of quantity and type of water.

Primary Inputs

The hypothetical case study considered in this paper is based upon the data from Morocco, but the conclusions reached based upon these data are not meant to represent conditions in Morocco.

Water Related Sectors

Water is one of the primary *inputs* to the economic production chain. Water is consumed in the economic sectors by becoming embedded in the sectoral *output*, which will appear in the national economic account, some of the water is recycled, and the remaining water reverts to the hydrological system, through losses, either to groundwater recharge or evaporation.

Continuity requires that each water sector insures a balance between the water *inputs* and the *outputs*, summarized in an account table, detailing the different sources of water, the type and the quantity.

After the production process, the remaining quantity of water has an economic value assigned to it, representing the shadow price of water to the corresponding sector. Rogers et al. (2) outline different methods for evaluating the economic value of water. Bouhia and Rogers (3) use a water sector optimizing model as another way of estimating these shadow prices[1]. The outflows from the economic sectors include wastewater -to be treated and recycled-, return flows -drainage and infiltration-, and evaporation. An additional category is "Water Losses", which is counted as part of the primary input in negative form.

Water as Part of the Production Process of the Economic Sectors

From the point of view of the economic sectors, the water cycle is also closed, with components that are not of a physical nature, but which represent the value of the water embedded in the locally produced economic goods. For each sector of the economy, the water account is determined by equalizing the total input (primary water input, water supplied through the utilities, recycled water reduced by the losses) and the total water output (water consumed, water for recycling, return flows and change in the natural stock).

For each sector of the economy, this relationship illustrates the hydrological cycle and, therefore, highlights the linkages between the water sector and the rest of the economic sectors. The outflows are both in physical units and value terms -i.e., the sectoral economic value of water multiplied by the quantity of outflow. Also, the amount demanded is specified from the output side.

MERGING THE TWO ACCOUNTS: WATER AND THE ECONOMY

[1] For the purposes of this paper, as a first approximation the shadow price of water are assumed to be 2 DH/m3 for agriculture and 6 DH/m3 for urban use (10DH = US $1).

Economic accounts have been computed for most countries and for many regions within those countries to summmarize the monetary flows between the economic sectors, and to estimate the different value-added to the economic sectors, in terms of employment, investment, cost to the government, and others. This can be used to evaluate the size of a nation's economy, traditionally denoted by the gross national product, GNP. The water account is incorporated in physical flow units for all the inflows from the water system to the economic sector into this table, which is in monetary terms. In their turn, the flows from the economic sectors to the water related activities enter as part of the economic flows in monetary terms, reflecting the economic value of the quantities of water in the hydro-economic system.

Methodology to Incorporate Water into Input/Output Tables

The hydrological cycle can be incorporated into the input-output table (**Table 1**) by following water from its sources through the intermediate transactions to the final demands. In order to incorporate water into I/O tables, it should be divided into the following components:

- "*Bulk Water*": representing the production of water from precipitation, groundwater, surface water and seawater.
- *Water Related activities*: are part of the intermediate demand. They represent all the services related to water and play the role of links from the primary input of water to the different parts of the economy. The water-related activities include water supply the different water utilities and entities that distribute water to the different users and sanitation services which collect the water used by the different sectors, and could sell it to the water supply utilities to be distributed for re-use once treated. The sanitation service is linked both to the intermediate demand (agriculture, manufacture, services, etc.) and the final demand (household, exports, change in natural stock, etc.). This sector could also be divided into different qualities of water to account for the different treatment costs and value-added for each sector.
- *Return flows*: Water planners distinguish between two types of return flows. The first type represents the water flows that could be captured in the system (a percentage of drainage or infiltration) and supplied at later periods of time, or be reduced by undertaking efficient water use techniques. This type of return flow will be considered part of the water related activities in the first quadrant of table. The second type of return flows correspond to the water that goes back to the nature through evaporation or evapo-transpiration (also the rest of drainage and infiltration water that does not go back to the primary input but leaks out to the ocean. This second type will yield a change in the natural stock of water in the final demand quadrant.

- *Change in the overall water stock*: This is part of the final demand, and captures the negative change in the total availability of water over the time period (this is a percentage of drainage and infiltration

as well as evaporation and evapo-transpiration).

If we follow the path of water from its primary stage to its last use we can cover all the flows of water in the economy (as in Figure 1). In fact, the outflows of Bulk Water from reservoirs or groundwater pumping will go to the water supply utilities, they can also go to the intermediate demand of industry or irrigated agriculture (if farms pump water through wells) or households, in the final demand. Also, as part of the primary inputs, there is a row in the matrix corresponding to the losses, which is a negative value that balances the water flows in the table. If we look at the column corresponding to the water supply, besides bulk water input to the water supply, other inputs are labor, capital, and government (through subsidies). The water supply sector is also an input to the other sectors (represented as rows); the water will be sold as an intermediate input to the different economic sectors and to satisfy the final demands (of households).

The water used will then be collected by the sanitation service and, after treatment, may be redistributed. Some of the water used in agriculture would infiltrate into the ground or through surface drainage, also evaporation accounts for a largest part of this water. This quantity could reappear as return flows net of evaporation, while evaporation appears as a negative change in the water stock (a negative number). One of the particular characteristics of this new table is that the flows from the economic sectors to the water related activities are in value terms. The quantity of water that goes back from the economic sectors to the water system is multiplied by the shadow price of water to the considered economic sector (these shadow prices are the output of a water sector specific optimization model (4). **Table 1** illustrates the expanded I-O table incorporating the water components.

Table 1: Structure of the Water Input-Output Table

	Activities Intermediate Demand	**Final Demand**
Economic Activities		
Water Related Activities		
Water Input		
Primary Input		

Impact Studies

Impact studies use Input-Output tables to evaluate effects on the output, employment, income, etc. due to economic changes in the country or region. Generally, the model results are very sensitive to variations in any of the elements of the final demand, causing the input-output model to be “demand driven” model.

In the raw data for the Water I-O table all the coefficients of the rows corresponding to the economic sectors are in monetary terms (note that the flows from the economic

sectors to the water related activities are also in these units), while the coefficients of the rows corresponding to the water related activities are in physical units. The sums of the coefficients of these two type of rows are homogeneous and represent the total output of each sector in value terms for the economic sectors and in physical terms for the water related activities.

PARAMETERS DEPENDING ON I/O TABLE COEFFICIENTS CAN FORM MULTIPLIERS FOR SECTORAL OUTPUTS

To attempt to address direct and indirect effects, parameters that depend on the final I/O table coefficients, such as employment, pollution, etc., can be computed to form a table of multipliers for the sectoral outputs. These multipliers and ratios give numeric measures to the relationships among the component sectors of the economy. The multipliers take into account the fact that the total effect on output depends on the sectors that are affected by the initial changes in the final demand. The multipliers most frequently used to estimate the economic changes (5) are:

- *Output Multipliers*: change in outputs of the sectors in the economy. This multiplier represents the ratio of the direct effect and the indirect effect.
- *Income Multipliers*: change in income earned by households (as a result of the change in output). These multipliers are determined from the coefficients of the Leontief inverse, which measure the direct and indirect effects on household income using the household coefficients.
- *Employment Multipliers*: change in employment in physical terms (to be generated as a result of the change in outputs). By determining the relationship between the value of the output in a given sector (such as agriculture) and the total employment (physical terms), we can determine the effect of the change in output on the level of employment, using the same method as the income multipliers. For example, this would help us determine the effect of water or macroeconomic policies on agricultural employment.

Using our new methodology we can add:

- *Water Use Multipliers*: representing an indicator of the effect of water on the output of each sector, by looking at the total quantity needed of the different water qualities and both primary inputs (bulk water) and intermediate inputs (water supply) of water in value terms as part of the total output of a given sectors. Using the employment multipliers, the impact of water availability on employment could be evaluated through employment and water use multipliers.

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[2] The Leontief inverse matrix can be expressed as:

$$(I - A)^{-1} = I + A + A^2 + A^3 + \ldots$$

The matrix I is the initial effect, the matrix A represents the direct effect and the rest $(A^2 + A^3 + \ldots)$ represent the indirect effect.

This set of multipliers represents a tool for deciding upon the level of investment in the different economic sectors, as well as the supplied water. These multipliers also give a hint regarding which are the most strategic sectors of the economy. Depending on the objectives and constraints, in terms of meeting a national goal, such as an increase in the GDP or creation of new opportunities for employment, the best alternatives and options could be evaluated using these multipliers. Also, in order to highlight the relationship between the initial effect (own sector income effect) and the total effect (including the consumption induced effect), Input/Output analysts commonly compute two type of ratios Type I and Type II. These two ratios are defined as follows:

Type I = (Direct & Indirect Effect) / Initial Effect
Type II = Total Effect / Initial Effect

Due to the mixed units, one of the innovative approaches of this paper is that each one of the multipliers and each one of the ratios are of two categories, one corresponding to the effects related to the economic sector in dollar terms, and the second category related to the effects from the water related activities in cubic meters.

SUMMARY AND CONCLUSIONS

The approach used here does appear to have great promise in the joint evaluation of water resources and macroeconomic decision-making and takes a step toward closing the disconnect that currently exists.

In addition, the Water Input-Output approach gives us the ability to construct demand curves for various supply scenarios that would indicate the marginal net benefits of water use in an inter-sectoral sense, rather than from a myopic sectoral point of view. This is done by maximizing the total valued added to the economy subject to meeting final demands and limitations on the water supplies. This may also yield useful clues to decision-makers seeking to determine optimal water pricing systems for water use in various sectors. Another use of the shadow prices is to identify strategic sectors where water availability (or lack thereof) becomes a major constraint. These developments are described in Bouhia & Rogers (4).

An economy-wide demand curve of water can be derived by noting the shadow price of water corresponding to different constraints on water availability. This will yield an economy-wide demand curve for water. One should note that this aggregated demand curve is valuable for the short and medium term only, due to the static assumptions of the I-O table. For the long term analysis, Leontief's matrix ought to be modified to incorporate the technical changes in the economic sectors, changes in water allocation and change in the sectoral output.

From a policy-oriented point of view, this type of optimizing I/O model can be used to generate a Decision Support System (DSS), which could target the appropriate choice of investments in the water sector and evaluate their attractiveness to the overall economy. For example using such an approach, proposed investments in water treatment can be represented by an increase in the availability of a higher type of water

quality, which will generate a new set of shadow prices for water. Similarly, the implementation of water loss reduction measures will increase the water availability and relax the water constraints of the model. The implementation of water efficiency techniques will result not only in a change in the water availability constraint, but also in a change in the coefficient corresponding to the water losses in the value added objective function. A comparison of the change in the economic value of water (which is also the benefit of the new investment) with the capital invested in treatment or in conservation measures will represent a guide for water sector investment decisions.

Finally, once the data have been developed for the Social Accounting Matrix (I/O table) the same data base can be used to estimate the coefficients for a Computable General Equilibrium (CGE) model. Dufournaud, Harrington, and Rogers (6) give an example of how this may be implemented and compared to the more traditional Leontief analysis pursued in this paper. Work is currently underway to apply this Water Input-Output model to Morocco utilizing data generated from a 140 sector I/O table and a 15,000 equation optimizing model of the water sector. When completed this model will be compared and contrasted with the CGE model made for Morocco by Goldin et al (7) which analyzed the impact of international trade on the Moroccan agricultural sector.

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LOW WATER STRESS - GOOD COPING CAPACITY

CANADA'S EXAMPLE

by Denis A. Davis

The highest income countries with low water stress as defined by the criterion used in the "Comprehensive Assessment of the Freshwater Resources of the World" are indeed the fortunate category in terms of future water issues. This select group of countries withdraw for use less than 10 percent of the renewable water resource available within the country and have a per capita income over US$8,956 per annum. The population of these countries totalled 112 million in 1995, representing two percent of the world's population.

