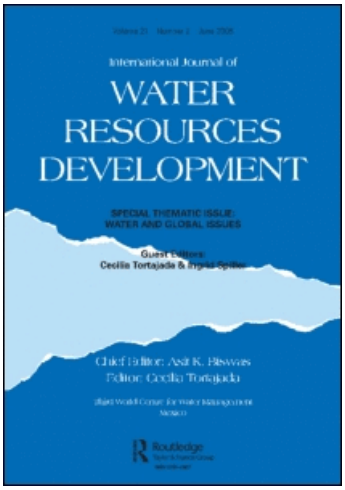

International Journal of Water Resources Development

Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713426247

Water for sustainable development in the 21st century

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To cite this Article Biswas, Asit K.(1991) 'Water for sustainable development in the 21st century', International Journal of Water Resources Development, 7: 4, 219 — 224
To link to this Article: DOI: 10.1080/07900629108722516
URL: http://dx.doi.org/10.1080/07900629108722516

Water for sustainable development in the 21st century

A global perspective

Asit K. Biswas

Many arid and semi-arid countries are already facing water crisis; the problem is likely to become more serious and will continue well into the 21st century. This article discusses the reasons for the water crisis, and the major water issues of the 21st century: conservation, pricing, social and environmental considerations, institutional responses to better management, international water bodies, and proper analytical framework.

During the past few years there has been an increasing realization of the importance of water in the continuing well-being and development of developing countries, especially those located in the arid and semiarid regions. More and more planners and decision makers have started to appreciate the critical importance of efficient water management for sustainable development of their countries. Compared with earlier generations of projects, new sources of water are becoming scarce, more expensive to develop and require more expertise and technological know-how for planning, design and implementation. Accordingly, decision makers are beginning to recognize that water can no longer be considered to be a cheap resource, which can be used, abused or squandered without much consequence for mankind's future. Like oil some 15 years ago, the days when water could be considered to be a cheap and plentiful resource are now virtually over. During the next two decades, water will be increasingly considered to be a critical resource for the future survival of the arid and semiarid countries, so much so that the political tension between certain neighbouring countries over the use of international rivers, lakes and aquifers may escalate to the point of war, even before we move into the 21st century.

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This article was first presented as the Presidential Address at the 7th World Congress on Water Resources, Rabat, Morocco, 13–18 May 1991.

Water crisis

The water crisis, which some arid and semiarid countries are already facing and which more and more countries will face as the 21st century dawns, can be considered to be the direct result of four important but interrelated phenomena.

First, the amount of fresh water available to any country on a long-term basis is limited. Since nearly all the easily available sources of water have now been developed or are in the process of development, the unit costs of future projects can only be higher. For example, recent review of domestic water supply projects indicates that the cost per cubic metre of water for the next generation of projects is often two to three times higher than the present generation. This is an important consideration, since many developing countries are now saddled with very high levels of debt burdens, and the amount of new investments available, both internally and externally, is limited. In addition, the demands and competition for whatever funds are available are intense. These factors, both individually and collectively, are bound to effect the next and later generations of various types of water projects, probably adversely in most cases.

Second, world population is increasing steadily.

0790-0627/91/040219-06

Consequently, water requirements for domestic, agricultural and industrial purposes and for hydroelectric generation will also increase. This, of course, is not a new trend. For example, current estimates indicate that total global water consumption during the present century (1900–2000) is likely to increase tenfold. The total agricultural water requirement is likely to increase 6.5 times during this century. There are, however, changes in the pattern of water requirements. In 1900, agriculture accounted for nearly 90% of total water requirements but, by the year 2000, the corresponding figure is likely to be around 62%. Industrial water use, which was only about 6% of total water consumption at the beginning of the present century, is likely to increase fourfold, to nearly 24%, by 2000.

This general trend is likely to continue well into the 21st century because of the steady increase in world population. Present estimates indicate that the current world population is likely to double to 10.64 billion by the year 2050, of which less developed countries will contribute nearly 87%, or 9.29 billion. The population of China would still be higher than India (1.637 billion against 1.525 billion). The current estimates of population in a few select countries by 2050 are (with 1990 estimates in brackets): Bangladesh 253 million (113), Egypt 117.4 million (55), Morocco 57.44 million (25) and USA 280 million (249). Viewed differently, a country like Bangladesh, with a per capita GNP of $170 in 1988, and having an area of 144 000 km^2 (approximately similar to that of Wisconsin), will have a population level by 2050 that would be rapidly approaching that of the USA, with a per capita GNP of $19 840 in 1988. It would not be an easy task to provide a reliable water control system to all the citizens of Bangladesh in the future under such adverse conditions.

