WATER RESOURCES MANAGEMENT SERIES

ASIAN INTERNATIONAL WATERS

FROM GANGES-BRAHMAPUTRA TO MEKONG

EDITED BY
ASIT K. BISWAS
TSUYOSHI HASHIMOTO

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This book is dedicated to

DR HABIB N. EL-HABR

without whose support and encouragement
it would not have been possible, and also
as a token of true regard for a friend

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These contaminants are seriously affecting the quality of available sources of water for various uses. Thus, water quality management is becoming an increasingly important concern all over the world.

Another major factor which could affect water management in the future is likely to be increasing delays in implementing new projects. Higher project costs and lack of investment funds would be two major reasons for this delay. Equally, social and environmental forces would significantly delay project initiation time, certainly more than has been witnessed in recent decades.

Since on a long-term basis the amount of water available to any country is limited, the traditional response of the past to increasing water availability to meet higher and higher water demands would no longer be a feasible solution in the future. This means 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 improve significantly the water planning and management processes is likely to be short, certainly no more than a decade or at most two. While technological problems, though complex, may prove comparatively easy to solve, economic, political, social and environmental constraints are likely to be more difficult to resolve. Thus, the approach to the solution of water problems may remain one of the most difficult challenges facing water management in the 21st century.

The Water Resources management series of books, monographs and state-of-the-art reviews consist of authoritative texts written by some of the world's leading experts in their field. The series as a whole will consider all aspects of water quantity and quality, surface water and ground water from the viewpoints of all the major associated disciplines: technical, economic, social, environmental, legal, health and political. It will also consider all types of water uses: domestic, industrial, agricultural, hydropower generation, navigation, recreation and wildlife enhancement. Individual books may of course, have more specific focus. The books of the series would not only be of direct interest to students and professors but also to all professionals associated with resources planning and management.

Oxford, England ASIT K. BISWAS

Preface

The efficient management of water resources in arid and semi-arid Asian countries is a difficult task under the best of circumstances. As the total water requirements of the Asian countries have increased very significantly in recent decades due to continually escalating demand on account of agricultural, industrial and domestic uses, efficient management of this natural resource has become a most critical requirement for the future sustainable development of these countries, as well as the welfare of their citizens. While water management practices have unquestionably improved significantly during the past 15–20 years in most Asian countries, there is no doubt that these could be, and must be, further improved—again very significantly—within at most the next one to two decades. In fact, my personal view is that while all the improvements in water management practices witnessed thus far are to be welcomed, the rates of improvement observed during the 1970s and 1980s in different parts of Asia were much slower than what were needed and what were possible due to a wide range of interrelated reasons and constraints.

In nearly all Asian countries, new sources of water are becoming scarce, more expensive to develop, and require more expertise and technological know-how for their planning, design, implementation, and operation. The situation can only become increasingly more serious and complex in the coming years. The time has long past in all Asian countries when water could be considered to be an abundant and cheap resource, which could be used, abused and squandered without any consideration of long-term human needs and of how these needs could be efficiently satisfied on a sustainable basis.

A critical issue that many Asian developing countries are facing at present is how to allocate and manage the scarce and most valuable water resources of the international rivers, that is those rivers which are shared by two or more countries, to satisfy the divergent needs and aspirations of all the co-basin countries as well as their people. As the water requirements in all Asian countries continue to increase, in most cases very significantly the issue of water allocation between the co-basin countries in all the international rivers can only become more and more complex with the passage of time. The allocation must not only be equitable but also must be viewed by each of the countries concerned as being fair to them indi-

vidually, so that any agreement proposed would be politically acceptable. There are no technical or economic formulae which would ensure that the water allocation between the co-basin countries, however they may be arrived at, whoever may have carried them out, and whatever may be the end results, would be considered to be equitable by all the parties. In fact, parties to a dispute regarding an international river seldom agree even as to what constitutes an equitable allocation or the processes and techniques through which it could be determined. Also, the methods which may work for one international river very often may not work for another. Thus, each river would represent a special case, and generally the issue has to be negotiated by the countries concerned on a case-by-case basis. The negotiation processes are invariably long (1 to 3 decades), complex and ardous, and could sometimes even be acrimonius. As an advisor to many governments on the negotiations on various international water bodies, I am now convinced more than ever than even if it were possible for the International Law Commission of the United Nations to finalize the law of the non-navigational uses of international waterways, it is most likely to be only of limited use, at least in terms of prompt resolution of the interstate disputes and conflicts over water allocation.

