OPTIMISING FUTURE WATER USE-CHALLENGES FOR MICRO AND MACRO POLICY MAKERS

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Abstract

The basic and conceptual framework needed to realise how the scarce resource water may be managed in an effective manner is presented in view of the global scenario. Various critical global issues that must be addressed are identified and analysed. Examples of practical experience are cited. At a time when the world population and food demands are increasing, it is becoming increasingly difficult to supply more water to farmers. It is in this context that optimisation through efficient management becomes vital and urgent. Fresh water being a finite source, the problem of managing this scarce resource includes both quantitative and qualitative aspects. On one hand we have a variety of policy options available for water management, while on the other we have the task of reform of public behaviour towards water. Time being a constraint in the implementation of policy, management measures need to be based on probable trends at global and local levels. An analysis of water use in relation to various sectoral requirements like food security, sustainable development, technological development, environmental management and such other closely related aspects are presented. Probable strategies for transformation and improvement, successful approaches to water development, priorities for action, future policy directions, research and technology transfer, capacity building and extension are presented and critically analysed.

Introduction

The supply of easily accessible water resources to fulfil the various needs is globally limited. Irrigated agriculture being a highly water-intensive activity claims nearly 70% of world water abstractions: over 90% in agricultural economies in the arid and semi-arid tropics, but less than 40% in the industrial economies in the humid temperate regions. Irrigated agriculture, which is far more productive than rain-fed agriculture, contributes nearly 40% of world food production only on 17% of cultivated land. The amount of fresh water currently available per person per year in major Asian countries (e.g. China, 2300 m^3, and India 2000 m^3) is nearly close to the amount of water needed to produce the food requirement per person per year (2000 m^3 for a balanced diet with meat). As 60% of the world population lives in Asia, the evolution has the potential to stress global food market in a major way. This automatically leads to reviewing of the water policies that lead to past misallocation and wastage. On one hand water is becoming scarce and on the other hand the use of water in many areas is highly inefficient. In many places, as much as 60% of the water diverted or pumped for irrigation does not reach the crop. The quantity of surface water too is deteriorating due mainly to the disposal of urban and industrial waste as well as chemical residues from agriculture. In addition, ground water and aquatic ecosystem too are affected both by the polluted surface sources. Irrigation performance has not always fulfilled expectations for increase in yield and efficiency of water use, despite the fact that large investments have been made and subsidies offered. It is therefore, high time that, the situation be seriously reviewed. Hence, security and stability in supplies of food in the next century will be closely linked to success in water management in a scientific manner. Success will not come only from expansion of water resources, but would come from improved management- rehabilitation of inefficient systems; substitution of traditional systems. In the following sections therefore, linkages between various aspects of water resources and food security are analysed.

Global Water Issues

The major global issues that are of concern are as follows:

Water-A scarce resource

Water available for consumption and agriculture comes essentially from rainfall. The average annual rainfall over land amounts to 1,10,000 km^3, of which some 70,000 km^3 evaporates back into the atmosphere. This portion called the **green water**, is the water supply for all non-irrigated vegetation, including forests and woodlands, grasslands and rain-fed crops. Of the green water, about 26% (18,000 km^3) is already being used by people, mainly for agriculture, leaving 74% (52,000 km^3) to meet the water needs of all other land-based species and natural communities. There remains on an average about 40,000 km^3 of fresh water in lakes, reservoirs, streams and aquifers in active exchange with surface water after discounting evaporation from global rainfall amount. This 40,000 km^3 of fresh water, often called the **blue water** is unevenly distributed over space and time and is in transient presence before flowing into a water sink. During its presence on the surface it is continuously evaporated. Further, this blue water is not fully accessible. They form about 20% of the total blue water. Further, a large part of runoff is not available for use since it is in the form of floodwater. Realistically it can be said that, only 9,000 km^3 is accessible for human use. To this can be added another 3,500 km^3 of runoff regulated by the existing reservoirs. Making use of the remaining 27,000 km^3 is difficult and costly because of factors like topography, inaccessibility and finally the social and environmental consequences. It is estimated that about 4,430 km^3 of water is annually withdrawn for agriculture, industry, municipalities coupled with reservoir losses. Of this amount about 2,285 km^3 (54%) is actually consumed, while the remaining 2,145 km^3 (46%) is returned at a lower quality. It is necessary to leave a part of the available surface water to follow its natural course to ensure effluent dilution and safeguard conservation of the aquatic ecosystem. Water needed for human use, including withdrawals and instream flow needs amounts to 6,780 km^3 per year. This is about 54% of accessible runoff. Estimates from various countries indicate that a critical condition has already been reached in many regions. This situation can be viewed from the following points of views:

