Considerations for Sustainable Irrigation Development in Asia

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ABSTRACT *The Asian population is expected to increase from 3103 million in 1990 to 5811 million in 2050 and to 6817 million in 2150. Such rises will invariably augment demands for all water uses. Water availability is unlikely to increase to accommodate all the expected demand growth. This will escalate the conflict between various water uses. Irrigation, which is now the most significant user of water, is likely to be the main loser. Its percentage share of total water used will decline steadily in the future. This will mean that the irrigation sector will have to do more with less water by increasing its efficiency significantly. The Asian countries will also have to take a balanced approach between irrigation development and environmental protection.*

Introduction

Water for development of irrigated agriculture has historically always been an important consideration in the Asian developing countries. Human civilizations and habitats often developed along the banks of the Asian rivers because of easy availability of water for drinking, farming and transportation. Thus, not surprisingly, when Rishi Narada, probably the earliest authority on politics from India, met the great Pandava King, Yudhisthra, his greeting was: "I hope your realm has reservoirs that are large and full of water, located in different parts of the land, so that agriculture does not depend on the caprice of the Rain God."

Because of the critical importance of water to agricultural production in a semi-arid country, the eminent Indian statesman Kautilya discussed the importance of rainfall in his epic *Arthasastra* (science of politics and administration), which was probably written towards the end of the fourth century BC. Kautilya organized a network of rain gauges in different parts of the country for two important reasons. First, land taxes were based on the amounts of rainfall received every year, since rainfalls could be considered proxies for agricultural production, and hence the income of the farmers. Second, good knowledge of rainfall was essential for planting crops, and thus to maximize agricultural production. It is worth noting that the rain gauges were unknown in the West until about 1639, more than two millennia after Kautilya, when the Italian Benedetto Castelli made some isolated measurements. The fact that water control and management received such emphasis in India some 2500 years ago clearly indicates the importance of this resource in the development process of the Asian arid and semi-arid countries. Unquestionably, from the Asian perspective and throughout history, water has always been considered to be a critical

component for human survival. This importance has not changed much in recent years (Biswas, 1992).

Population and Water Resources

Clearly the demand for water in Asia is on an upward trend from the twin pressures of population growth and increasing per capita water demand. The latest World Bank population estimates (Bos *et al.*, 1992) indicate that Asia accounted for 59% of the total global population in 1990 (3103 million out of 5268 million). While on a global percentage basis the Asian population is likely to remain fairly stable (56.6% of the global population by the year 2100), in absolute terms there are major causes for concern. The Asian population is estimated to increase from 3103 million in 1990 to 5811 million in 2050 and to 6817 million in 2150.

Since Asia is a vast continent, not surprisingly the different subregions will have different population growth rates. South Asia, containing some 1.24 billion people, had an estimated growth rate of 2.0% in 1992, but East and Southeast Asia, containing another 1.85 billion people, was growing at a much lower rate of 1.4%. By the year 2025, the growth rates are expected to decline to 1.1% and 0.9% respectively. Even with such reduced growth rates, 23 million new people are likely to be added each year in South Asia by 2025, and another 17 million in East and Southeast Asia because of their large population bases of 2.05 billion and 2.54 billion respectively.

Even within the subregions, countries may have differing population growth rates. For example, the ratio of the eventual stationary population to the 1990 population in South Asian countries is expected to vary from 2.4 for Bangladesh to 1.7 for Sri Lanka. For a country like Japan, this ratio is likely to be 1.0, which means that the Japanese population is expected to differ very marginally from what it is at present.

The population growth rates for some important Asian countries are given in Table 1.

While reliable population projections for the future are always very difficult and subject to significant errors, the fact remains that in all the Asian developing countries the total population in 20, 50 and 100 years from now will be significantly higher than at present. Even though it may not be possible to estimate the actual population numbers for specific years with any degree of certainty, what is indisputable is the fact that the countries will have to provide for continually higher population levels in the coming decades.

Water is essential for all human activities, ranging from drinking to agricultural production, and industrial development to energy generation. Accordingly, as population numbers increase, so do the human activities. These developments have meant that the water requirements in Asia have increased significantly in the past, and will undoubtedly continue to do so in the foreseeable future. In terms of water development, such rapid increases in water requirements have two important implications.