If and when the Law is endorsed by the General Assembly of the United Nations, the most likely scenario would be that the co-basin countries which would perceive the Law to be favourable to their case would embrace it wholeheartedly. Equally the countries that feel the Law unfavourable to them would, in all probability, not even be a signatory to its ratification process. Accordingly, the negotiations between the co-basin countries would still continue to be the primary alternative through which such disputes would continue be resolved. The Law would most probably be of limited help.

In most Asian countries, international rivers are now often the main sources of water that can still be developed. Because of the political complexities that are invariably associated with the management of such water bodies, they have generally been neglected thus far. Because of the impending water crises looming over most of the Asian countries, and the urgency of developing new sources of water in a sustainable manner to alleviate such shortages, the Committee on International Waters of the International Water Resources Association (IWRA) convened the Asian Water Forum on International Waters in Bangkok, Thailand, 30 January–1 February 1995. As the Past president of IWRA and the Chairman of the Committee, I had the privilege to convene this important and timely Forum.

Three major Asian international river systems were specifically selected for discussion during the Forum: Ganges–Brahmaputra, Mekong and Salween. The three case studies represented different levels of disputes, ranging from the long-running and well-established problems over the use of the waters of the Ganges–Brahmaputra and the Mekong systems to the comparatively recent concern over the Salween, where the two countries have no entrenched negotiating positions.

Participation to the Forum was strictly restricted to the most knowledgeable experts of the three river systems. Two categories of people were invited: senior technocrats from the co-basin countries, and senior representatives of major development agencies. Only 30 experts were finally invited to participate in the Forum in their personal capacities to ensure a free, frank and authoritative exchange of ideas, facts and opinions.

The preparation and the organization of a well-focused Forum, with the right choice and level of senior participants from the various countries concerned and the major development organizations is a difficult and demanding task under the best of circumstances. The problem becomes infinitely more difficult and complex when very sensitive issues like international rivers are to be considered, primarily because of their inherent political and institutional implications at the national levels of all the countries concerned. Fortunately, I have been advising many of the governments of the region and all the major development organizations concerned on water and environmental issues for well over three decades. It was thus possible to convince the governments that the IWRA Committee had no hidden agenda, nor had it any vested interest in any specific solution to any problems. Our only objective was to provide a Forum, where even long-term adversaries during various negotiations could meet as friends and colleagues under informal conditions, away from the media spotlight and without predetermined official government positions. In addition, all the participants had to stay at the excellent facilities provided by the Asian Institute of Technology during the entire duration of the Forum. There were intense interactions between all the participants not only during the meeting itself, but also during all meals and any free time available. Thus, not surprisingly, the unanimous conclusion of the participants was that the Forum was most effective in terms of developing personal contacts, new ideas and better understanding and appreciation of the various viewpoints which had been expressed earlier. They felt the event was an important and timely contribution which could facilitate the various ongoing discussions and negotiations on the three river systems.

The Forum was officially opened by Dr Subin Pinkayan, former Foreign Minister of Thailand, who is also a distinguished water engineer and a personal friend for well over two decades. Professor Aaron T. Wolf acted as Rapporteur. Their contributions are gratefully acknowledged.

Since the participants were invited in their personal capacities, it was necessary to pay all their expenses. Hence, finance for the Forum was an important consideration. I am thus most grateful to Dr Habib N. El-Habr of the United Nations Environment Programme and Dr Juha Uitto of the United Nations University for their unstinted support and technical advice which made the Forum not only possible but also an outstanding success.

Last but not least, I would like to express my personal appreciation to my co-editor, Dr Tsuyoshi Hashimoto, who as a friend, colleague and a well-known international expert, advised me regularly on both the technical and the organizational aspects of the Forum. To a significant extent, the Forum owes its success to Dr Hashimoto's wise counsel and overall organizational assistance.

ASIT K. BISWAS

1 / Asian International Waters

SUBIN PINKAYAN

When Professor Asit K. Biswas first discussed the Asian Water Forum on International Waters with me in early 1994, and asked me to give the Opening Address, I promptly agreed—for three important reasons. First, of course, when a friend of more than 20 years asks you to do something, you really have no choice but to agree. Second, the three international rivers which this Forum will discuss, Mekong, Ganges-Brahmaputra and Salween, are vitally important for the survival of hundreds of millions of people in South and Southeast Asia. Third, as a water resources engineer, a technocrat and a former Foreign Minister of Thailand, I have a special interest in the sustainable development of all these three major rivers. I was personally involved in many of the negotiations on the Mekong, and I am delighted to note that as a result of long periods of negotiations and discussions, an agreement has just been reached between Cambodia, Laos, Thailand and Viet Nam 'to work together in all fields of sustainable development related to the Mekong, the twelfth longest river in the world'.