Water use for food production

About 70% of world water withdrawals take place due to agriculture while domestic, municipal and industrial uses account for the remaining 30%. The largest part of agriculture water withdrawal goes to irrigation of about 250 million hectares world-wide. Global estimates indicate that irrigated agriculture produces about 40% of food and agricultural commodities on 17% of agricultural land. This makes irrigated agriculture immensely important to global food security. Depending on climate, crops and cropping intensity, irrigation uses from 2,000 km^3 to 20,000 km^3 of water per hectare. Accessible blue water, 50% of which is already globally committed, can not be replaced in some of its functions (e.g. Drinking water for humans and animals, for hygiene, washing, sanitation and municipal uses, for industrial process and for fish, aquatic life and the environment. That is why blue water has a much higher scarcity value than green water entailing most efficient use of it.

Situation of water by regions and countries

In terms of continental runoff Asia ranks the first while in terms of specific discharge (runoff/km2), South America is better endowed with water than any other country. Trend shows that evolution of water resources from 1960 to date reflects demographic growth. As such, Asia, Europe and Africa are approaching water scarcity. Europe has a fairly stable situation, while

Africa now has about one-third of the per capita water it had in 1960. Table 1 lists a selection of countries expected to have low water availability per capita by the year 2000 and therefore facing or going to face a critical water management situation.

Table 1 Countries predicted to have scarce water resources in the year 2000

Country	**Population in the year 2000 *(million)***	**Water availability *(m3 per caput)***	
		Internal renewable	**Including transboundary inflows**
Egypt	**62.4**	**29**	**934**
Saudi Arabia	**21.3**	**103**	**103**
Libyan Arab Jamahiriya	**6.5**	**108**	**108**
United Arab Emirates	**2.0**	**152**	**152**
Jordan	**4.6**	**153**	**240**
Mauritania	**2.6**	**154**	**2 843**
Yemen	**16.2**	**155**	**155**
Tunisia	**9.8**	**384**	**445**
Syrian Arab Republic	**17.7**	**430**	**2 008**
Kenya	**34.0**	**436**	**436**
Burundi	**7.4**	**487**	**487**
Algeria	**33.1**	**570**	**576**
Hungary	**10.1**	**591**	**11 326**
Rwanda	**10.4**	**604**	**604**
Botswana	**1.6**	**62**	**11 187**
Malawi	**11.8**	**7602**	**760**
Oman	**2.3**	**880**	**880**
Sudan	**33.1**	**905**	**3 923**
Morocco	**31.8**	**943**	**943**
Somalia	**10.6**	**1 086**	**1 086**

Source: FAO, 1993.

Managing water scarcity

Water scarcity means competition for water among users. Agriculture is mainly in competition for limited supplies with other users, such as urban and municipal water supplies and industry that have a higher potential and economic weight. Most important is the understanding of how alternative economic policy instruments influence water across economic sectors as well as among local, regional and national levels and among house holds, farms and manufacturers. It is therefore, needed that macro and micro economic policies be aimed specifically at the water sector for the simple reason that they have a strategic impact on resource allocation and aggregate demand in the economy. As has been observed, information, development of awareness and intervention at the global and national levels are not effective enough. It is in this context that initiative at grass root level is required to be taken. Hence, the policy makers at micro level have to be more rational, realistic and in a position to back the policy makers at the macro level.

Need for water management policy

Water management policy in general must address a multitude of issues, such as- management of supplies (for improvement of water availability in time and space), management of demands (efficiency of water use, sectoral interactions with economic activities), balancing competing demands (urban-rural, upstream-downstream, federal-state), preservation of the integrity of water-dependent ecosystem, political, institutional and technical mediation for efficient water management.