While it is not easy to grasp the meaning of billions of people, it should be seen in its proper perspective. If we resettled all the 5.386 billion people of this world (early May 1991 estimate) in an African country like Zambia, whose area is 753 000 km^2, a family of four would have an area of 561 m^2, which is a typical single-family one-storey house in North America, with a front and back yard!

While there is no one-to-one relationship between population and water requirements, it is clear that with a substantial increase in world population, total water requirements will increase as well. Furthermore, past experiences indicate that as standard of living increases so do per capita water requirements. Hence, if the present poverty alleviation programmes succeed, water requirements will increase further – a fact which has often not been considered by our policy planners, both nationally and internationally.

Third, as human activities increase, more and more waste products are contaminating available sources of water. Among the major contaminants are untreated or partially treated sewage, agricultural chemicals and industrial effluents. These contaminants are seriously affecting the quality of water, especially for domestic use. Already many sources of water near urban centres of developing countries have been severely contaminated, thus impairing their potential use.

Since comprehensive water quality monitoring programmes in nearly all developing countries are either in their infancy or even non-existent, a clear picture of the status of water pollution and the extent to which water quality has been impaired for different potential uses is simply not available at present. On the basis of the anecdotal and very limited information available, it can be said that the problem is already very serious near urban centres, especially for groundwater and lakes and for some rivers as well. It should be noted that once groundwater is contaminated, it cannot be easily decontaminated. Furthermore, for developing countries cost-effective technologies simply do not exist for removing pollutants such as nitrates from water. Equally, alternatives like forcing people, through regulations, to use bottled water for babies because of high nitrate contents in local drinking water, as is currently practised in 38 towns in Nebraska, are not feasible because of widespread poverty.

Even in advanced industrialized countries like the USA or Europe, despite all the recent rhetoric, no clear picture is available of water contamination. The monitoring and detection processes have mostly focused on selected chemicals that are toxic and mobile. Equally it is only the parent compounds that are being monitored: monitoring of their metabolites is seldom carried out. Thus, at our present state of knowledge, we simply do not know the extent of contamination that has already occurred which may render some water sources unusable in the future without expensive treatment. On the basis of the present trend, it is highly unlikely that a good picture of the global water quality situation will be available by the beginning of the 21st century at the very earliest. Thus, it is quite possible that many sources of water may not be considered to be appropriate, especially for drinking purposes, in the coming decades.

The fourth major factor is the increasing delays that are likely to be witnessed in the coming decades in implementing new water projects. Higher project costs and lack of investment funds will be two major reasons for this delay. Equally, social and

environmental reasons will significantly delay project initiation time, certainly more than has been witnessed in earlier decades.

There is no doubt that the water requirements of developing countries will continue to increase significantly during the next several decades. However, the traditional response of increasing water availability to meet higher and higher water demands will no longer be adequate in the future for two important reasons:

(1) Many countries simply do not have any major additional sources of water to develop economically.
(2) Even for those countries that may have additional sources of water, the time periods required to implement those projects are likely to be much longer than expected at present.

This will mean that water professionals will come under increasing strain to make the management process more efficient than it has ever been in human history. However, the transition period available to us to significantly improve the management process is likely to be short – certainly no more than a decade, or at most two. While technological problems may be comparatively easy to solve, political, institutional and social constraints are likely to be very difficult to resolve. Herein may lie the most difficult challenge facing water management in the 21st century.

Major issues in the 21st century

On the basis of an objective analysis of the current status of water development and management all over the world, and the present trends in other areas that may affect water management practices, the following major issues can be identified for the 21st century. These issues are not mutually exclusive: in fact they are often interrelated. Also, some of these issues are already visible, but they are likely to become significantly more important and complex in the next century than they are at present. Furthermore, these issues cannot be listed in any order of priority on a global basis since their importance and relevance may well differ from one country to another, and over time.

Water conservation and efficient use of water

Up to now water conservation and efficient use of water have not received the attention they deserve. Water conservation has basically received lip-service thus far.

Since agriculture is by far the largest user of water, efficient irrigation management will undoubtedly be a major conservation option of the future. At present, it is fairly common to find that more than half the amount of water abstracted from a river does not even reach the fields being irrigated. In addition, there is considerable scope for improving the efficiency of application of water once it reaches the field. This means that not only is a critical resource being used inefficiently, and thus uneconomically, but also that such poor practices are directly contributing to the development of unwanted environmental impacts such as waterlogging and salinity, which are actually contributing to the reduction of the production potential of these areas.