It appears to me that after many years of slow progress on the management of international waters, interest in this complex area is increasing rapidly at present, both regionally and globally. We now have a draft agreement among the four countries of Cambodia, Laos, Thailand and Viet Nam on the lower Mekong which is expected to be signed in April 1995 in Chiang Rai, Thailand. Similarly, the water resources ministers of the ten Nile basin countries are expected to sign another agreement in mid-February 1995, in Arusha, Tanzania. To me, these are very positive signs, and I sincerely hope that we will be fortunate enough to witness similar progress in other international rivers and lakes, not just in Asia but also in other parts of the world.

Management of international freshwater bodies, that is those rivers, lakes and aquifers that are shared by two or more countries, is likely to be one of the most critical development issues of the twenty-first century for several important interrelated reasons. Let me share with you some main reasons why I think this will be the case, especially from an Asian perspective.

The total demand for water in Asia has been increasing steadily from the twin pressures of population growth and increasing per capita demand as more and more people attain higher standards of living. The latest published World Bank estimates indicate that the Asian population is likely to increase from 3.1 billion in 1990 to 5.8 billion in 2050, to 6.8 billion in 2150. While reliable population projections for the future have always proved to be difficult and subject to significant errors, the fundamental fact remains, that in each Asian developing country, the total population in the year 2050 would be significantly higher than what it is at present. One could argue about exact numbers, but there is absolute unanimity among all analyses that the trend is an increasing one.

Water is essential for all human activities, ranging from drinking to agricultural production, and industrial development to energy generation. As population numbers increase, so do human activities; thus 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, 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 per cent by the year 2000. By contrast, the corresponding ratio in 1960 was only about 6 per cent.

At this ratio of 22 per cent, the extent of available water utilization in Asia in the year 2000 would be the highest among all the continents, and will be nearly twice the global average. Currently there are no visible signs that these growth rates in water utilization 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, 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 cubic metre of water for the next generation of water projects would be significantly higher, often by a factor of 2 to 3, than what it is at present.

One area to which Asian developing countries have not paid adequate attention thus far is the substantial water requirements in the future for large-scale electricity generation. The current high development growth rates in many Asian countries, including here in Thailand, can only be maintained if adequate energy is made available to sustain that growth. 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 generally not been recognized by national planners thus far. Even for China, which alone consumes 61 per cent of all commercial energy produced in Asia, estimates of water required to produce such energy are not available.

On an average, Asia converts 30 per cent of its energy to electricity. The Asian developing countries had a total generating capacity of 250,000 MW in 1990, nearly 70 per cent of which was thermally generated (mainly coal), with the balance of 30 per cent being 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 these countries are to be fulfilled. This doubling of electricity generation within the short period of a decade means that the 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 twenty-first century. Accordingly, 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 per cent of all water currently abstracted is accounted for by the energy generation industry alone. Reuse of wastewater from treatment plants for cooling in power generation plants should be encouraged.

There is now no question that in the coming decades, the demand for water for various uses will steadily increase in the region that we are focusing on today—that of the South and Southeast Asian countries. However, most countries have already developed, or are in the process of developing, those exclusively national water sources that can be economically and technologically exploited comparatively easily.

The only major sources of water that remain to be developed, not only in Asia but also in other parts of the developing world, are generally international in nature. Absence of treaties between the neighbouring co-basin countries has meant that the legal framework for the development of such international waters has been missing. Equally, international financing institutions have deliberately stayed away from any development project on an international river, unless the countries concerned have come to an amicable agreement between themselves on the use of that water. Since water resources development projects are capital-intensive, it has generally not been possible for developing countries to undertake such

projects on international rivers without external loans, even if they have wanted to do so unilaterally.

The development and management of international waters will undoubtedly be a critically important issue in the twenty-first century. The three rivers that will be discussed at this Forum—Mekong, Ganges-Brahmaputra and Salween—are no exception. Handled properly, fairly, and efficiently, the stream of benefits to all the co-basin countries would not only be very significant but also could be long-lasting. Under such conditions, it would undoubtedly contribute to a demonstrable 'win-win' situation for all the countries concerned. Conversely, if these complex situations are mishandled, the potential for serious conflicts between the countries, or even serious regional instabilities, cannot be ruled out.

However, I am an optimist by nature. The very fact that this Forum is taking place today, with the world's leading experts on international waters, senior technocrats from the co-basin countries concerned, and representatives of major international funding agencies, is indeed a very positive sign. The collective wisdom of the present gathering of carefully selected outstanding personalities of this region, as well as from the rest of the world, is clearly capable of analyzing the various complex, interrelated issues objectively and comprehensively, and presenting us with viable and implementable strategies and options. I realize this is an ambitious expectation: but we expect nothing less from such an eminent group of multidisciplinary specialists.