Function of ground water

The role of ground water in water resource management is very important. About one-third of river flow emerges from ground water aquifers and this represents the most stable component of surface flow. Ground water acts as a buffer against seasonal shortfalls in rainfall. North Indian agricultural economy for example, is helped by ground water from fluctuations in the monsoon season. However, the current trend shows that in most arid areas (e.g. in Asia, Mexico, the Near East, North Africa and the Western USA) there is over-pumping of ground water and depletion of aquifers. Aquifer contamination is a growing problem world-wide and needs immediate attention of policy makers world-wide.

Food and water security

In the context of food sufficiency, water security can be obtained through a policy of economic development and rational, sustainable use of the limited water resources. The policy must be aimed at meeting the needs of domestic and urban areas, as well as to supply water needed by commerce, tourism and industry so as to be able to provide employment to the people. Attempts have been made to quantify minimum water needs compatible with water security. In the Near East for example, a minimum requirement of 125 m3 per person per year has been proposed to cover domestic, urban and industrial use and to grow fresh vegetables, raising paultry and livestock (Shuval 1996). However, minimum water requirement should be determined based on local condition and needs.

Review of water policy and institutional changes

The statement of purpose emerging from ICWE served as the foundation for the water chapter of the global action plan developed at the 1992 United Nations Conference on Environment and Development (UNCED), Rio de Janeiro, Brazil. In 1993, the World Bank published a water resources policy paper that established a framework for water management (World Bank, 1993b). These documents indicate that there is an urgent need to recognise the links between economic development and protection of natural ecosystems, for planning of water to be recognised as an economic good and for planning of water use and development to involve the people. Many countries have since initiated a process of review and reform of water-resources policy (FAO, 1995d; FAO/UNDP, 1995)

Transboundary water

More than 200 rivers flow through two or more nations with political borders that cut across watersheds. At present, international law offers little help in resolving water conflicts since there is no legal framework to govern the allocation and use of transboundary water. The International Law Association (ILA) and the United Nations International Law Commission (ILC) have put forward a set of principles including four obligations in this regard. In practice, water sharing and prevention of conflict depend on treaties among countries that are riparian to the same river. Few treaties exist that include all countries within the river basin. Jordan, Euphrates, the Nile, the Ganges, the Brahmaputra and the Aral Sea tributaries are some of the hot spots.

Contribution of Water Control to Food Supply

Formulation of future policies for effective management of water should take into account the following specific aspects.

Water control and food production

As has been stated earlier, between 30 and 40% of food comes from a 250 million hectare irrigated area world-wide. Regional variations do exist in the proportion of agricultural land that receives irrigation: 35% in Asia, 11% in Latin America and 6% in Sub-Saharan Africa. In developing world about 18% of total arable land is irrigated with average yield increases in irrigated vis-à-vis rain-fed land ranging from 50-200%. It is Asia, however, that irrigation makes the greatest contribution to global food security (80% of food in Pakistan, 70% in China and over 50% in India).

Potential for irrigation

Available estimates indicate that irrigation potential of a given country is difficult to assess. A World Bank/ UNDP study (1990) indicates that there is scope for an increase of over 110 million hectares (59%) in the irrigated areas in developing countries, the largest potential being in Asia (69 million hectares). Exploitation of this 110 million hectares could produce an additional 300-400 million tones of grain, enough to provide the basic diet of 1.5 to 2.0 billion people.

Drought and water management

Rainfall variability over time is as much a characteristic of climate as the mean annual total. In areas that receive high amounts, even 50% of normal levels will have little negative impact on agricultural production, though river flows (blue water) may be significantly affected. In water development projects, intended to have a drought-proofing effect by ensuring water supply over spells of dry years, economic analysis should include social cost of drought, including the cost of food insecurity and the damage to the natural resource base stemming from overuse of resources during dry spells.

Strategies for Transformation and Improvement

Agricultural strategy concepts over the last three decades have been polarised between the alternatives of transformation to a new system or improvement of the existing ones. On the other hand we have strategies to promote building on successful development initiatives in the regions having a high potential or spreading the benefits to less well-endowed marginal areas. The following factors contribute to defence of irrigation and may lead to a new generation of successful water projects.