First, as water demands have increased, the Asian countries have steadily increased the extent of utilization of their available resources. It is estimated that the ratio of water consumption to available water resources in Asia as a whole is likely to reach about 22% by the year 2000: the corresponding ratio in 1960 was only about 6 (Figure 1).

Table 1. Population projections for major Asian countries in millions.

Country	1990	2000	2010	2020	Stationary population	Ratio to 1990
Bangladesh	106.7	127.9	148.8	166.9	255	2.4
China	1133.7	1293.5	1420.3	1540.3	1886	1.7
India	849.5	1006.1	1153.4	1284.5	1855	2.2
Indonesia	178.2	208.9	236.3	262.4	358	2.0
Japan	123.5	127.6	130.0	128.9	128	1.0
Korea, South	42.8	46.6	50.0	52.5	56	1.3
Laos	4.1	5.6	7.4	9.4	21	5.1
Malayasia	17.9	22.3	26.4	30.1	44	2.5
Myanmar	41.6	50.9	58.6	65.9	96	2.3
Nepal	18.9	24.1	29.4	34.4	58	3.1
Pakistan	112.4	147.3	184.2	222.1	397	3.5
Sri Lanka	17.0	18.9	21.0	22.8	28	1.7
Thailand	55.9	63.9	72.1	79.4	102	1.9
Vietnam	66.3	82.0	95.6	109.0	159	2.4

Source: World Bank (1992).

Equally, at a ratio of 22%, the extent of available water utilization in Asia in 2000 will be the highest among all continents, and will be nearly twice the global average. Currently there are no visible signs that these growth rates in the various Asian countries are likely to come down in the foreseeable future.

Second, the quantity of freshwater in any country that can be exploited at any given time is limited for economic and technological reasons. Not surprisingly,

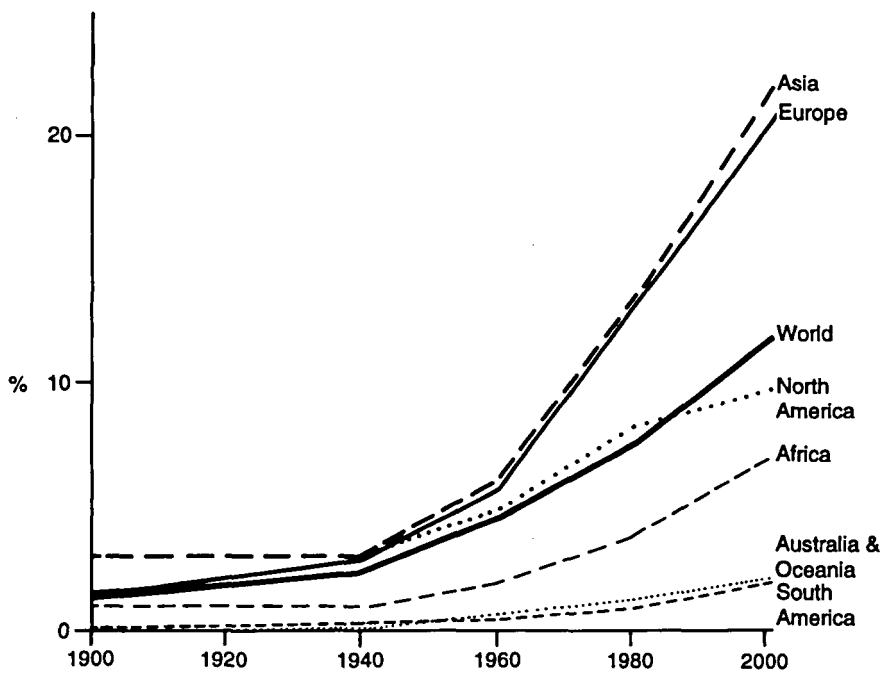

Figure 1. Dynamic of the ratio water consumption and water resources.