With such high expectations, I would like to propose one topic for your discussion on the Mekong. There is a great demand for electricity in Thailand and a huge potential for hydropower generation in Yunnan, China. Laos and Myanmar are situated between the source and the demand. I would like to challenge this group to demonstrate a 'win-win' approach for all the countries concerned.

Finally, may I take this opportunity to express my sincere appreciation to the International Water Resources Association, United Nations Environment Programme and United Nations University for sponsoring this important Forum. I would especially like to thank Professor Asit K. Biswas, the Convener of this Forum, for making this Forum possible.

I shall be looking forward to the results of your discussions and deliberations. I wish the Forum every success.

2 / Water for Sustainable Development of South and Southeast Asia in the Twenty-first Century

ASIT K. BISWAS

INTRODUCTION

Historically, economically and culturally, water has always been considered a critically important resource in all the Asian countries. Civilizations and human habitats often developed along the banks of the rivers because of easy availability of water for drinking and farming, and also their use for transportation. Accordingly, water has important religious implications for most important Asian religions, and certain rivers like the Ganges are considered holy by hundreds of millions of people. Thus, not surprisingly, when Rishi Narada, probably the earliest authority on political science, met the great Indian King, Yudhistira, his greeting was directly related to water: 'I hope your realm has reservoirs that are large and full of water, located in different parts of the land, so that the agriculture does not depend on the caprice of the Rain God.'

Water was equally important in the western world in the earlier times. More than two millennia ago, the eminent Greek philosopher, Pindar, said that the 'best of all things is water'. Similarly, the Italian scholar Leonardo da Vinci said 'Water is the driver of nature'. However, in recent decades, the various western economies have become more resilient, and hence much less dependent on water. Concerns are expressed only when there are catastrophic floods or prolonged droughts, which are short-lived—public and political interest on water disappears until the occurrence of the next serious flood or drought.

Herein lies a major dichotomy which the water profession has failed to recognize so far: in recent decades, the interests of the developed and developing countries have diverged, especially in terms of relative importance allocated to water resources. In my view, this is a very important

issue which developing countries and water profession need to realize urgently; otherwise, it could contribute to serious repercussions on the future development potential for all developing countries in general, and the Asian developing countries in particular. I will return to the very serious implications of this diverging interest in the second half of this chapter.

WATER REQUIREMENTS IN ASIA

Historically, water requirements in Asian countries have increased steadily over the years. This is to be expected, because as the populations in the various countries have increased, so have their water requirements. This general trend is likely to continue for the next several decades.

While the historical trend is likely to continue, there are certain fundamental differences between the earlier and the present conditions, which should be noted because they have significant policy and management implications.

Extent of Water Utilization

Water requirements in Asia started to increase exponentially from about the middle of the twentieth century. In 1950, only about 5 per cent of the available water resources of Asia were used: the corresponding estimate for the year 2000 is about 22 per cent, which means that this ratio would increase by a factor of 4½ times in a relatively short period of 50 years. This is shown in Figure 2.1. It should be noted that these are estimates only, since reliable data of water requirements at national levels for most Asian countries are simply not available at present. These estimates are the best educated guesses that can be made currently.

The figure indicates that, at 22 per cent, the extent of water utilization in Asia by the year 2000 would be the highest among all the continents, nearly three times that of Africa, and twice the global average. While the situation in Europe is somewhat similar, the policy implications are generally very different, since the Asian economies are far more dependent on water as compared to the European countries, especially most of the countries of western Europe. Also, while the percentage ratios of utilization in Asia and Europe are now somewhat similar, in terms of total volume of water used there is simply no comparison between these two continents. The total volume of water used in Asia is significantly higher than in Europe, and this means that the political, social, environmental and economic implications are of a much higher order in Asia than in Europe.