Some limited progress has been made during the past decade in improving the efficiency of irrigation management but the overall system efficiency is still far too low for complacency. The reasons for such poor efficiency have now been well documented and the solutions are also well known. However, in spite of this knowledge base, it has not been possible to improve irrigation efficiency appreciably in most countries. On the basis of the current trend, it is unlikely that major progress can be made until well into the 21st century.

Considerable scope also exists for practising water conservation in the domestic and industrial sectors. In many urban centres of developing countries, more than half the treated water is lost due to leakage. Similarly, appropriate design changes can significantly reduce water requirements for the industrial sector. For example, extensive use of recycling can reduce the amount of water needed to produce one ton of steel by 96%. In the early part of the 21st century, some countries may be forced to institute water audit to ensure an efficient water management system for the agricultural, industrial and domestic sectors.

Water pricing and cost recovery

During the 1980s there were periodic discussions on the economic aspects of water allocation, including the issues of water pricing and cost recovery, in many arid and semiarid countries. Conceptually at least water pricing could affect:

- water allocation between competing uses;
- water conservation;
- generation of additional revenue which could be used to operate and maintain water systems, and even repay part or all of investment costs;
- cropping pattern;
- income distribution;
- efficiency of water management; and
- overall environmental impacts.

A noteworthy feature of the 1980s was the number of papers that were produced in academia on water

pricing, especially for the agricultural sector. The overwhelming thrust of the hypothesis was that if the right water prices could be charged to farmers, they would become rational optimizers. If farmers had to pay an economic price for the water used, its distribution would become more reliable and equitable. Government departments would receive the revenues generated by water pricing, which would enable them to operate and maintain their irrigation systems properly. Thus, water pricing would contribute to a desirable win–win situation. These hopes, however, have remained unrealized thus far.

While water pricing and cost recovery will unquestionably be an important policy instrument in the 21st century, at least two fundamental issues have to be considered before it can be effectively implemented. First, water pricing has thus far been viewed primarily as an economic instrument for efficient water management. Its socio-political and cultural implications in developing countries have generally been not understood, much less addressed, by Western academics. Second, water has been traditionally subsidized to achieve the very specific socio-political objectives of food security, provision of clean drinking water, and increasing the income and health of the rural poor. If economic water pricing is to be introduced, other policy instruments have to be developed to achieve the same objectives. These alternative options may not necessarily make water use more efficient. For example, crop subsidies could encourage excessive water use. Thus, decision makers have to analyse carefully the various policy options available holistically and in their totality. Compartmentalized policy making will generally not be optimal.

Second, on what criteria should the water charges be based? Should the beneficiaries pay only the operation and maintenance costs of the water systems? Or should they be expected to pay for total investment costs as well? Should such pricing include external costs such as environmental and social damages? If so, how should these costs be calculated? These difficult issues will have to be resolved during the present decade if water pricing is to be an effective option in the 21st century.

Social and environmental considerations

Social and environmental considerations of water resources development and management will, in all probability, become even more rigorous in the 21st century than they are at present.

Water quality management will increasingly become as important as water quantity management, though the former at present is mostly considered to be a poor cousin. Water quality monitoring will become essential for efficient water management. This transition, however, will not be easy. This is because water quality monitoring is significantly more difficult, time-consuming and complex than water quantity monitoring, and the expertise and equipment required are also correspondingly of much higher order.

In order to achieve a functional water quality monitoring system, the following issues need to be considered: institutional arrangements within which such a system can be properly established; development of an effective network; selection of water quality parameters that need to be monitored at different locations; choice of these locations; frequency of monitoring different parameters in each location; development of indigenous expertise to carry out the necessary analyses; dissemination of information to potential users; and regular presentation of appropriate information to decision makers in a timely fashion. It will take more than a decade before the above issues can be effectively resolved. However, without such information, water management cannot be efficient in the 21st century.

Institutional response to better management

Water management can be rational only if the institutions responsible for such management are efficient. As a general rule it can be said that most water management institutions in developing countries need considerable strengthening. While considerable progress has been made in some selected countries in the recent past, much needs to be done to face successfully the challenges of water management in the 21st century.