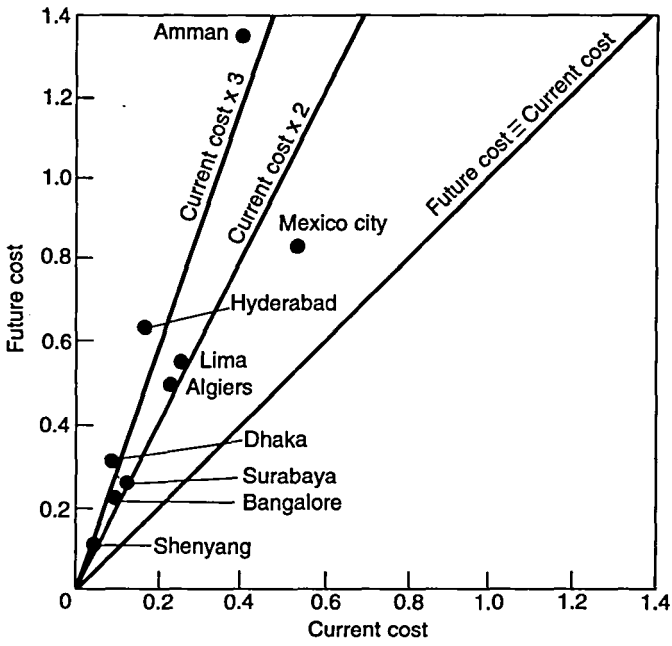

Figure 2. Current and projected future water costs per m^3 (US$1988).

nearly all the easily exploitable sources of water in most Asian countries have already been developed or are in the process of development. This means that the cost of development of each new additional source of water is likely to be much higher in real terms in the future than has been witnessed in the past. For example, a recent review of the domestic water supply projects carried out by the World Bank (1992) indicated that the cost of development of each cubic metre of water for the next generation of projects is often two to three times higher than that of the present generation. Figure 2 shows current and projected future costs in 1988 dollars per cubic metre of water for supplying water to certain major urban centres of Asia as well as to other similar centres elsewhere in the world.

Increased costs of water development are an important factor to consider, since many Asian developing countries are now confronted with high levels of debt burdens, and the amount of new investment available, both internally and externally, is limited. In addition, the demands for and the competition between the different sectors for whatever limited funds are available in each country are already intense, and are likely to become more intense in the foreseeable future. This means that financing of increasingly more expensive capital-intensive water development projects would not be an easy task in the future.

The above two implications, both individually and collectively, are highly likely to affect the next and later generations of water development projects in Asia, probably somewhat adversely in the vast majority of cases. The situation is likely to be similar in other parts of the developing world as well.

Table 2. Water use by sectors in major Asian countries and five industrialized countries.

Country	Water use (%)		
	Irrigation	Domestic	Industrial
Afghanistan	99	1	0
Bangladesh	96	3	1
China	87	6	7
India	93	3	4
Indonesia	76	13	11
Japan	50	17	33
Korea, South	75	11	14
Laos	82	8	10
Malaysia	47	23	30
Myanmar	90	7	3
Nepal	95	4	1
Pakistan	98	1	1
Philippines	61	18	21
Singapore	4	45	51
Sri Lanka	96	2	2
Thailand	90	4	6
Vietnam	78	13	9
Canada	12	18	70
France	15	16	69
Germany	19	12	69
UK	3	20	77
USA	42	12	46

Conflicting Demands

The demand for water for all purposes (drinking, industry, agriculture, energy generation, navigation, waste assimilation and environmental needs) will continue to increase in the future in nearly all the Asian countries. The extent of these increases, however, is likely to be country-specific, depending upon their present and future development patterns, climatic conditions, and social and cultural practices.

Overall, in the larger Asian countries, irrigation is the dominant water demand, ranging from a very high figure of 99% of all water requirements in Afghanistan to about 47% in Malaysia at present. Depending on the countries concerned, either domestic or industrial water use is the next important component. For example, for a country like Indonesia, domestic and industrial water uses account for 13% and 11% respectively of total water use. Corresponding figures for some other Asian countries are: Japan—17% and 33%, Nepal—4% and 1%, the Philippines—18% and 21% and Thailand—4% and 6%. Current water uses by the different sectors for certain important countries are shown in Table 2.