TRANSITION TO AND FROM THE CATEGORY

Some of the common characteristics of the highest income countries with low water stress presented in **Table 1** which meet the criterion in 1995 are a mature economy, low population growth rates, moderate to high level of industrialization and low growth rates in water use. A number of these countries are large enough that regions within the country do indeed suffer water shortages and works have been constructed to store water, or divert it from other basins to meet growing demand. Hydropower development is significant within these countries and river regulation common. Water legislation and water policies are generally in place. By 2025 the category will include countries where the economy has gone through a transition to increased industrialization and water use for irrigation is significant.

Table 1. Countries in Highest Income and Low Water Stress Category

	1995		2025	
	AWD %	GNP $ US	AWD %	GNP $US
ARGENTINA	*4*	8,100	5	11,200
AUSTRALIA	8	18,000	8	28,400
AUSTRIA	3	24,600	3	47,400
CANADA	2	19,500	2	34,900
DENMARK	9	28,000	*10+*	53,800
FINLAND	2	18,900	2	36,300
ICELAND	0	24,600	0	47,400
IRELAND	2	13,500	2	26,000
NETHERLANDS	6	22,000	7	42,300
NEW ZEALAND	1	13,400	1	21,000
NORWAY	0	26,400	1	50,800
SWEDEN	2	23,500	2	45,300
SWITZERLAND	2	34,000	3	50,000
YUGO-SLOVENIA	*3*	6,500	4	12,500

AWD - Available Water Withdrawn (withdrawal/availability)
GNP - Gross National Product per capita per year

BASIC CHARACTERISTICS FOR THE CATEGORY

Argentina and Yugo-Slovenia, both low water use countries, move into the "high income" category by 2025, while Denmark exceeds the criteria of low water stress by 2025 and enters into the medium low water stress category. If the projections of water stress and income grouping are correct the percentage of the world's population that falls within the high income and low water stress category remains at about two percent of the world's population until 2025.

Water shortages per se are generally restricted to regions, but conflicts between competing sectors, such as municipal or industrial use and agricultural use, still need to be resolved as demand increases. Past practices and allocations of the water supply where water is scarce have often not given enough weight to maintaining in-stream uses or protection of the aquatic environment. There has also been a tendency to increase supply as the preferred option to keeping supply and demand in balance rather than introducing demand management, conservation and appropriate water pricing. Another problem is the one of perception that the water resources are unlimited and a "free" good. Often the enabling legislative framework and basin management concepts are already in place or well known, but the political and public will may be lacking to introduce major changes in management practices because of these perceptions. However these countries have the knowledge base, skills and resources to balance supply and demand, solve allocation problems and introduce sustainable water management without major economic disruption.

Water use in the manufacturing and mining sector per unit of output has decreased at the rate of 3.7 percent over the past 30 years in developed countries. Scenario's developed for the CFWA indicate that the historic rate of increases in withdrawals should slow considerably for developed countries, which can generally be equated to the high income and low water stress category. The domestic use intensities will drop slightly, agricultural use will not increase significantly, and the major water use growth sectors will be the industrial and commercial sectors. The commercial sector includes commercial establishments and public services, such as restaurants, retail stores, golf courses and use in public parks. Increased water use due to expansion of the manufacturing and mining sectors will be partially offset by the continuing decrease in the use per unit of output. Overall water withdrawals for these countries are expected to increase by approximately 10 percent over the period 1995 to 2025 under a conventional development scenario.

NEED TO MITIGATE THE IMPACTS OF PAST, PRESENT AND FUTURE POLLUTION

Projections of effluent discharges under a conventional development scenario, however, are an entirely different matter from projections of water withdrawal. Conventional parameters such as Biological Oxygen Demand, Chemical OD, Suspended Solids and Total Dissolved Solids are projected to increase by a factor of 4 to 5 times by 2025. By inference it would be logical to assume that toxic substance discharges could rise by an equivalent amount without controls being applied. Long term exposure of fish, wildlife and humans to

persistent toxic substances has been linked to reproductive, metabolical, neurological and behavioural abnormalities, to immune system suppression, and to increasing levels of breast and other cancers. Evidence points to long-term reproductive and intergenerational effects. Recent science indicates that for a select number of hormone active chemicals long-term exposure is not required, as exposure at critical times can affect the offspring. As science has increased our understanding of the impacts of toxic substances on humans and the environment the standards for discharge of such compounds to air or water have been ratcheted downward accordingly. This has often left a legacy of deposits of heavy metals, organochlorines and other compounds in soils, groundwater, streams, lakes and in aquatic and other organisms, that continue to be a source of contamination. The major challenge of the high income and low water stress countries over the next 25 years will be to find ways of mitigating the impacts of past, present and future pollution loadings on human health and the environment.

The short-term policy options of the high income and low water stress countries must move them toward sustainable and integrated water and related resource management. In particular the ecosystem approach must become ingrained and pollution prevention, which emphasises the need for preventive and precautionary approaches to managing toxic substances, must become the top priority. After-the-fact cleanup, which treats symptoms and not causes, is inefficient and ineffective. Prevention is the only way to stop pollutants from entering air, soil and water. A number of policy components are listed below. None are independent from the others, but are separated for the purposes of description and example.

DIFFERENT POLICIES NEED TO BE APPLIED

Pollution Reduction and Control

As our understanding of the impacts of persistent and bioaccumulative toxic substances on humans and the environment improves continued focus can be expected on further measures to reduce loadings. Strategies can include pollution taxes, tradable permits and voluntary initiatives as well as the traditional command and control type of regulations. Effluent taxes have been applied successfully in a number of European countries, tradable permits are in place for certain air pollutants in the United States, and Canada has had success with the voluntary approach to stopping toxic emissions. The Canadian ARET (Accelerated Reduction/Elimination of Toxics) program includes participating companies from eight major industrial sectors and covers 117 toxic substances, including 30 which are persistent and bioaccumulative. For the participating companies commitments have been received to reduce discharges from 17,977 Tonnes in 1995 to 9,954 Tonnes by the year 2000. No strictly regulatory program could have resulted in such a major reduction in such a short period of time.

New Pollution Prevention Policies

A policy of pollution prevention should provide a framework for effective management of substances of concern. Science is not always able to predict what kind of long-term effects a substance might have on human health or the environment so a pro-active preventive

approach is required. The focus is usually on substances that are bioaccumulative and persistent, with virtual elimination as a goal. Strategies include changing industrial processes so that toxics are not produced, ensuring the safe transport of hazardous goods still produced and ensuring appropriate waste destruction facilities are in place. Any waste produced, toxic or not, should be regarded as an inefficiency in production that needs to be recovered for economic benefit.

Clean-up of industrial past

The costs of cleanup of the legacy of our industrial past is immense. For example the estimated cost of treatment of the contaminated sediments in 34 identified areas of concern in the Great Lakes of the United States and Canada is estimated at US$25 billion. Until the recycling of contaminants back into the aquatic environment is stopped further progress on protecting human health and the environment is difficult. Policies, usually based on site specific information, need to be developed and schedules and timetables set.

Pricing the water resource at its full value

Polluter and User Pay principles are an integral part of any policy. Setting an appropriate price for use of the resource, over and above the direct cost of treatment and delivery, acts as a market mechanism for assigning the resource to higher value uses. It also frees up scarce public resources that can then be assigned to other socio-economic objectives. Based on economic studies in Canada of 2700 residential and commercial municipal water supply and sewerage rates few systems recovered even direct costs and only 30 percent had significant efficiency incentives. True cost recovery, including capital investments and future maintenance, would require an overall doubling of average water prices, a 60 percent sewerage surcharge and full metering.

Ecosystem's "need" for water

Sustainable development policies must recognise and assign value to the aquatic environment, including the protection of habitat. Standards need to be introduced that include aquatic protection objectives and minimum flow standards. Particularly in areas where water resources are scarce a portion of that precious resource must be assigned to protection of the natural environment.

Transboundary Agreements

While only applicable to countries that share water resources, it is important that the allocation of the quantity of the water resource, its timing, minimum flows and water quality standards be negotiated between the parties. All the parties can then develop long-term policies and plans that reflect the true sustainable availability of the resource. Agreements can also set the stage for projects of mutual advantage and reduce tensions over other resource and trade issues.

Increased Water use Efficiency

While not a policy in itself, but rather a principle to be built into all policies, it is important to give improved efficiency of utilization of the water resource appropriate attention. Demand reduction, rather than increases in supply, should become the strategy of choice in balancing supply and demand. As water pricing is introduced it is important to consider infrastructure upgrading to reduce leakage and wastage, so that the water saved can be allocated to alternate uses as demand increases. It is also important to focus on pollution prevention as a way to maximise resource utilization.

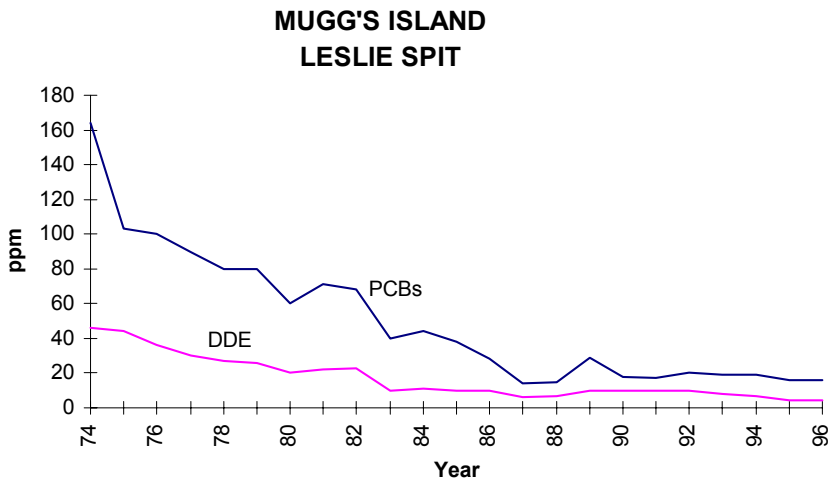
LONG TERM INTEGRATION BETWEEN SECTORS, ORGANIZATIONS AND REGIONS

In the longer term, policies must overcome the barriers between sectors and organizations with a view to achieving truly integrated water and related resource management using ecosystem and sustainability principles. In addition attention needs to shift to the protection of sensitive environments. Once pollution protection goals have been reached the protection of biodiversity within the aquatic environment is dependent on preserving wetlands along rivers and lakes and within the coastal zone. The sensitive areas that remain must receive some form of protection, and consideration needs to be given to wetlands restoration for endangered species where habitat is limited.

Twenty-five years ago the United States and Canada signed the Great Lakes Water Quality Agreement based on the ecosystem approach and the virtual elimination of persistent toxic contaminants. Considerable progress has been made. In the early 1970's Herring Gulls, a top predator in the food chain and a biological indicator, suffered severe reproduction difficulties but with the introduction of regulations for key contaminants the populations have recovered. The contaminant burden in Herring Gull eggs for Mugg's Island/Leslie Spit since 1971 are contained in **Figure 1**. Further progress will be dependent on controlling the long-range transport of airborne contaminants from outside the basin.

The high income countries with low water stress are well placed to support global initiatives related to water resources. They have the pollution prevention and control technologies that are needed in developing countries. They also have the financial resources to support sustainability initiatives in other countries, and be active participants and initiators of Conventions and Agreements. They are also countries that can play a direct production role in support of global food security, and assist in transfer of successful public-private partnerships to countries seeking to reach sustainability. Their relative wealth in water can, and should, play a role on the broader world stage.

Figure 1: Concentration of PCBs and DDE in Herring Gull Eggs



Note: DDE actual values are half of values stated.

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HIGH WATER STRESS - GOOD COPING CAPABILITY

SPAIN'S EXAMPLE

by José Maria Martin Mendiluce & Julio Prado Pérez del Rio

Spain is a water-stressed country with a long history of settling water disputes including the famous Valencia water tribunal. The country has been a forerunner both in terms of user associations and river basin organizations, and is now in the phase of introducing controlled water markets to improve water use efficiency. A dozen years is however not enough to get practical results. In Spain water as a social good attitude causes a large reluctance to changes that do not have a clear economical promotion.