In addition to institutional strengthening, nearly all countries must substantially improve their inter-institutional collaboration in order to practise efficient water management policies in the future. At present water-related policies are developed in a fragmented fashion. For example, irrigation and large-scale water development generally comes under the Irrigation or Water Resources Ministry, domestic water supply under the Ministry of Public Works, navigation under the Ministry of Transport, hydropower under the Ministry of Energy, environmental impacts under the Ministry of Environment and health issues under the Ministry of Health. The coordination between these various ministries leaves much to be desired. Sometimes the ministries are even adversaries! Thus, within this general milieu efficient water management policies are not easy to develop.

If nations are expected to manage their water resources properly in the 21st century, major institutional changes will be necessary.

Management of international water bodies

One of the critical issues of the 21st century will undoubtedly be the management of international water bodies. The global magnitude of this potential problem has not been generally recognized thus far. Nearly 47% of the area of the world (excluding Antarctica) falls within shared rivers and lake basins, and this does not include shared aquifers. Nearly 60% of the areas of Africa and South America are within shared basins. Expressed differently, there are countries (20 in Africa) where at least 80% of the total area lies within international basins.

Current analysis indicates that there are 214 river and lake basins that are shared by two or more countries, of which 57 are in Africa. Of these 214 basins, the vast majority, 156 or nearly 75%, are shared by two countries. There are nine basins which are shared by six or more countries, of which only two – the Danube and Rhine – are in the developed world.

Very limited numbers of objective and in-depth analyses of international water bodies in developing countries are available to draw definitive conclusions. To a great extent international organizations have deliberately stayed away from international water bodies mainly because such issues have been considered to be politically sensitive. The leadership shown by President Black of the World Bank in the 1950s, who was instrumental in expediting the Indus River Treaty, has been generally missing, except for Mostafa Tolba, the present Executive Director of the UN Environment Programme, who engineered the Zambezi Action Plan.

As the demand for water increases in the Third World, and the exclusively national sources of water are developed, the only major sources of water that remain to be developed in the 21st century are likely to be international in nature. Herein will lie a major opportunity or a serious problem for the future.

Unless proper treaties are negotiated between the co-basin countries, international water bodies are likely to be a fertile area for emerging conflicts in the 21st century. Unilateral exploitation of shared water resources by one country, without the prior agreement of the other co-basin countries, could contribute to serious regional instability, or even war, during the later part of this decade and beyond. The number of such conflicts is likely to increase significantly during the next century, unless the seeds for their solution are properly planted in this decade.

Proper analytical frameworks

In order to meet the challenges of the 21st century successfully, water professionals have to review critically the reliability of some of the existing analytical frameworks. Some of the present frameworks, which have been used for at least two or more decades, and are thus now accepted automatically, need to be seriously questioned and hopefully significantly improved. Only two widely used methodologies will be mentioned here.

First is the common technique of generating synthetic streamflow based on whatever short periods of data are available. Analyses of climatic fluctuations observed during the past five or more decades in many parts of the world clearly indicate that the concept of generating synthetic streamflow on the basis of short periods of data is flawed, to the extent that its continued use to plan and manage large-scale and high-investment water projects can be seriously questioned. It is becoming increasingly evident that complex mathematical manipulations are no real substitute for getting better information, if the short periods of data on which such manipulations fundamentally depend are unrepresentative of the long-term pattern. Since the probability that a short period of available data is really representative of the long-term pattern cannot be very high, continued use of synthetic streamflow generation must be seriously questioned.

Second is the current practice of environmental impact assessment (EIA). The methodologies used have serious shortcomings. At a macro level, the linkages of EIA to the planning of social and economic development are not clear. While considerable expertise has been developed on the application of EIA at the project level, commensurate progress at policy and programme levels simply has not been made.

Even at the project level, EIA considers almost exclusively negative impacts: positive impacts are completely ignored. If EIA is to be effective, this all-pervasive bias has to be eliminated. The overall thrust must be modified to maximize positive environmental impacts, a step that is completely omitted at present, and to minimize negative ones. Such a balanced and holistic approach is urgently needed to enhance the future welfare of mankind.

Concluding remarks

On the basis of the present review, it is clear that the water management profession will face a problem in the 21st century, the magnitude and complexity of which no earlier generation has had to face. In the run-up to the 21st 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 projects, or to continue in earnest an accelerated effort to plan, manage and

use the world's water resources sustainably and fairly.

All of the major issues facing the world are interrelated, and the dynamics of the future of mankind 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 investments, more technology and expertise and intensified cooperation. 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 responses. 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 salutory exhortation, one can only be reminded of the warning of William Shakespeare that 'men at some time are masters of their fates. The fault dear friends is not in our stars but in ourselves that we are underlings.'