It is interesting to note that the estimates of water requirements for energy production are mostly unavailable in the Asian countries at present. And yet, no large-scale electricity generation is possible without large quantities of water. In addition to hydropower generation, thermal and nuclear power plants require

large quantities of cooling water for their operation, a fact that has not been clearly recognized by the planners thus far. Even for China, which alone consumes 61% of all commercial energy produced in Asia, estimates of water required to produce such energy is not available.

On average, Asia converts 30% of its energy to electricity (Brandon & Ramankutty, 1993). The Asian developing countries had a total generating capacity of 250 000 MW in 1990, nearly 70% of which was thermally generated (mainly coal) and the balance of 30% was accounted for mostly by hydropower. It is forecast that an additional 240 000 MW will be needed by the year 2000, if the current development plans of the countries are to be fulfilled. This doubling of electricity generation within a very short period of a decade means that water requirements for a very rapidly expanding Asian energy sector must be a major cause for concern, especially as similar high growth rates are likely to continue during the earlier part of the 21st century. Water requirements for a rapidly expanding energy sector can no longer be ignored in terms of any national water strategy, especially when it is considered that, in countries like England and Wales, some 36% of all water currently abstracted is accounted for by the energy generation industry.

Based on development experiences from all over the world, it can be predicted with considerable certainty that in the Asian developing countries, the percentage of water available to the irrigation sector is likely to decline very significantly during the next two to three decades. In contrast, the percentage of water used for industry will increase steadily in the future. Globally this trend has been witnessed throughout the 20th century. For example, the total global agricultural demand declined from a high of 90.5% of all water use in 1900 to 63.6% in 1990. During the corresponding period, industrial water use increased from 6.4% to about 22.2%.

To the best knowledge of this author, no Asian country has prepared realistic estimates of future water requirements, based on factors such as expected population growth, development patterns, social and environmental requirements, management techniques and other related issues. Such studies are now critically needed to formulate long-term viable national strategies for water.

An attempt was made in India to estimate water demands for the year 2025. Table 3 shows this estimate along with the demand pattern for 1985. While the directions of changes between the years 1985 and 2025 are likely to be correct, it is highly unlikely that it will be possible to reach the unrealistic goal of utilizing 45% of all available water sources of the country because of high development costs, environmental constraints, interstate political rivalries and other reasons. Thus, alternatives such as supply and demand management have to be considered simultaneously in order to develop a more feasible water utilization scenario.

Signs of conflict between irrigation and urban/industrial water demands are already becoming increasingly evident in different parts of Asia. For example, in the Philippines, the domestic and electricity demands of Manila are creating water shortages for irrigation in Central Luzon. In India, water demands for the city of Hyderabad are having an adverse impact on irrigation of the neighbouring areas. Similarly, in Indonesia, municipal water requirements for the Jakarta region and Surabaya are now in direct conflict with existing irrigation arrangements for the surrounding areas. In all the above three cases, the situation deteriorates significantly during low flow years. Similar conflicts between differ-

Table 3. Water demands in India, 1985 and 2025.

	1985		2025	
Water uses	Billion m^3	%	Billion m^3	%
Agriculture	470	94	770	83
Domestic & livestock	17	3	40	4
Industry & urban	14	3	120	13
Total	501	100	930	100
Total demand as % of total availability		24		45

ent water demands are now visible in many different parts of Asia. Since the Asian countries generally have either established or have a *de facto* policy of giving domestic water needs priority over irrigation demands, agricultural water use has thus far been the main loser in this conflict. This trend is likely to continue in the foreseeable future.

The magnitude of the urbanization problem in Asia can best be realized by the fact that it is now estimated that by the year 2025 the urban population is likely to treble, to about 2.5 billion, which will account for 50% of the continent's total. The number of Asian megacities, that is cities with more than eight million inhabitants, will increase from nine in 1990 to 13 in the year 2000. With this phenomenal growth in urbanization and industrialization, agriculture will continue to have its share of water availability progressively reduced in the coming decades. This is a fact that the Asian water and agricultural planners will have to acce pt, and the sooner the better since up to now there is no indication that this clear trend has been factored in preparing long-term national water management plans or strategies.