SPAIN'S WATER RESOURCES PREDICAMENT

Due to the semi-arid climate water has been the axis of economic development in Spain. The country's renewable freshwater resources, amount to some 114 000 million m3/yr (Mm3/yr) corresponding to some 2 900 m3/cap yr. Out of this some 50 000 Mm3/yr have been made readily available, i e 1 200 m3/ cap yr. See **Table 1**.

The overall water uses for households, industry and irrigated agriculture are estimated at 37 000 Mm3/yr. This represents 27 % of the national water resources and 62 % of the readily available resources.

Taking into account that GNP per capita in 1994 was 13.280 US dollars, Spain can be classified as a High- income country with high water stress. The nation's water resources management is strongly influenced by the regional unbalance in water availability and water demand. Adding up all the respective regional surpluses and deficits y for the different subregions,the outcome is a gross subregional surplus of over 18.000 Mm3/year - close to 40% of the present available - and a subregional deficit of over 3.000 Mm3/year. Most of the latter can be compensated with surplus from neighbouring subregions, except the ones belonging to the Mediterranean catchment, except Ebro basin, and South of Spain.

Groundwater amounts to almost 5.500 Mm3/year but more than 1.000 Mm3/year originates from overpumped aquifers in water scarce areas.

Table 1. Water availability and use in Spain

National water resources (renewable freshwater)

* Average river flow: From surface runoff 94.277 Mm^3/year

From aquifers 17.406 Mm^3/ year

Total river flow 111.683 Mm^3/year

* Ground water from aquifers going directly to sea ..... 2.615 Mm^3/year

TOTAL NATURAL RESOURCES 114.298 Mm^3/year

Reservoir capacity ..... 53.160 Mm^3

(47,6% of total river flow)

Readily available water (accessible water)

* Surface ..... 44.099 Mm^3/year

* Groundwater ..... 5.428 Mm^3/year

TOTAL ACCESSIBLE 49.527 Mm^3/year

Water use (1992)

Demands

Irrigation (3.315.628 has) ..... 24.245 Mm^3/year

Domestic ..... 4.305 Mm^3/year

Industrial .... 1.944 Mm^3/year

Altogether ... 30.494 Mm^3/year

Others (cooling, stream, etc.) ..... 6.598 Mm^3/year

TOTAL DEMANDS (without hydropower) 37.092 Mm^3/year

Current challenges

Mainnear-future challenges that Spain has to face from the quantitative perspective are related with the following aspects:

- Water conservation: to promote more efficient water use by “demand management“, by facilitating reuse of water in scarcity areas, and by improving conjunctive use of surface and groundwater resources.

- Equitable water distribution at national level: to promote legally and economically the redistribution of regional water surplus through a sustainable policy of interbasin water transfers.

Another very important item is water quality. Only 56% of the population is connected to waste water treatment plants. 48% of the total volume of Spanish reservoirs is at an advanced state of eutrophication. Spain is however obliged to accomplish the European Community Directive 91/271 about waste water. Near-future programs will therefore substantially improve the actual situation.

LONG TRADITION IN WATER RESOURCES MANAGEMENT

Early attention to water disputes

Spain has a long tradition in water management because of the semiarid condition of the country and the irregular flow of its rivers. Water administration and management have played a very important role in the country's development. The first written orders for water use date from the XII century. They established some principles, that still remain valid as general conceptions:

* Water cannot be a private property; it belongs to the irrigated land and has to be transferred with the land.
* The administration of the water is the user's task. The State's task consists only of protecting the user organizations from outside interferences.
* Legal measures needed to protect technical activities must be in line with the majority's opinion.

Water scarcity over a large part of the territory has been a good school for hearings in water disputes, leading to the conclusions that water use licenses have to be in line with the public opinion. The user's central role in water management is reflected in the famous Valencia Water Tribunal which existed during more than ten centuries (since 960). The Tribunal de las Aguas was composed of irrigators, elected as Judges by the users of every canal of the Turia river (Valencia). It met every Thursday at noon at the door of the cathedral, to solve the quarrels (disputes) on irrigation arisen in the area, and to sentence violations of the ordinances, constitutions or by-laws. Although sentences were firm, it never happened during the long history any case of disobedience, nor any appeal to State organizations of higher competence.

The water works era

During this first "private development" era water was considered as a public and free commodity and was used only in the way that Nature provided it. At the end of 19th and the beginning of the 20th century a new water use strategy was introduced, driven by the need for a much more active involvement of the State in water resources development. The loss of the last colonies and the end of emigration generated a New Hydraulic Water Policy with the aim to develop the water resources to create wealth.

Irrigation expanded as part of the country's development to provide permanent jobs to the population.

"New water" was created by regulation and "new rivers" by building big canals. In 1902, the National Plan of Canals and Reservoirs was approved to set the framework for the State's water resources development program. In the beginning of the century, consecutive water plans (1902,1909, 1916 and 1919) were issued that were basically catalogues of potential projects that could be developed. This was the era of "planning of works".

After some years of experience, the State was overloaded with the control of water concessions and the new task of water resources development. Three solutions were considered:

* To limit the task of Water Users Associations to that of canal water administration and create new State organizations for the rest of the water management functions.
* To assign all the functions of water management to the Water Users Associations.
* To create a mixed State/User system to assume all the water management functions.

Creating river basin organizations

In 1926 the River Basin Authorities known as "Confederaciones Hidrográficas"were created to involve the users (stakehorders) in the planning, construction and management of water resources. One of the priority tasks was the river regulation needed to guarantee irrigation demands and to enlarge the irrigation area.

Spain has been a pioneer of such River Basin Organizations. Other countries have followed later: USA with Tennessee Valley Authority (TVA) in 1933; France with the "Agences du Basin" in 1964; Great Britain with the Water Authorities in 1973 and so on.

National water resources planning

A National Plan of Hydraulic Works considering the country as one hydrologic unit was initiated in 1933. This Plan contains the first official proposals for large water transfers: the Tajo-Segura scheme, to transfer Atlantic flows to the Mediterranean area - one of the most water scarce but promising regions for irrigation development. This plan was a forerunner of "water resources planning". It was however never approved; the efforts were interupted by the Spanish civil war and the subsequent reconstruction of the country.

The first plan that can be qualified as a National Hydrological Plan emerged in 1967, and included water balances for the time horizons 1967, 1972 and 2000. After this report had been approved in the Quadrennial Economic Plan (1967-1972), the construction of Tajo-Segura water transfer scheme was started. The Ebro-Pirineo Scheme (transfer water from Ebro river mouth to Catalonia) was proposed in 1974, but met a strong opposition. The approval was therefore postponed until a more complete water resources planning would be available, mainly at regional level.

1985 INNOVATIONS

Reasons to modify the 1879 law

The Law of 1879 remained in force during 106 years. The most important innovations of the 1985 Water Act with regard to the previous one are the following:

* Water is legally recognized as a single renewable resource, therefore declaring all kinds of water including groundwater, public property.
* The regional administrative division for water management and planning must be based on hydrographic basins, as it was traditionally from 1926.
* The use of water must be subject to hydrological planning. Although a real practice in Spain, it was not established as a legal requirement in the old Law.
* Water conservation is encouraged for efficient use of available water.
* Water's economic value is recognized and new pricing policies introduced to encourage correction of inefficiency and waste.
* Water quality is protected by imposition of modern water pollution control, and special fees for water pollution.
* Water user's association concept is broadened.
* Concessions or licenses are defined in a more precise way.
* The possibility of flexible priorities are introduced in the licenses.

Co-ordination between the Regional and the Central Administration for water management is contemplated in line with the Autonomic regions that had been introduced in the new Constitution (1978).

Water planning - a key component

The new procedure of water planning contrasts with the old one where the State made all the studies and proposals, and public participation entered only when the project was submitted to public information. We believe that to establish water planning at two levels, Regional and National, is a good strategy. Now it is possible to discuss with all the competent authorities and persons already before submitting the definitive proposals. To start planning at the regional level in the public podium of the "Confederaciones" is one of the achievements of the new legislation. Regional level will provide the goals for the future of the people living in the region. As integral water planning requires, sometimes, the change of origin of water in the concessions already established, the new law contemplates this possibility (art 59.3), in order to ensure the rational use of the resource.

Once regional planning has been developed, the National Hydrological Plan, taking into account the country as a unit, will adjust the regional plans and suggest the changes required and the inter-basin water transfers needed to meet future demands. Moreover, water planning pays much more attention than in the past to environmental and ecological aspects of water development, that is now mandatory to be included in the River Basin Plans. The National Hydrological Plan has to be mandatorily advised by the National Water Board, before it is submitted by the Government to the Parliament to be

approved by law. Consequently, water planning in Spain has today the maximum level of public participation.

Strengthening the river basin organizations

The new Organization introduced by the Water Act (1985) makes the water process to be as follows:

GOVERNMENT
⇑
⇓
MINISTRY OF ENVIRONMENT ⇔ NATIONAL WATER BOARD (COUNCIL)
⇑
⇓
RIVER BASIN AUTHORITIES (Basin Water Councils)
(water user's associations)

The main philosophy was to enhance the public participation in the water field. The most important features are:

* A National Water Board or Water Council has been created as the high-test advisory board, consisting of representatives from the State's Administration and the Autonomous Regions, the River Basin Authorities, as well as representatives from the most important national professional and business organizations related to the different uses of water.
* River Basin Authorities have been strengthened and given a special task of River Basin Plans through the Basin Water Council.
* It is the responsibility of the Water Council to submit to the central Government, through the Ministry of Environment, the River Basin Plan, prepared by the River Basin Authority, as well as any subsequent revision thereof.
* With the creation of Water Resources Councils or Advisory Boards at both the Basin level and the National level the preliminary public participation established in 1926 has been further enhanced.
* The water user's associations concept has been enlarged to comprise also non-irrigating users , that are obliged to form a users association.

Substantial reduction of water subsidies

The economic guidelines for irrigation, according to the Law of 7 July 1911 involved the following:

Subsidies up to 50% of the total cost
Rate of interest 1,5% - 2.0%
Period of repayment - - 25 years

The Law did not contemplate any type of depreciation or inflation when annually fixing the fees . Average real subsidies - instead of being the 50% as supposed in the law - has reached figures close to 90%.The new Law substantially reduces these subsidies (zero as general rule) and takes into account inflation when establishing water fees every year. It prescribes that each fee shall be fixed for each budget year by adding the following amounts:

a) Total estimated expenses for the operation and maintenance of the works carried out,

b) Cost borne by the administrative body attributable to the aforementioned works.

c) Four percent (4%) of the value of the investments made by the state, duly actualized, taking into account the technical depreciation of the works and installations as well as the depreciation of the currency, in the manner established by applicable regulations.

Other water management strategies

Also the water quality strategy has been completely changed with the new Law. In the old Law, penalties for pollution where insignificant. Instead of establishing waste treatment plants, polluters preferred to pay penalties. The new Law, following the principle "who pollutes pays", establishes fees for waste water discharge depending on the pollutant content. In case of no treatment on the side of the user, the fees are high enough to allow the state to build proper waste water treatment without any additional cost. Violations are punished with fines high enough to discourage them.

Water conservation is encouraged by state "grants for those who engage in the development, introduction or change of technologies, processes, installations or equipment, as well as changes in the use, which result in a reduction in the use or consumption of water or decrease of pollutants at the source in the waters being used. Likewise, grants may be available to those who promote forestation to protect water resources.

These grants shall also be extended to those who engage in desalination and sewage purification activities by using improved processes or methods; put in place systems for recycling sewage waters or engage in research activities in this field " (article 102).

Facilitating water markets

A trend in Spain towards water markets is reflected in the new system for domestic and industrial water supply of the Tarragona area (1980). Because of opposition of the people to the earlier mentioned Ebro Basin inter-basin water transfer proposed by the State in 1974, an agreement was reached with the irrigation users at the mouth of the Ebro to divert 4 m3/sec out of the licensed 22 m3/sec . The fee to be paid per m3 is going to a special fund to improve the irrigation system, in order to save more water than the proposed 4m3/sec. This is in fact a water market operation, justified by water conservation. The solution was approved by a special Law in 1981. A similar solution has later been adopted, by the Metropolitan Water District of Southern California to provide water to Los Angeles city.