Water policy and legal prerequisites

Due to increase of pressure on water resources and public finance, the legal and institutional issues need to be reviewed. Traditional informal approaches are better than resolution of conflicts through litigation in court. The status of users' groups needs to be tailored to the scope and functions of users' associations and be legally established. Water management performance depends to a large extent on good governance. Considerable progress has been made but further improvements are still required in many countries (FAO 1993).

Water pricing

Water prices have an impact on both efficiency and equity and influence agency revenues. Rate setting can be evaluated considering allocation efficiency, equity of income distribution and fairness in appointing cost. The secondary criteria like simplicity, administrative feasibility and stability need also be taken into consideration (FAO1993). Evidence suggests that farmers are willing to pay for reliable supply of water. The cost of metering and collecting fee can be to measure the flow per tertiary turn-out area supplying water to a farmers' association, that in turn is responsible for distribution of water to individual farmers and collecting fees.

Institutional development

Intensification of agriculture with water control is a relatively easy proposal as compared to dealing with skilled traditional irrigation farmers. This is because, when water development reaches out to populations with no tradition in irrigated agriculture and more familiar with rain-fed agriculture and pastoralism, substantial capacity problems arise among farmers, administrators and extension workers. Operationalisation of water management concepts will therefore need institutional reform of government advisory services.

Important Issues to be Addressed

A range of issues confronting water development will have to be addressed in most cases to promote privatisation and transfer of water management responsibilities to water users' associations. If irrigated agriculture is to make a substantial jump in productivity, transfer of knowledge and adoption of suitable crop technologies under irrigation have to take place. The following specific issues need immediate attention:

- Macroeconomic imbalances and water management
- Social aspects of irrigation
- Technological adaptation
- Promoting private-sector initiatives

Successful Approaches to Water Development

The second generation of water development schemes has emerged in almost all parts of the world, which incorporates some of the elements essential to success as discussed earlier. Some of the basic approaches that can be adopted for development, management and realisation of water are- low volume high frequency irrigation, water harvesting, inland valley swamp development, low lift pump schemes, peri-urban irrigation, use of shallow aquifers, conjunctive use of surface and ground water and rehabilitation of existing schemes.

Benefits and Costs of Water Control

The investment trends show that Asia has always been the major recipient of funds for irrigation. Asia has received about 70% of total World Bank lending for irrigation, although lending and assistance to the Asian region by the end of the 1980s was less than 50% of lending during the peak period of the late 1970s (Yudelman, 1994). The average size of projects in Africa is small, hence Africa accounts for 30% of the number of World Bank funded projects (World Bank 1994). The International Fund for Agricultural Development (IFAD) has been supporting more projects in South and East Asia than anywhere else (IFAD, 1994). The main reason for the decrease in investment in irrigation are- increased construction cost, falling real prices for crops, poor irrigation performance and concern about the negative environmental impacts of projects. However, it is urgent that the trend be reversed. Basic investment in water development and irrigation must be made now considering the long gestation period of development schemes. Some of the basic reasons of high cost of irrigation schemes are- schemes include storage works to regulate river flows, severe climate requiring high irrigation capacity and expensive flood protection, high transport cost due to remoteness of schemes, insufficient local engineering experience entailing hiring of foreign expensive firms, overdesign by the consultants to preserve their reputation, high overheads and establishment cost, importation of materials and equipments. These factors if countered properly would not only save construction costs but also at the same time would make irrigated agriculture a highly profitable venture.

Economically Justifiable Investment in Water Control

The recent evaluation of irrigation development by the World Bank indicate that the average economic rate of return is 15% which is satisfactory although it was 7% lower than the appraisal estimates. If the project outcomes are weighted by their size, the evaluated rate of return is 25% (29% at appraisal), indicating higher returns from larger projects. On the other hand, an FAO review of investment performance showed higher success rate. The return rate situation is different in different parts of the world.

Solving operational and maintenance problems

Poor maintenance and poor water deliveries are two main factors affecting most public water schemes. The argument goes that this results from the fact that many farmers do not pay water charges and therefore proper services can not be rendered. Farmers on the other hand argue that crop returns are too low, that services provided are inefficient and that they can not pay the charges. Public irrigation schemes are less productive than those developed by individual farmers or farmers' groups. On the other hand, when irrigation agencies are made accountable and farmers pay for services actually received, irrigation performance improves considerably.