Sustainable Irrigation Development

On the basis of the above analysis, the following overall prognosis can be made on the future of sustainable irrigation development in Asia:

- In order to support an increasing population in terms of national food sufficiency, more water will be required for irrigation in nearly all Asian countries.
- Simultaneously, water demands for other purposes, domestic and livestock, industrial development and electricity generation, will increase steadily as well.
- Since all the easily exploitable sources of water have already been developed or are in the process of development, future water projects will be more expensive, technologically more difficult and take more time to construct.
- For environmental and social (primarily resettlement) reasons, it will take significantly more time than most governments currently expect to develop their new generation of water projects.
- Considering realistic growth rates for new water development projects in the

coming decades, it is now evident that nearly all the Asian countries will have insufficient water to satisfy the demands for all the different uses.

- Under this competing situation, the percentage share of water that will be available for irrigation will start to decline steadily in the coming decades. Domestic and industrial uses will receive an increasing share of the available water.
- Under these conditions, irrigation water management has no option but to become increasingly efficient in the future.
- On the basis of the present trends, it appears that irrigation management is unlikely to improve as fast as would be necessary to compensate for the percentage loss of water that is likely to be available to this sector.
- Unless irrigation managers and national decision makers realize what is likely to happen in the foreseeable future, and there are no signs that this realization is taking place at present, the situation is likely to get progressively worse for many years to come.

While a realistic assessment of the future of irrigation development and management in Asia does not appear to be rosy at present, the following issues need urgent consideration and discussion by the water profession in particular and society as a whole in general.

Environmentally Sound Water Management

Like many other societal concerns, currently there is no general agreement on this complex issue. There are many developmentalists who would like to develop as many water projects as possible, with only cursory environmental examinations. This group would opt for quick developments giving only lip-service to the various environmental and social concerns.

In contrast, there are many environmentalists who champion the cause of environmentally sound development, but in reality what they are often lobbying for is for no development under any conditions. This group of people have now gone beyond the NIMBY (not in my backyard) syndrome to what this author terms the BANANA (build absolutely nothing anywhere near anything) mentality. Generally speaking, this group of people are now receiving more attention than the developmentalists, primarily because of the media attention to their activities.

Clearly the views and objectives of both the groups are wrong. The days when major development projects, irrigation or otherwise, could be constructed without any serious environmental and social assessments are now over, and very few objective people should miss their passing. It is essential that all new water development projects be instigated and managed with their long-term sustainability in view. The Asian countries simply do not have other options since there are now only a limited number of new sources which can be developed effectively. It is equally essential that the existing operational projects be carefully managed so as to ensure water availability from these sources for many decades, or even centuries, to come. Without such a concerted approach, water scarcities in the future are likely to become even more serious than can rationally be expected at present.

The BANANA approach of the so-called 'environmentalists' is also wrong. One can even logically argue that this approach will actually contribute to more

and not less degradation on a medium- to long-term basis. This is because if all new projects are stopped or delayed significantly, the increasing water demands will not disappear. Already in some megacities like Delhi, minor riots have taken place because of water shortages. If new projects do not come on stream in the coming years, as the general public currently expect, to alleviate the water scarcities, the political situation and the law and order conditions are likely to deteriorate very fast. When the public demands water, and the intensity of this demand is very high, the most likely course for the politicians, who in all countries would like to be re-elected and stay in power, would probably be to authorize rapid construction of new projects, irrespective of their adverse environmental and social impacts.

Accordingly a balanced approach of environmentally sound water development is the only alternative available to the Asian countries at present. The overall philosophy has to be that the environment must not be sacrificed; equally, proper development must not be hindered. For all major water projects, environment and development must be viewed as two sides of the same coin.

Definition of Sustainability

While everyone now appears to be on the sustainability 'bandwagon', there is no agreement on even the conceptual definition of sustainability at present. Even the various United Nations agencies do not have a commonly agreed definition of sustainability: definitions used often differ from each other in certain significant ways. One is reminded of a similar popular bandwagon during the early part of the present century, conservation, about which President Roosevelt had exasperatedly exclaimed: "Everyone is for conservation—no matter what it means!" One is tempted to replace 'conservation' with 'sustainability': the situation would then be not much different!