TOWARDS MORE EFFICIENT USE OF LIMITED WATER RESOURCES

Lessons learnt

According to Spanish experience, a good water management has to be supported by four basic pillars:
- A proper legislation.
- An adequate institutional organization.
- An integrated and comprehensive water resources planning.
- An attitude to water not only as a social but also as an economic good through a sound basis for water tariffs and commercial principles.

As already indicated, the main problems at present in Spain are:
- Need for better efficiency in water use.
- Need to correct the hydraulic desequilibrium by inter-basin water transfers.
- Need to improve water quality.

To cover those aspects, the Ministry of Environment is going to introduce some modifications in the Water Law (29/1985): not to change the main principles that inspire that Law, but opening new possibilities.

Aim of the legal reform

The objectives of the reform of the Law are:
a) To rebound environmental aspects of continental waters.
b) To envisage new realities like desalting and reuse, in accordance with modern technology, and to include them in the water law.
c) To see hydraulic works as a special kind of public works, filling a legal vacuum that now leads to a juridical uncertainty.
d) To realize the financial aspects of the actual Law, reinforcing the equitable distribution of the total costs generated between State and users.
e) To introduce transparency in the system by proper measures of demands, by regulation of the right to information and by promotion of water savings.
f) To promote similar treatment of the users in groundwater management.
g) To make more flexible actual concession's in order to allow changes in a more practical way (water right transfers by controlled water markets).
h) To allow a deeper collaboration between State Water Administration and the Authonome Communities, strengthening competences of the participating bodies of the River Basin Authorities (Confederaciones Hidrográficas).
i) To strengthen waste water control in a most effective way.

Potential of water markets

One of the most interesting changes proposed is the introduction of controlled water markets, for improving water management so that enaction of a Law will not be required in each case like it happened in the Tarragona area case.

This water market process needs to be controlled by the State or Water Authority, at least until the moment when all water rights be properly defined. As earlier mentioned, most of the concessions are not properly defined quantitatively. This is a result of the ancient 1879 Law that established the rules for use of natural flows and not for regulated flows from reservoirs.

Proper definition of user's rights has to be made not only for surface waters, but also for groundwater, with the real checking of affections of groundwater uses to prior concessions of surface waters or regulated waters that remain without user. The aim is to establish the proper tariffs and real costs for this type of resource, and to avoid duplicating concessions of the same water. This is still a pending issue in water management in Spain.

On the other hand the largest user of water (irrigation) has in the past developed by means of substantial subsidies. Before allowing any water selling rights it is necessary to reach an agreement with the users about the part of water price that has to be returned to the State. Irrespective of such preliminary difficulties that have to be solved before water markets are established in Spain, we believe that in semiarid countries like ours, controlled markets are a good solution for the future.

The Spanish tendency is, rather than substantially enlarging the irrigated area (3,4 million has), to improve water management and water saving in existing areas. Water transfers should be promoted only to consolidate irrigated production in scarcity areas. Water markets, in our opinion, are going to be definitive tools in the interbasin water transfers for this purpose.

FUNDAMENTAL SHIFTS TAKE TIME

Short summary

From the beginning of the history water has been considered a public property in Spain and its use controlled by concessions. The 1879 Water Law remained in force for 106 years before it was modified. Four key points of the 1985 Law should be emphasized :

- Publicity of all water (surface and ground).
- Water planning as a legal requirement and large public participation for its development.
- Consolidation of water user's associations and River Basin Authorities.
- Water pollution control as principal tool for not causing harm to the environment.

The strengthening of the River Basin Authorities by the 1985 Law was a recognition of their usefulness and efficiency in both water management and planning. Spanish experience recommends that water planning be established at two levels: Regional and National. The Regional level of planning will provide for the goals of regional people. The National level can then put regional planning in a regional perspective and outline necessary inter-basin transfers. Public participation is an imperative. The 1985 Law gives a large importance to public participation in water planning, creating the River Basin Water Councils for Regional planning and the National Water Board, as an advisory body to the Government. Changes proposed reinforce the influence of participate bodies at the River Basin Authorities. Water conservation, as one of the main sources to cover future demands, is encouraged in the 1985 Spanish Law.

Introduction of fees - a slow process

The law of 1985 introduced the conception of water as an economic good and established the necessary guidelines to advance in water efficiency through the fees. Currently Spain is considering to modify the 1985 law by introducing some aspects for better demand management and controlled water markets. There are actual proposals to introduce controlled water markets, to reach proper prices for water use . This process is however going to be slow.

Water quality is treated following the principle "who Pollutes pays", through a fee for waste discharges depending on the pollutant contents and allowing to establish the necessary treatment to reach the allowable standard for the water after the discharge.

Inter-basin water transfers is one of the solutions proposed during the seventies to solve the main water problems in scarcity areas. Pending projects were stopped until the National Hydrological Plan had been approved. More solidarity or economic advantages is however needed in water surplus areas to arrive at real solutions. We believe that water markets can help to this end. A dozen years is however not enough time to get practical results - we can talk only of “good tendencies observed“.

Controlled water markets are one of the promising tools of a better water management facilitating water transfers. The task is not an easy one and the process will be, for sure, slow because water as a social good presents a large reluctance to changes that do not have a clear economical promotion.

LOW WATER STRESS - LOW COPING CAPABILITY

BRAZIL'S EXAMPLE

by Jerson Kelman

Key challenges in water rich developing countries are rapid urbanization and associated flood events. Since public companies have large problems in expanding water supply and sanitation quickly enough, private companies may be an alternative. Addressing the causes of floods by involving stakeholders may be more economical than consequence-focused engineering works.

INTRODUCTION

Low water stress regions may contain water stressed products

According to a report recently approved by the UN Commission on Sustainable Development (1), "water stress can begin once the use of freshwater rises above 10 percent of renewable freshwater resources..." (paragraph 70). Scandinavia, Canada, most of the extinct Soviet Union, Australia, most of Africa, and all of South America are below this threshold level and, as such, could be classified as low water stress regions/countries. However, depending on the size of the region/country and on the internal hydrological diversity, this classification may be misleading. Brazil, for example, which covers roughly half of South America, has a per capita availability of 102 m^3/day, which is more than 5 times the water availability in Europe. Nevertheless, scarcity of water is the major problem in the dry Brazilian Northeast, an area inhabited by more than 30 million people.

Even in those parts of the world which are indeed blessed with low water stress, often there are water related problems, as for example pollution. This is almost always the case in countries with low capability to cope with water management problems.

Capability depends on both income and institutions

Because income level is perhaps the most important reason for this low capability, the UN report has used it "as a rough measure of the ability of different groups of countries to deal with water issues. In general countries with higher per capita incomes are in a better position... as the financial resources and skilled people for management and development are more readily available" (1, paragraph 72). Still according to the UN report, a low income country has a per capita income of less than $795, and a high income country has a per capita income of more than $8,956 (there are two intermediate classes between these two extremes).

There are numerous countries that, despite being blessed with low water stress and with per capita income well above $795, still are unable to achieve rational use of the abundant water resources, due to lack of institutional capability. For the sake of this article, these countries will also be ranked as "low coping capability".

COPING WITH URBAN WATER PROBLEMS

Water resources problems of "low water stress - low coping capability" countries are usually related to the consequences of uncontrolled urbanization processes and to the lack of integration among sectors (irrigation, hydroelectricity, water supply, ...) in planning and management water resources at the river basin scale.

The most important of these problems are water supply and sanitation to large cities, and flood control.

Public Water Supply and Sanitation not always efficient

The explosive growth of urban centers over the last 25 years, which continues unabated, is rapidly depleting previously bountiful freshwater resources. By the turn of the century, 21 megacities (ten-million-plus), 18 of them in developing countries and innumerable smaller cities and towns will have to satiate their thirst by drawing from ever more distant and degraded freshwater sources (2).
In general, public water and sanitation services or companies in developing countries are not efficient, due to a number of reasons:

a) Bad operational practices. In general, there is lack of proper planning and maintenance. Sometimes the physical losses reach 50% of the treated water. **Figure 1** shows, as example, a pipeline crossing a polluted creek in Niteroi, Rio de Janeiro. It is wasting water through several holes. Besides, it has the wrong elevation, which will certainly cause upstream inundation during storms and may result on infiltration of the contaminated water of the creek into the pipe.

b) Bad commercial practices. The general picture is that metering is applied to a small percentage of consumers, subsidies are implicit rather than explicit, and there is no cutting-of-water policy for lack of payment. In these circumstances, no wonder there is a high waste of water. Furthermore, because the poorest segments of society are not commercially attractive, due to the high percentage of unpaid bills, sometimes they are simply not connected to the water distribution system, even in cases where the connection would be technically feasible.

Desperate people seek individual solutions

Figure 2 shows a typical result of this blind policy. It shows a photo of the "distribution system" adopted in the "favela" (slum) known as "Rio das Pedras", Rio de Janeiro, consisting of PVC pipes hanging from a bridge, in the most precarious way. The explanation for such awkward scene is quite simple. Since the water company does not deliver water to the poor households, desperate people seek individual solutions that result in the most inefficient, wasteful and dangerous "system" one conceive. Each household, or small group of households, stretches its own PVC pipe to the manhole

and simply steal water from it. One can notice that contamination in this case is almost a sure event, as several pipes are actually immersed in the polluted river. In addition, the hanging pipes form a "nest" that retains trash during storms, which blocks the river course and causes inundation.

Public companies - poor functioning

Public companies often lack of financial and administrative autonomy. The board of directors of public companies in developing countries are usually severely constrained in their autonomy to run the business by complicated legal systems. They can not hire or fire personnel, sign contracts or equipment, as a private company would do. There are too many controls over their action and in the general these controls are focused on "processes" rather than on "results".

Political interference - Directors of public companies are often selected based on their political connections to the ruling party, rather than on their technical or managerial abilities. Furthermore, and most importantly, tariff setting is often affected by macro-economical considerations, as for example inflation control. As a consequence, tariffs are disconnected from costs, resulting on no incentives for cost minimization.

Public companies finally tend to lack of financial resources necessary. In Latin America alone, it is estimated that the region's countries need to invest an annual $5 thousand million in water supply and $7 thousand million in sewerage and sewage treatment over the next decade. These requirements are well beyond the public sector's financial capacity.

Private companies to act within regulatory framework

As a reaction to the above problems facing public water and sanitation companies, the notion is spreading that the public sector should establish the legal and regulatory framework, and then allow public and private companies to compete for the mandate to provide service (3). In real life application of these principles has been hampered by the conflict between the need to establish the legal and regulatory framework, which means the creation of new responsibilities for the public sector, and the prevailing trend for decreasing the size of governments.

In some cases, concessions of public services previously held by public companies, that were loosely controlled by governments, are now being transferred to private companies, even before putting in place the regulatory framework. This state of affairs creates a risk for both, the population and the private companies that are getting the concessions, as the absence of rules may result in future lack of continuity of services or on decay of its quality.

This position is supported by some people that oppose government intervention in the economy, even for controlling public services. They like to cite the obvious improvement of performance that could be observed in the telephone sector, after de-regulation. However, competition could be established in the telephone sector, and others alike, because they are no longer natural monopolies, due to several

technological breakthroughs (cellular phones, for example). In other words, competition inside a concession area could be established. Certainly this is not the case of water supply and sanitation, that persists as a natural monopoly.

If competition for the service on a day to day basis is not feasible in natural monopolies, one can at least establish competition for the concession even if the universe of private companies competing for water and sanitation concessions is rather small. The formation of coalitions among these companies can not be ruled out.

An alternative for public companies of developing countries - rarely used unfortunately, is the adoption of management contracts between government and the board of directors. These contracts would consist of well established economical and social targets, in exchange for financial and managerial autonomy.

Flood Control: addressing consequences rather than causes

The chaotic expansion of big cities in developing countries, subjected to hot humid tropical climate, is usually associated with a time increase of the flood frequency. For example, there are several neighborhoods in the poor outskirts of Rio de Janeiro that are now inundated almost every year. That is, storms that in the past would cause minor problems, now cause major problems, with huge human suffering, due to:

- Occupation of the flood prone areas by the poor, that do not have any other option (**Figure 3**);

- Clogging of rivers and channels with garbage, which is not properly collected neither disposed (**Figure 4**);

- Sedimentation of channels and rivers, as a result of erosion on the hillsides;

- Increase of surface flow, due to the impervious surface laid on top soil.