Scenario without Irrigation

To justify the massive investments necessary to make existing irrigation sustainable, scenarios with and without maintenance and rehabilitation should be compared. Industrialised countries may adopt policies of not exporting precious water and topsoil in the form of low-value basic gains. Unless water development projects are undertaken in rain-fed areas, population expansion will force millions of people to undertake unsustainable farming systems in arid, drought-prone, low-productivity areas or otherwise ecologically fragile areas.

Water Development and Environment

The effects of development on the environment can not be ignored or externalised. It has already been mentioned that water control as a key to intensive, high-value agriculture can have many positive environmental impacts in particular when compared with without irrigation scenario. The following are some of the aspects that that need attention:

Instream water requirements

How much water needs to be left in a river depends primarily on- the time of the year, the habitat requirement of aquatic life, the salt and sediment balance of the system, significance of the river for local people and other factors specific to each river basin. To factor instream flow requirements in water demand, the amount of 1,000m3 per person per year is sometimes used if waste water is returned untreated, corresponding to a dilution factor of 30 litres per second per 1000 people (Postel, Daily and Ehrlich, 19996). Assuming that 50% of municipal and industrial waste receives treatment before discharge, the instream flow requirement is halved to 500 m3 per person per year. However, such figures do not take into account the complex situations specific to each river basin.

Crucial role of upper catchments

Degradation and devastation of the upper catchments in river basins is a phenomenon of global dimension. It is estimated that over 200 million people live in the mountains, mostly under marginal conditions, contributing to activities that actually influence the characteristics of the water resources. Much money has been spent on forest, soil and water conservation projects and programmes over the past 50 years often with disappointing results.

Water development and health

Water-related vector-borne diseases are most likely to be found in areas where irrigation has been introduced. Among water-related diseases, malaria is by far the most important, both in terms of the number of people annually infected and in terms of deaths. The total number of cases is estimated at 100 million per year out of which 90% of cases and deaths occur in sub-Saharan Africa. Further, Schistosomiasis (bilharzia) is spread over 74 countries and about 200 million people are infected worldwide.

Preventing degradation of irrigated lands

It is estimated that there are about 20-30 million hectares of irrigated land world-wide affected by salinity. An additional 60-80 million hectares are affected to some extent by waterlogging and salinity. Many of these areas will go out of production unless correction measures are taken immediately. It is the task of the public authorities to ensure that drainage effluents are disposed off safely. In areas with active private-sector development, drainage is often neglected due to the short-term economic objectives of the developers. It is essential that in these areas the basic infrastructure for a main-drain system is created and maintained from the very beginning.

Priorities for Action

The priority area for action are- proper assessment of resources and use, review of existing water development policies, research and technology transfer, capacity building and extension, infrastructure and investment, enabling environment and finally preservation of natural resources. Special efforts are required to develop national capacities in the low-income food-deficit countries. Global targets by the year 2010 within an appropriate framework of national and regional water policies and plans are- to increase water use efficiency by at least 20% of current levels, to increase irrigated area by an average of 1.1% per year, opening 40 million hectares of land to irrigation by the target date and to reclaim 10 million hectares of waterlogged and salinised lands.

Conclusion

From the foregoing discussion, it can be concluded that intensified demand for water will stimulate efforts to develop new water policies and to use existing supplies in a more efficient manner. At the level of the river basin, integrated water management, both structural and non-structural can reduce water losses from evaporation, pollution and salinisation. At the irrigation scheme and farm level, irrigation efficiency can be considerably increased. Existing infrastructure can be rehabilitated and modernised and water management improved. When appropriate, farmers should be assisted in assuming ownership rights and management responsibilities for assets developed by the public sector without which there will be much reduced scope for farmers and consumers to benefit from the array of existing agricultural technologies. The major challenge, however, is to build capacity at all levels in order to achieve the efficient, highly productive management of water needed to secure sustainable, sufficient and low-priced food for the projected population. Lessons from evaluation of irrigation should be included in new policies and investments. The most important among these lessons is the need to complete projects to deal with the whole catchment area including the non-irrigated upland areas and to ensure that mechanisms are in place that will maintain the scheme over the life of the project.

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