The conceptual and operational problems associated with sustainable water development have been discussed in detail elsewhere (Biswas, 1994), and hence these will not be repeated here. Suffice it to say that there are some major fundamental problems which need to be resolved before water developments can be made inherently 'sustainable', no matter how sustainability is defined.

Environmental Impact Assessment

In many Asian countries, environmental impact assessments (EIA) of new projects or significant modifications of existing ones are now mandatory. It is estimated that the Asian developing countries have carried out some 12 000 EIA studies thus far (Biswas & Agarwala, 1992). Two countries—Thailand and the Philippines—have carried out several thousand EIA studies. Unquestionably considerable expertise is now available on conducting EIA studies in the region.

The very fact that many Asian countries have been conducting environmental assessments of irrigation projects for some years is a definite improvement in the situation over that which existed before. However, an objective analysis of the present state of affairs indicates that the improvements may not be as high as one would have expected. There are many reasons for this underperformance; only the main ones will be discussed here. First, EIA, as usually practised in Asia, has generally become a mechanistic process for project approval purposes

only. The philosophy behind the process, that is environmentally sound development, is basically forgotten. The majority of indigenously conducted EIA studies now contain numerous tables of data, mostly available before, without any definite ideas about their relevance or even necessity to the problems being considered. Too much emphasis is placed on data compilation and collection but not enough on their analysis, interpretation and their environmental implications. The EIA process, as it is used at present, can probably best be described as an end in itself, rather than as a means to an end to ensure better environmental management. Acceptance or rejection of the EIA report appears to be the ultimate and the *only* objective. It is also interesting to note that, of several thousand EIA studies carried out in the region during the past decade, *not even a single project was eventually rejected because of the environmental costs.*

Second, because of the overwhelming emphasis of the national environmental agencies on the EIA report preparation and its clearance, regular compliance monitoring for all practical purposes is virtually unknown at present. Accordingly, no clear judgement can be made on the effectiveness of EIA in improving the environmental acceptability of the Asian irrigation development projects.

Absence of monitoring creates another problem. All large and medium irrigation projects are complex, where the results of interactions between the physical, biological, economic, social and environmental forces are difficult to predict. For major irrigation projects, it is simply not possible to predict *a priori* all environmental impacts, or the time when individual impacts may surface, or their spatial distributions. Our knowledge base is still limited, which makes the overall process of environmental predictions an art rather than a science.

Under these conditions, regular environmental monitoring of irrigation projects is essential to ensure that:

- unpredicted or unexpected impacts can be identified as soon as they occur; and
- magnitudes and distributions of the predicted impacts are along the lines expected.

If new impacts arise, and/or if the magnitude and distribution of the predicted impacts are different, the management plans may have to be altered, in some cases radically. If there is no monitoring, the project management will be unaware of the unanticipated problems, and accordingly no effective countermeasures can be taken, until the problems become very serious and can no longer be ignored. The total cost, in economic, social and environmental terms, may by then already have significantly reduced the expected stream of benefits, in certain cases even irrevocably.

Another major problem that has been created by the general absence of environmental monitoring of irrigation projects is the validity of the current predicting techniques and methodologies. Because there has been no feedback between the predictions and the actual occurrences of the impacts, methods that may not be reliable continue to be used, and thus the errors are perpetuated regularly. Accordingly, the overall benefits of using the existing methodologies to predict and manage the environmental impacts of irrigation projects in the Asian countries have been somewhat limited (Biswas, 1994).

Conclusions

With the existing population base in Asia and the projected increases in the coming decades, water requirements will also increase significantly. Since the total quantity of water that can be developed economically and technologically at any specific period of time in a given country is limited, it is unlikely that all the water demands can be met.

Irrigation is now the largest user of water in Asia. The Asian countries today have a policy, enunciated or *de facto*, which gives priority first to domestic and then to industrial uses of water. Thus, the percentage share of water likely to be available to the irrigation sector will decline steadily in the coming decades. This means irrigation use efficiency has to be substantially increased in the future.

Asian countries will have to accept a balanced approach between irrigation development and environmental protection. It will not be an easy task since there are many fundamental problems and constraints which must be overcome to ensure the sustainability of irrigation projects. It may be a difficult and complex task but the irrigation profession has no alternative but to rise to this challenge within one or at most two decades.

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