Usually governments of developing countries tend to deal with the consequences of these processes, rather than with the causes. They are prone to expend large quantities of money on costly engineering works, such as construction of channels, dikes and pumping stations, much because construction companies lobbies, and very little on land use planning and management, as well as on maintenance of the existing infrastructure. Under these circumstances, an optimal engineering solution may not be the most recommended one. For example, this author refused to adopt a flood control solution based on the creation of a polder, that would be the optimal alternative in Holland, but that would not long last in the outskirts of Rio de Janeiro, due either to lack of maintenance of the pumps, or to uncontrolled settlement in the flood storage area.

Active stakeholder involvement

Experience has demonstrated that all these problems are greatly reduced whenever there is an active involvement of the stakeholders in the decision process. It has been proved

in a real case (4) that the local population reacts quite positively when the decisions are taken with their involvement. In this specific case, people that previously lived in risky areas along the banks of rivers were moved to new homes, built on more valuable land. Once the flood threat had been removed, they started to expand their houses, while businesses invested in construction and renewal. Tax revenue collected by the Municipalities raised, and opened up a new phase of economic and social development.

PLANNING AND MANAGEMENT OF WATER RESOURCES

A new paradigm of water resources management has emerged from some important international meetings and policy papers on water (2, 5, 6):

- planning and management of water resources should be done at the scale of the river basin, with the participation of stakeholders;
- controlled issuance of water permits for intakes or for dilution of effluents is an essential tool for planning and for investment by the water users;
- bulk water is an economic good and as such should be charged in order to: (i) achieve rational allocation; (ii) create the financial resources necessary for the improvement of the river basin;
- human supply is top priority among competitive uses.

River basin scale not always the best

It has not been easy to apply these concepts in developing countries. One of the difficulties is that the river basin scale is proper in most cases, but not in all. Hydroelectric power plants in different river basins can be electrically interconnected. When a drought strikes a particular river basin, sometimes for several years on a row, the system may be sustained by the power plants located in different river basins, apart from each other by thousands of kilometers. In these circumstances, the electric power sector will tend to plan and operate the reservoirs from the interconnected system perspective, rather than from the river basin perspective.

The river basin committee - the right mix

The proper mix of representatives in the river basin committee can make a big difference. Limited experience has shown that if the NGO's outweigh the users representatives (water-supply/sanitation companies, industries, irrigation districts, power companies...), decisions of river basin committees tend to become unfeasible because those that decide do not have to pay for their decisions. On the other hand, if decisions are left only to users, there is a risk that the environment would not be properly preserved for present and future generations. River basin committees do not need to be established across the board. Committees should be formed only in basins, or sub-basins, which have some water conflict, actual or potential. Local problems may induce the formation of committees for some of the upstream sub-basins. In this case it is necessary to create a hierarchical relationship between basin and sub-basin committees. When it comes to flood control, community participation in the selection of

solutions is highly useful. However, because flood protection is a community benefit, rather than an individual benefit, government financing is unavoidable.

Consistency in water permits

Water use permits should apply either to quantitative uses of water, such as irrigation/ urban supply, or to qualitative uses, such as dilution of industrial/urban waste. However, in most cases quantitative and qualitative permits are issued by different government agencies, which are often rivals. Ideally, both kinds of permits should be issued by the same agency. For this, the same yardstick should be adopted in order to reduce quantitative and qualitative uses to common ground.

Revenues should finance improvements

Pricing bulk water should not be a source of revenue for governments, as there is a widespread disbelief in developing countries about government capability to carry on new policies, such as the rational use of water resources. Instead, the corresponding river basin committee should preferably use the revenue in the same river basin where it originated. Ideally, revenue should decrease with time because the money raised with the water tariff should finance improvements for the river basin as a whole.
Pricing bulk water face resistance from sectors that believe that accepting lower environmental standards, which result in lower production costs, is the only hope for developing countries to compete within the global market.

CONCLUSIONS

Low water stress is a necessary but not sufficient condition for a country or region to be free of water related problems. When the coping capability is low, there will be all sorts of problems related to excess of water, excess of pollution, or both. Coping capability may be low due to the weakness of institutions, even in countries with reasonable per capita income.

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HIGH WATER STRESS - LOW COPING CAPABILITY

MOROCCO'S EXAMPLE

by Mohamed Ait Kadi

Morocco is a highly water-stressed country, with high population growth, rapid urban migration and highly erratic rainfall with frequent droughts. The country is now reaching the end of the water resources development era. Water resources management is therefore shifting to the more difficult task of ensuring socially and technically efficient water allocation within the existing water resource constraints.

THE GENERAL CONTEXT AND THE APPROACH

Call for decisive break from past policies

The report on Comprehensive Assessment of the Fresh Water of the World has categorised how coping capability countries as those with per capita income of less than US$ 795 and high water stress where the water use to resource ratio is over 40%. A number of countries in the arid or semi arid regions of North Africa, South and West Asia fall within this category.

The major water issues and challenges facing these countries as identified in the report can be summarised as follows:

- Present water use patterns and withdrawals are not sustainable and water security will become a major limiting factor for socio economic development;

- Under current trends, many countries in this category will become less self sufficient in food production and will rely on the world market for food imports;

- These countries will need major investments to mobilize resources and improve water use efficiency, and the portion of GDP allocated to water resources management can become substantial;

- Low income - high water stress countries are the most constrained with respect to future development because they have neither the extra water nor the financial resources to restructure consumption patterns away from wastefull and low-value water intensive uses

There is no need to elaborate more on these issues as a general consensus is well reached now on the global appreciation of the situation, its seriousness and the urgent need to act now. Low income - high water stress countries have no choice. They must make a decisive break from past policies and management practices to embrace a holistic water sector approach that is economically, socially and environmentally sustainable.

A coherent set of policy components

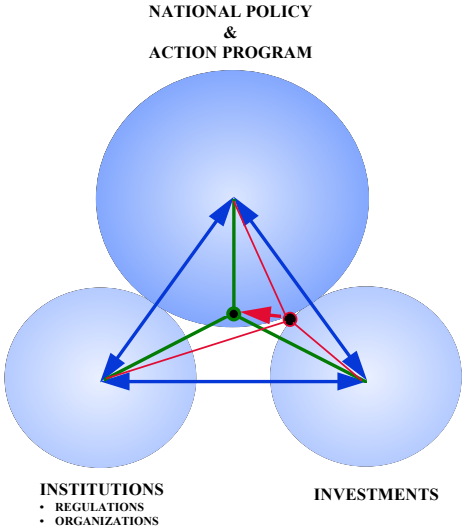
From a country perspective, the challenges posed by growing scarcity of water can only be adressed through a holistic water sector approach based on:

1. developing an enabling environment in terms of adequate policies and institutions (including regulations and organisations); and

2. mobilising the necessary financial resources required both for selective development and exploitation of new water supplies and more vigourous demand management with comprehensive reforms and actions to make better use of existing supplies. Of course the appropriate mix of supply and demand management strategies will vary from country to country depending on the level of development of its water resources.

As depicted in **Figure 1**, Policy - Institutions - Investments should be considered as a coherent whole. National water resources development should be undertaken in a holistic, determined and sustained manner to meet national development goals and protect the environment within a trans parent policy framework without wich investmens cannot fulfill their potential. A policy statement is often required as an expression of a long term vision and commitment at the highest level of government.

Figure 1. Water sector development
- Holistic approach -



However, a policy statement is a necessary but not a sufficient condition. Putting into practice the concept of holistic management means also that governments need to strengthen or create new institutions capable of integrated water management. They need to assign high priority to capacity building and human resources development.

There is also a need to put in place a coherent set of incentives and regulatory controls to support national water policy.

Finally, investments are required not only to mobilise additional water resources and improve water use efficiency but also to restructure the economy of the country and its consumption patterns away from wasteful and low-value water intensive uses to cope with transitional difficulties and transitional costs. This is a difficult task as most low income countries are facing shrinking national budgets due mainly to their external debt burden.

In this context, the international community has to translate the emerging international consensus on water issues into a concrete move of solidarity and international cooperation for water and by water to help low income countries with high water stress meet the important development challenge they are facing wich is increasing wealth and reducing resources use !!

MOROCCO'S EXAMPLE

In Morocco, the consequence of increased industrialization and a rapidly growing population, accentuated by a progressive shift from rural to urban living is the growth of requirements for the quantity and quality of water resources and for their more intensive and comprehensive use.

For the last three decades the emphasis in Moroccan development planning has been on maximizing the capture of the country's surface water resources and providing for their optimal use in irrigated agriculture, potable water supplies, industrialization and energy generation.. Enormous capital resources have been invested in the essential infrastructure to control surface water flows. Infrastructure to capture and utilize about two-third of the surface water potential is in place and a number of major infrastructure projects are in advanced stages of planning and/or construction to capture most of the remaining potential.

As Morocco nears the end of the infrastructure phase of its national development plan, emphasis is beginning to shift to the more sophisticated and difficult task of ensuring socially and technically efficient allocation of the existing water resources among competing consumer groups on a sustainable basis. This task is ever more complex given Morocco's relatively high population growth (2.06 % per annum), the higher rate of immigration from rural to urban areas (urban population has increased from 42.7 % in 1982 to 51.4 % in 1994) and the great spatial and temporal variability in annual rainfall with droughts of frequent occurrence.

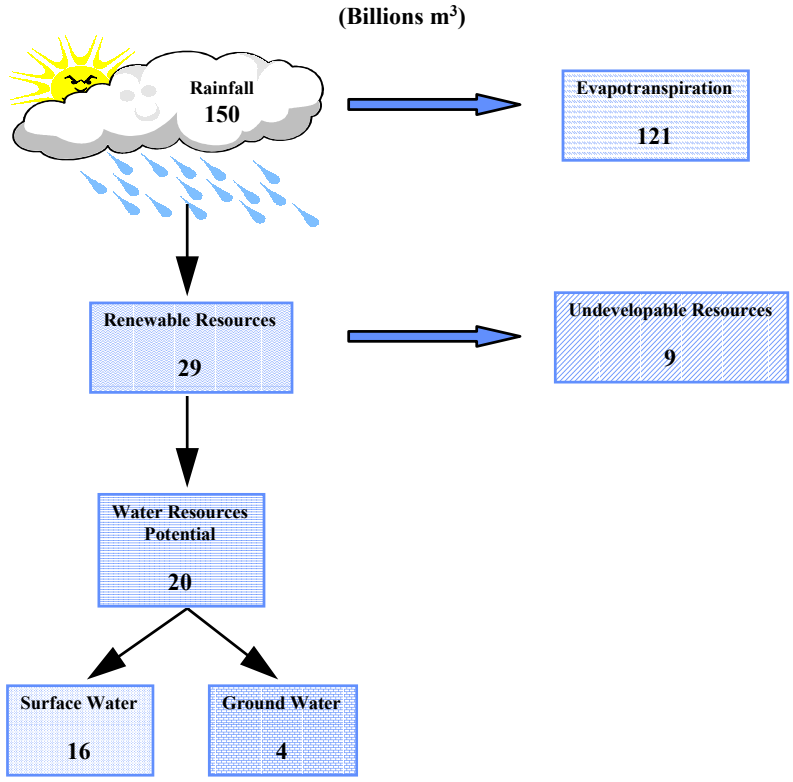
Issues and constraints

Despite remarkable achievements, Morocco faces a growing challenge in the water sector. The main issues and constraints can be summarized as follows:

Decline in available water resources

The mean annual rainfall across Morocco under average seasonal conditions is estimated to total 150 billion cubic meters (**Figure 2**). However, the renewable water resources do not exceed 29 billion cubic meters (BCM). Taking into account potential storage sites and groundwater development possibilities only 20 BCM are divertible annually, 16 BCM from surface water and 4 BCM from groundwater.

Figure 2. Morocco's water resources



Some 88 large dams have been built increasing the storage capacity from 2.3 billion cubic meters in 1967 to 14 BCM in1997.

Morocco is also endowed with groundwater resources. Some 32 deep aquifers and more than 46 shallow ones scattered all over the country have been inventoried. Groundwater withdrawals have increased from 1.5 BCM in 1960 to 3.6 BCM in 1997.

Some 11 BCM are now committed to agriculture, domestic and industrial uses. As population numbers increase, coupled with demands for high per capita domestic and industrial consumption resulting from improved standards of living, the sustainable upper limit or "carrying capacity" of water resources utilization will be approached by the year 2020 (**Figure 3**). Thus, a growing scarcity is anticipated as a result of rising demands resulting from expansion of irrigated areas and urban development and a slowing of the growth in accessible supplies, the depletion of aquifers and the pollution of available resources. Per capita renewable water resources per annum are expected to fall from 850 cubic meters to 410 cubic meters in 2020, when all renewable resources are projected to be mobilised. That is in 2020 Morocco will move from being defined as a « water stressed » to being a « chronically water stressed » country.

A number of river basins are already experiencing water shortages which will impose costly interbasin transfers (**Figure 4**). Some of the more intensively used aquifers are now considered to be under stress with serious draw downs with salt water intrusion in the coastal ones.

Figure 3. Morocco's water balance 1990-2020

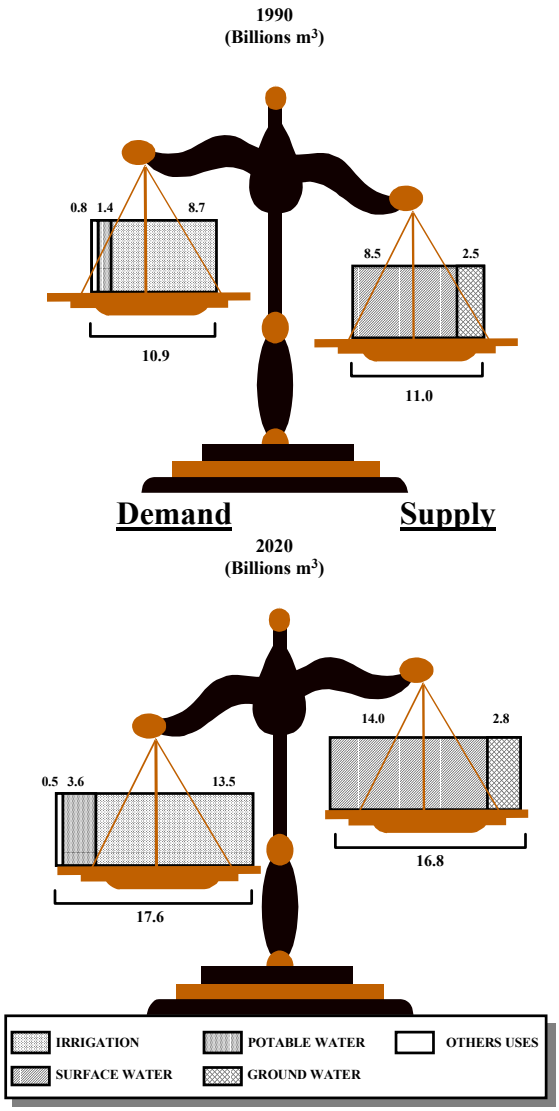
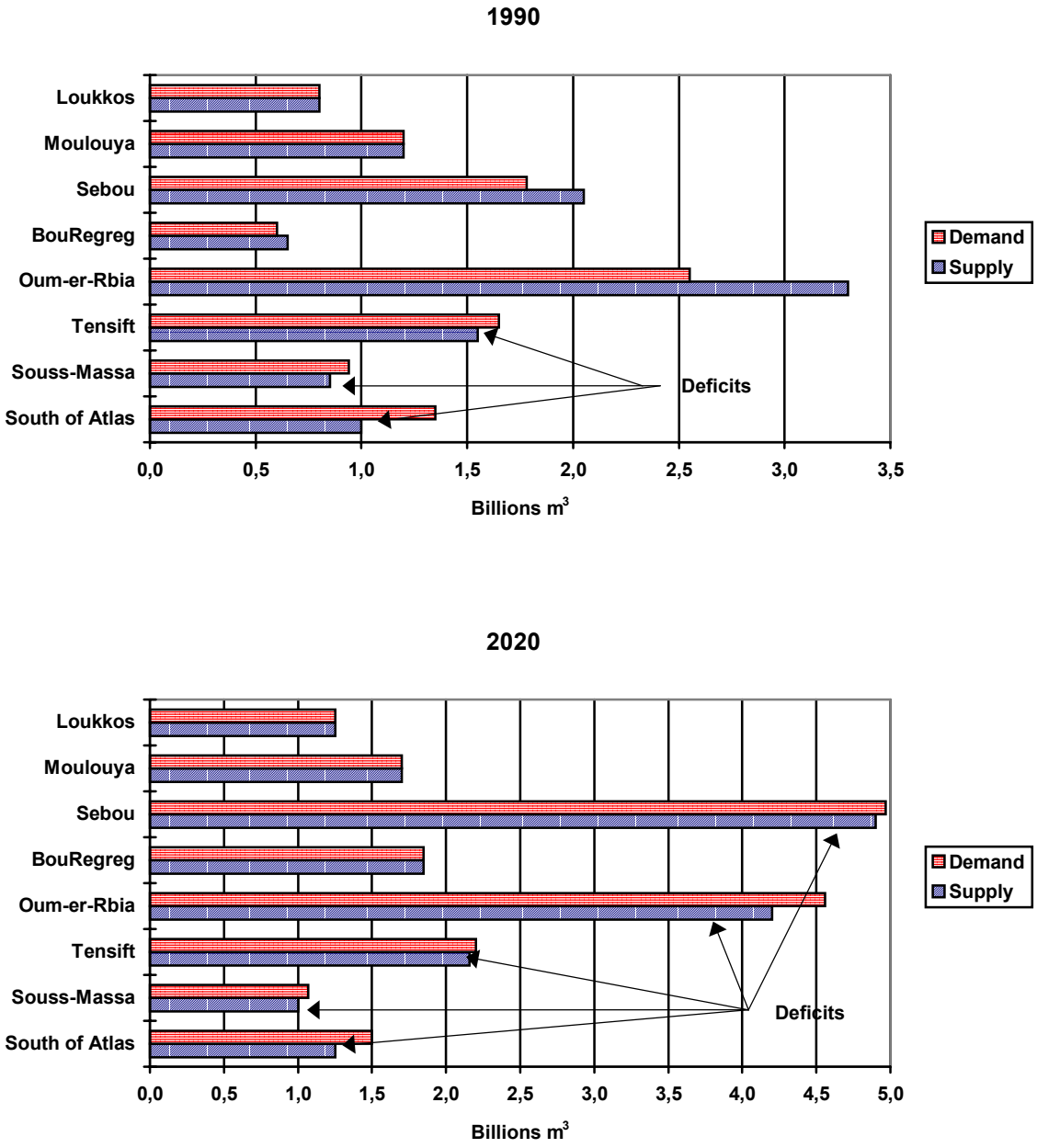


Figure 4. River basins' water balance



Rapid degradation of water quality

Due mainly to under-developed sewerage subsector. Sanitation infrastructure has not kept pace with drinking water supply and urban effluent is currently a major contributor to the pollution of surface, coastal and groundwater. If the Moroccan economy is to proceed along its growth path, water quality requirements are growing faster than those of water quantity.

Inadequate maintenance of existing infrastructure and silting of reservoirs

A key challenge is the ineffective use of existing hydraulic infrastructure caused by inadequate maintenance due to insufficient financial resources.Dams'siltation, due to the high rate of erosion, mainty in the northern watersheds because of deforestation, has diminished available storage capacity by as much as 8 percent. Measures to enhance watershed management and maintenance of existing infrastructural investments are expected to result in considerable financial and water savings.

Low level of provision of potable water to rural population

Despite Morocco's success in providing water to virtually all its urban inhabitants, the provision of rural potable supplies remains an immediate challenge. Half of the population lives in rural areas and barely 32 per cent have access to safe and reliable supplies of water. However, an important program has been recently launched with the aim to provide potable water to 80 per cent of the rural population before the year 2010.

Low water use efficiency in irrigation

Irrigation is the largest water consumer. It accounts for 88 % of the water use compared to 8 % for domestic use and 4 % for industry. Increasing water resources development costs, along with severe financial constraints and competition for scarce public funds, have fostered a substantial change in attitudes to water conservation. Serious questions have been directed towards water use efficiency in the irrigation sector while recognizing its strategic role in the economic and social development of the country. Indeed, the whole irrigation subsector currently represents only 10 per cent of the arable lands but contributes 45 % of the agricultural value added and produces 75 % of the agricultural exports. In addition to boosting food production, irrigation development has also increased rural employment, promoted agroindustry and helped stabilize domestic production. It has also raised productivity and incomes significantly by bringing modern agriculture to small farm families. It has, in several areas, reversed the flow of people from rural to urban areas. Furthermore, it has also contributed to natural resources conservation by reliefing the pressure on areas with fragile ecology.

Morocco's water economy is now characterized by sharply rising costs of supplying additional water and more direct and intense competition among different kind of water users and uses. In this context, a better mix of increasing supply and demand management can be considered as the most rational response to water scarcity.

Finally, there is a felt need to strengthen the institutional capacity and develop a more cohesive and integrated legal framework moving away from sector based legislation. Furthermore, it is necessary to develop a rational mechanism for intersectoral water allocation and to adopt a coherent water strategy and planning to guide its effective use and management.

MEETING THE CHALLENGES OF GROWING WATER SCARCITY

To meet the challenges posed by the growing water scarcity, Morocco has adopted an integrated approach to water resources management through mutually reinforcing policy and institutional reforms as well as the development of a long term investment programme:

The major policy reforms adopted are the following:

- The adoption of a long term strategy for an integrated water resources management. The National Water Plan will be the vehicle for strategy implementation and will serve as the framework for investment programs until the year 2020;

- The development of a new legal and institutional framework to promote decentralized management and increase stakeholder participation;

- Introducing economic incentives in water allocation decisions through rational tariff and cost recovery;

- Taking capacity enhancing measures to meet institutional challenges for the management of water resources; and

- Establishing effective monitoring and control of water quality to reduce environmental degradation.

All these policy features are inbedded in the new legal and institutional framework.

The New Legal and Institutional Framework

A new water law has been promulgated in 1995. It provides a comprehensive framework for integrated water management. Some of the salient features of this law are:

- Water resources are public property;

- The law provides for the establishment of River Basin Agencies (RBA) in individual or group of river catchments. It clarifies the mandates, functions and responsibilities of the institutions involved in water management. In particular, the status and the role of the High Water and Climate Council has been enhanced as the higher advisory body and a forum on national water policies and programs. All the stakeholders from public and private sectors including water users associations seat in this council;

- The law provides for the elaboration of national and river basin master plans;

- It has established a mechanism for recovery of costs through charges for water abstraction and introduction of a water pollution tax based on the principle « user - pays » and « polluter-pays ».

- The law reinforces water quality protection by defining environmental mandates and enforcing sanctions and penalties.

Concerning the institutional set up, the major change is the establishment of River Basin Agencies empowered to manage individual or groups of river basins. The three principal responsibilities of these agencies consist of the development of water resources, the allocation of water as defined by the master plan and the control of water quality. The agencies reinforce the network of existing institutions in charge of different water management functions. But capacity building requirements are high to make this network of institutions capable of integrated water management.

The Investment Programme

Enormous capital resources have been invested in the essential infrastructure to capture and utilize two thirds of the surface water potential, develop hydropower, urban and rural potable supply and irrigation. As shown in **Figure 5**, during the 1990-95 period, total expenditures in the water sector (investments plus operation and maintenance) have reached 2.6 to 3.2 % of the country's GDP. This portion will increase to about 4.3 % during the 1996-2000 period as efforts will be continued to:

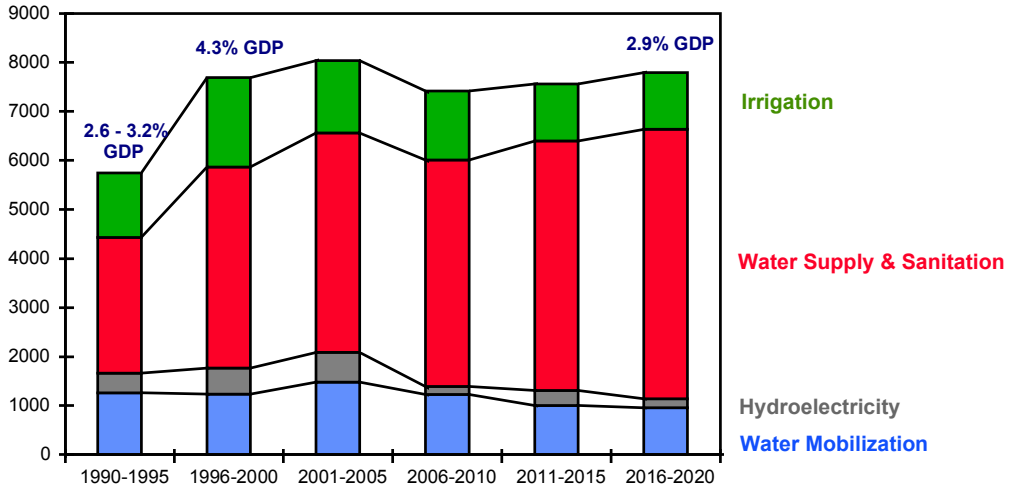
- capture most of the remaining potential and develop the accompagnying hydropower infrastructure to reduce energy imports;

- meet the government objective for the potable water supply sub-sector which is to supply virtually the entire rural and urban population by the year 2020; and

- continue the on-going expansion of modern irrigation which is expected to bring the total irrigated area by 2020 to the irrigable potential of the country given the available water resources. However, in view of the current concerns about impeding critical water shortages, conserving water and improving efficiency, productivity, cost effectiveness and sustainability of irrigated agriculture are increasingly necessary if Morocco's economic growth is to continue. In this context, the National Irrigation Program (1993-2000) has adopted an integrated approach to carry out, along with the expansion investments, improvements in three major, interrelated areas which are:((i) improving hydraulic efficiency of irrigation systems, (ii) strengthening irrigation agencies'managerial capacities and (iii) increasing productivity.

Perhaps, it is worth to elaborate on the irrigation improvement programme and the food security issue associated with it as this is urgently needed in most low coping capability - high water stress countries to avert severe water scarcities that will depress agricultural production, parch the household and industrial sectors, damage the environment and escalate water-related health problems.

Figure 5. Total expenditures in the water sector (Investments + O & M) - M US $



Figures 6 and 7 show the components of the programme and their relations.

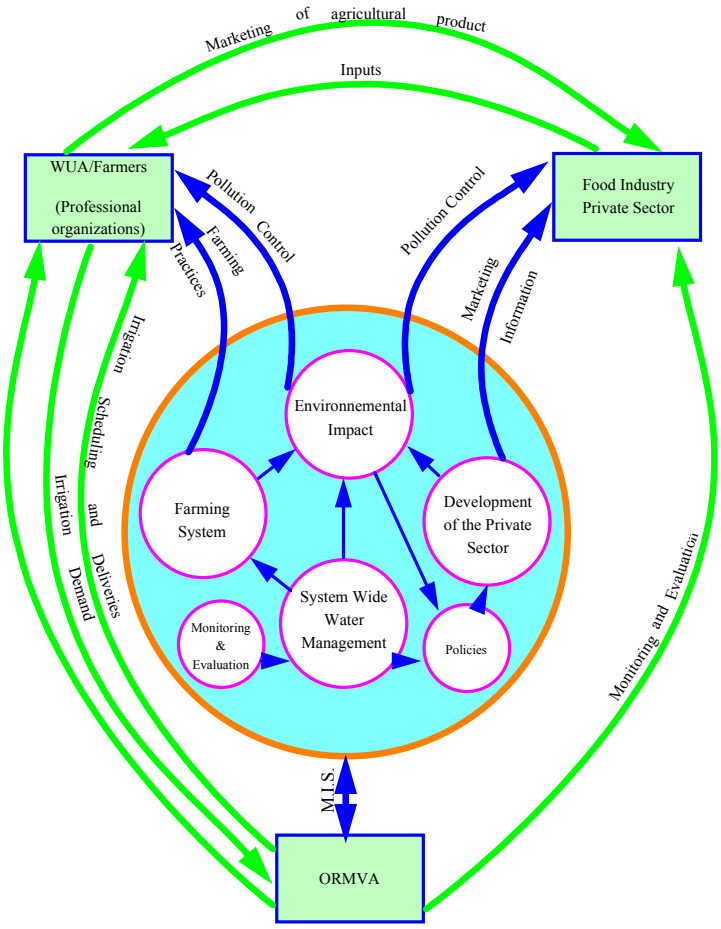
More efficient irrigation systems

The hydraulic performance of irrigation systems will be improved through:

1- rehabilitation of infrastructure throughout 200 000 ha of which 138 000 ha concern small and medium scale traditional irrigation systems. It includes reconstruction, repair, upgrading or replacement of canals, drains, feeder roads, control structures, farm hydrants and pumping equipment;

2- strengthening the irrigation agencies, in charge of large scale irrigation projects (the ORMVA) water management capacities through introducing modern O&M practices to provide reliable, flexible and equitable water supply to farmers at optimal costs. Perhaps one of the most significant policy change in the large scale irrigation projects is the gradual liberalization of cropping patterns and reduced ORMVA's intervention in farmer decision making. This not only affects ORMVA - farmer relations but also calls for radical changes in management of the irrigation system to introduce greater flexibility in water deliveries to meet farmer's new needs and reduce operational losses. It requires an improved knowledge base for irrigation planning through: (i) improved knowledge and understanding of cropping, land use, and tenure patterns and ongoing changes, (ii) improved ORMVA staff knowledge and understanding of farmer's decision making processes and an enhanced capacity to be responsive to farmer's needs, (iii) knowledge and understanding of constraints on water resources and the hydraulic system, etc;

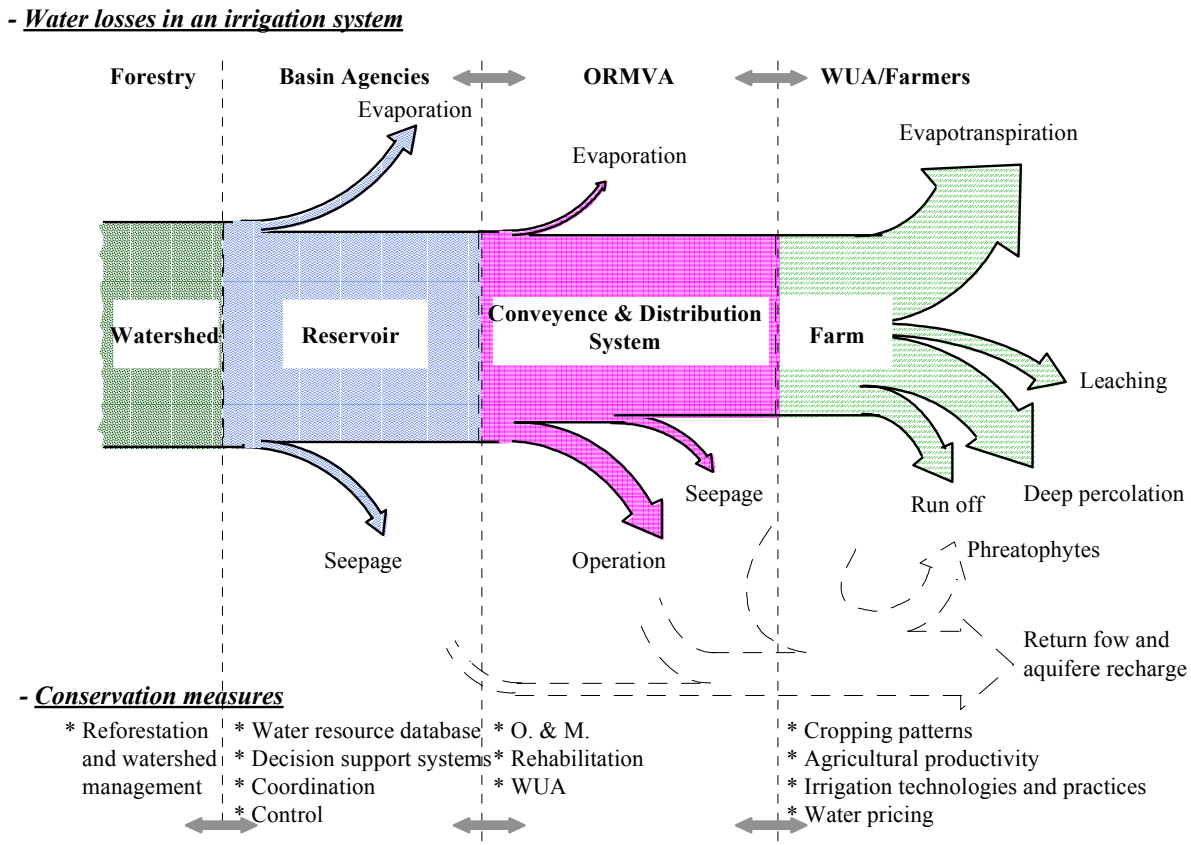
Figure 6. Synoptic of the "Holistic" Approach



3- improving on-farm water management through the reinforcement of irrigation management extension services and on-farm investments to introduce water saving irrigation technologies. A national network of research, training and extension centers has been established for testing and disseminating improved irrigation practices to alleviate constraints on efficiencies and economic performance. Incentives in the form of subsidies and credit are provided to farmers to motivate them to invest in land leveling, canal lining, improved sprinkler equipment and drip irrigation systems;

4- developing Water Users Associations that are able to effectively participate in the management of their irrigation systems. It is also hoped that these Water User's Associations will serve as a communication link and forum for disseminating information and assistance on improved water use, agricultural practices and technologies;

Figure 7. Water losses in an irrigation system and conservation measures



5- restructuring of the irrigation water tariff to better reflect the trend to water scarcity in Morocco and the growing economic competition from other sectors as well as to cover the entire estimated true O&M costs and a reasonable portion of depreciation costs. Low water charges is the root cause of inefficient on-farm water management which leads to waterlogging and salinity problems in some areas and induces losses on agricultural production and incomes. Moreover, at present water charges most ORMVA still need Government financing to close the gap between billed charges and actual direct costs of water.

Increasing agricultural productivity

Cropping intensities and yields whose corollary is increasing farmer's ability to pay water charges will be increased. Key measures include:

1- providing appropriate agricultural extension services to farmers;

2- strengthening farmers' capacity to market their products through organizing professional commodity associations and enhancing the role of the private sector;

3- optimizing cropping patterns in each irrigation scheme in terms of competitive advantages with regard to maximizing water use efficiency, taking into account the globalization of markets along with new production and trade structures as for example those specified in the Association Agreement with the E.U.

Strengthening ORMVA managerial capacities

In order to improve their managerial capacities, ORMVA's will be made more client-oriented and cost conscious through the following measures:

1- revising the organizational structure of the ORMVA and introducing appropriate management information system (MIS) for better delivery of services to farmers as well as better financial control including cost accounting systems;

2- reinforcing human resources development programmes and trainig of staff.

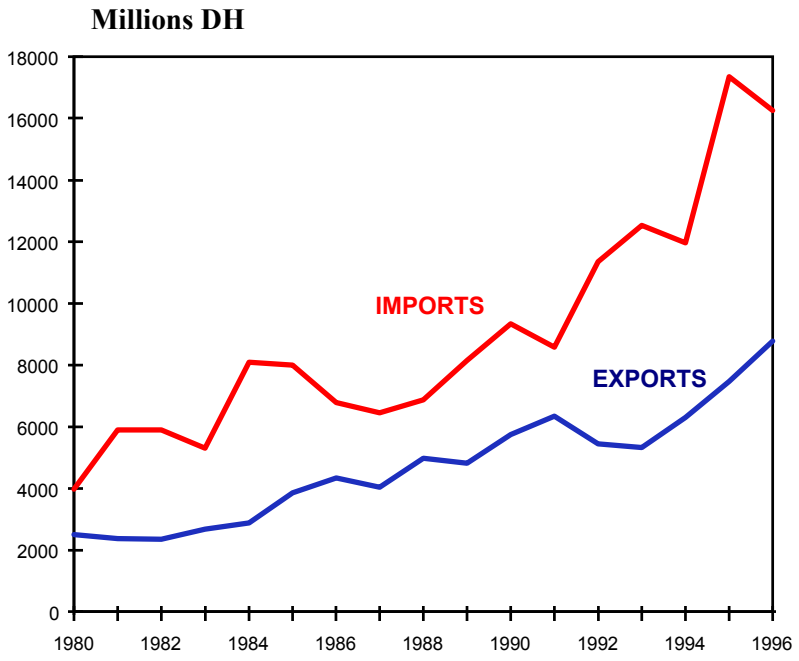
This comprehensive set of actions is completed by policy and institutional reforms to clarify and formalize relations between Government, ORMVAs, farmers and private sector with the objective to reflect the changes in sectorial and macroeconomic policies.

From food self sufficiency to food security

In this context, Morocco's agricultural strategy has moved from the food self-sufficiency objective to the food security objective. This means that food domestic needs will be met through strategic levels of national agricultural production The gap will be covered by relying on the international market in order to make the best use of the country's competitive advantages given the water resources constraint.

Of course, the liberalisation of agricultural trade widens the entire spectrum of economic possibilities offering countries like Morocco the potential to make efficient allocation of their water resources and to make the most of their comparative advantages. The challenge for them is to identify agricultural opportunities and start moving forward. Morocco is already on this track as shown by the evolution of its agricultural foreign trade. But appropriate trade policies require astute understanding of the underlying economic competitiveness in any agricultural sector in liberalized world markets and strong government policy that encourages its development. The other essential ingredients are immense investments in infrastructure and technology to increase productivity and improve quality.

Figure 8. Morocco's agricultural trade



It is important to realize that there are transitional difficulties and adjustment costs both economic and human. Indeed, as it is the case in Morocco, agriculture has still an important role in the national economy. Although it contributes only 20 % of GDP its performance strongly influences the performance of the whole economy as depicted in **Figure 9** wich represents the fluctuations of the agricultural gross production and those of GDP. Furthermore, agriculture still provides employment to a large portion of the rural population. **Table 1** gives some comparative figures. agricultural gross production (AGP) over GDP, agricultural employment (AE) over total employment and irrigated land (IL) over cultivated land (CL) for a number of Mediterranean countries.

But the most limiting factor is that the agricultural trading system is not yet neither truly global nor truly free. Low income countries of the South have still a difficult access to the markets of the countries of the North. We still have to develop a trading system that draws on the expertise of every nation and returns to every nation a more diverse and above all secure supply of food. This has been well recognized by the FAO World Food Summit November 1996. The hope is that the international community works towards the implementation of the important recommendations of this Summit.

Figure 9. Fluctuation of Morocco's agricultural gross product (AGP) and GDP

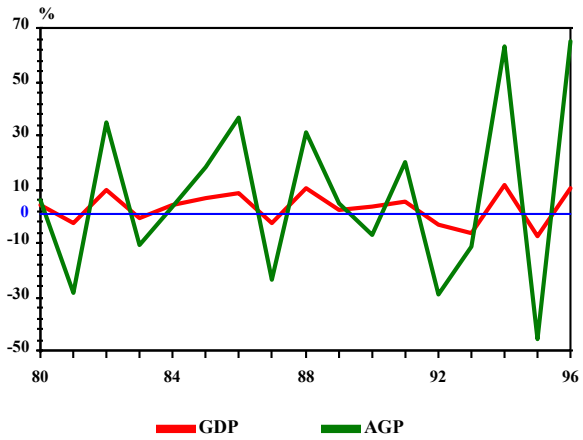


Table 1. Comparative ratios for some Mediterranean countries

COUNTRIES	AGP/GDP %	AE/E %	IL/CL %
Spain	3.3	9.2	18
France	2.2	4.4	8
Italy	2.7	7.2	24
Greece	8.2	20.4	37
Portugal	2.5	14.9	21
Cyprus	6.0	10.7	-
Malta	3.0	1.5	-
Albania	55.0	53.8	43
Israel	9.0	3.5	50
Lebanon	10.0	4.7	33
Libya	8.0	6.9	23
Algeria	12.0	24.3	6
Morocco	19.5	41.4	14
Tunisia	15.0	24.4	8
Egypt	16.6	34.4	100
Syria	11.6	32.5	20
Turkey	16.0	51.1	15

Legend: AGP = agricultural gross product. AE = agricultural employment. E = total employment. IL = irrigated land. CL = cultivated land.

MAR DEL PLATA: TWENTY YEAR LATER - CONCLUDING REMARKS

by Asit K. Biswas

The Seminar commemorating the 20th anniverdsary of the United Nations Water Conference at Mar del Plata is one of the first activities of the newly-established Stockholm International Water Institute (SIWI). Judging by the organization of this Seminar, and its results. there is no doubt SIWI is likely to play a very important role in water management in the years to come.

During the Seminar, eight papers on different aspects of water development during the past two decades were presented. In addition, there was an excellent opening speech by Mrs Anna Lindh, Minister of the Environment of Sweden, as well as a Panel Discussion. As normally is the case for all seminars, there were considerable variations in the papers in terms coverage, depth of analyses and qualities of information provided.

FOUR KEY ISSUES

Based on the papers presented and the ensuing discussions, the following comments can be made. These comments are not listed in any order of priority, since priorities may differ from region to region, as well as with time.

1. Where do we want to go from here and how do we get there?

Pierre Najlis and Johan Kyulenstierna provided an objective analysis of the developments following the Mar del Plata Conference. I fully agree with the authors that the Mar del Plata Action Plan was an extraordinary document, much of which is still valid even two decades after its formulation. Regrettably institutional memories are somewhat short since Mar del Plata produced significantly better results than the Dublin Conference, even though most institutions now speak primarily of Dublin and basically ignore the Mar del Plata. It is of course true that in a few areas, global thinking has shifted significantly since 1977. Among these areas are the decreasing role of the governments in water management, increasing private sector participation, more emphasis on environmental and social issues, higher levels of public participation and the enhanced role of women.

While the Mar del Plata Action Plan provided an excellent road map, it would be true to say that we have not succeeded to follow this map to any significant extent. There have been many global meetings and discussions on water issues, ranging from Dublin and Rio in 1992, to New York in 1997. All of these have contributed marginally so far in terms of:
* putting water firmly in the international political agenda
* making governments aware of the real urgency of the water crisis facing mankind, so that they are forced to take immediate and concrete actions; and
* where do we now want to go, and how do we get there?

Sadly there has been very little serious debate on the last factor: where do we now want to go and how do we get there? Thus, not surprisingly, as Najlis and Kyulenstierna have pointed out, in many areas we are now worse off compared to 1977.

Undoubtedly, SIWI can make a major contribution if it can initiate an effective global discussion on the above issue. However, if we are to make any progress, we need to eschew the current entrenched syndrome of political correctness. No significant progress is possible until and unless we explicitly

recognize the real problems and are willing to call a spade a spade. Neither general statements that everything is fine, nor assurances that some international organizations are looking after specific issues, would solve the problems.

2. South-South experience transfer

While much lip service has been given to this subject in the past, we have made very limited progress thus far. It is an established fact that major water developments have not occurred in the Western Europe or in the North America during the past 20 years. These developments have taken place in countries like Brazil, China, India, Mexico and Turkey. Regrettably, we currently have very little knowledge of these developments. People in Brazil or China know much about water developments in the United States or England, but not in their own countries or in other developing countries. And yet, in many instances countries like Brazil or Turkey are light-years ahead of their counterpartrs. For example, Brazil has enumerated the principles of sustainable water management in operational terms, which are significantly better than the so-called Dublin principles. Currently one needs to visit Mexico or Turkey to observe the latest advances in the area of transfer of.....??.....irrigation districts, or to Egypt for the control of schistosomiasis. And yet, such advances are still basically unknown in the world, and some times often even within the countries themselves.

We thus need to change our mind-set, and learn from the rapid advances made by certain countries in the South, especially during the past decade. Furthermore, similarities in climatic, economic, social and environmental conditions often mean that South-South experience transfer could often provide better results than the existing almost exclusive North-South knowledge transfer.

3. Ecosystem need for water

Ecosystems need water for survival, and they evolve on the basis of water availability as well as water quality. If the existing ecosystems around the river systems are to be maintained on a long-term basis, certain amounts of water must be allowed to flow through the water bodies to the sea. At present, water needs of ecosystems are not considered as "legitimate" users of water. I am convinced that this view would change within the next decade.

This would however mean that the conflicts between the various water users would become even more intense in the future. In addition, our existing knowledge on how to estimate the ecosystem needs of rivers with some degree of accuracy is very rudimentary. Urgent research is necessary to develop usable methodologies for such estimation.

4. Water for food, energy and health

Wulf Klohn and Bo Appelgren discussed the close linkages between water and food security during this Seminar. Unquestionably, this is a critical issue for the future of mankind. Furtunately, in recent years, the issue of water and food security is receiving increased attention, primarily through the good work of FAO.

ISSUES NEGLECTED

There are two areas, however, where either such discussions have not started, or they are not complete. For example, in the area of energy, regrettably water requirements for electricity generation is a totally neglected issue. And yet, no large-scale energy production is possible without water. In addition to hydropower, thermal and nuclear power generation requires large quantitites of water.

The Asian developing countries had a total generating capacity of 250,000 MW in 1990, nearly 70 percent of which was thermally generated (mainly coal), and the balance of 30 percent being accounted for by mostly hydropower. If the current development plans of these countries are to be fulfilled, an additional 240,000 MW would be needed by the year 2000. This doubling of electricity production within the short ....??...is lowering, however, has been more than compensated by increasing unconventional security threats from new factors like population growth and the associated impacts such as depletion and degradation of natural resources, especially water, and environmental deterioration.

Very few people have realized the importance of these new and emerging factors as a serious threat to future national, regional and global peace, and even fewer have a clearer understanding of where, how and when such threats could effect peace and security issues.

To the extent that these non-conventional concerns have received some attention in recent years, they have generally tended to concentrate only on one issue: global warming and climate change. And yet, the most immediate and most serious threat to national and regional peace is likely to come not from climate change, though an important issue, but from the lack of good quality freshwater. Unfortunately, this is a fact that has mostly been neglected in recent global discussions.

FUTURE DEMANDS UPON WATER MANAGEMENT PROFESSIONALS

On the basis of the above analysis of the Seminar, it is clear that the water management profession is likely to face a problem in the twenty-first century, the magnitude and complextiy of which no earlier generation has had to face. In the run-up to the twenty-first century, our profession really has two choices: to carry on as before with a "business-as-usual" attitude and endow our future generations with a legacy of suboptimal water management process, or continue in earnest an accelerated effort to plan, manage, and use the world's water resources sustainably and fairly.

All the major issues facing the world are interrelated, and the dynamics of the future of making will be determined not by any one single individual issue but by the interactions of a multitude of issues. An increase in population means more food, energy, and other raw materials. Augmenting food and energy supplies necessitates sustainable water management. The common requirements in all practical responses to the solution of all these major problems must include greater investment, more technology and expertize, and intensified co-operation.

The interrelationships are global in character, and hence they can be best understood and then resolved within a global framework. While the framework could be global, within this there must be a wide variety of integrated national and regional response. Within this overall framework, water professionals must also play their own constructive part. Mankind has a common future: we survive or perish together, North and South, East and West! Should we ignore that salutary exhortation, we can only be reminded of the warning of William Shakespeare that: "men at some time masters of their fates. The fault dear friends is not in our stars but in ourselves that we are the underlings."