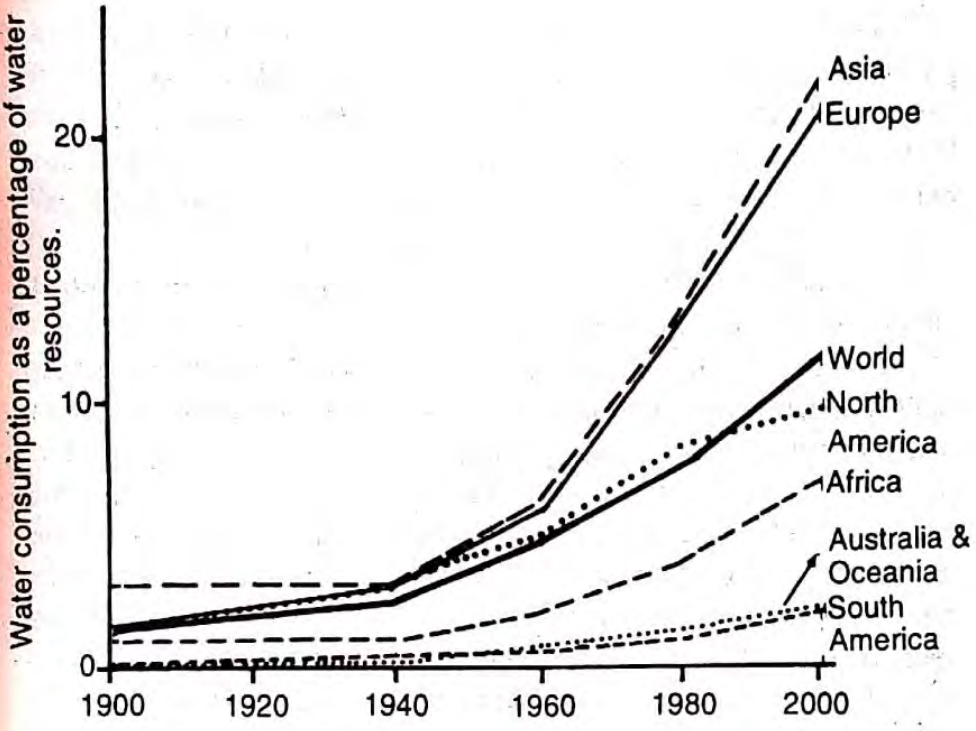


Figure 2.1. Dynamic of the ratio of water consumption to water resources.

Population and Water Requirements

Asian countries are facing continually higher water requirements for two main reasons, the principal one being the steadily increasing population. The latest World Bank population estimates (Bos et al., 1992) indicate that Asia accounted for 59 per cent 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 per cent 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 the year 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 per cent in 1992, but East and Southeast Asia, containing another 1.85 billion people, was growing at a much lower rate of 1.4 per cent. By the year 2025, the growth rates are expected to decline to 1.1 and 0.9 per cent respectively. Even with such reduced growth rates, 23 million more people are likely to be added

each year in South Asia by the year 2025, and another 17 million in East and Southeast Asia, because of their large population base of 2.05 billion and 2.54 billion respectively.

Within the subregions, countries may also have differing population growth rates. For example, the ratio of the eventual stationary population to the 1990 population in the 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 that are of special relevance to this Forum are given in Table 2.1.

As population numbers have increased, so have the extent and magnitude of human activities. Since water is essential for all important human activities, ranging from drinking to agricultural production, and industrial development to energy generation, the total Asian water requirements have steadfastly increased in the recent years. While there is no one-to-one relationship between population and water requirements, the fact remains that higher population numbers have contributed to higher water requirements in the past. There is considerable potential for decoupling population growth from the total water requirements, especially when one considers the current inefficiencies that are inherent in various water uses all over the world. It is, however, not going to be an easy process. As a general rule, the political and socio-economic constraints to efficient water use have thus far been grossly underestimated in both developed and developing countries. Overall water is still far too cheap, sometimes even almost

Table 2.1. Population projections for selected South and Southeast 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
Laos	4.1	5.6	7.4	9.4	21	5.1
Myanmar	41.6	50.9	58.6	65.9	96	2.3
Nepal	18.9	24.1	29.4	34.4	58	3.1
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).

free, to increase its efficiency of use significantly. Nor can we at present conceive a sudden global crisis, like the one for energy in the 1970s, which could significantly increase its efficiency of use during the coming two decades. The efficiency gains in water use during the next decade in the different Asian countries are likely to be slow and steady, but perhaps at a somewhat higher rate than what was observed during the past decade.

Water Requirements and Lifestyle Changes

One aspect of the increasing water requirements which has been basically ignored by water planners in all Asian countries, is the higher per capita demand as more and more Asians reach higher standards of living. If the economic growth in countries like Thailand continues at the current high rates, there would be major changes in the lifestyles of hundreds of millions of people all over Asia during the coming decades, which would undoubtedly translate into higher water requirements.

The impact of lifestyle changes on future water requirements is likely to be substantial. The recently completed National Water Study for England and Wales indicates that by the year 2020, water requirements will go up by 25 per cent, even though the population is expected to be almost stationary, primarily because of lifestyle changes in terms of increasing use of washing machines and dishwashers.

Another factor not adequately considered at present is the rapid urbanization process in Asia. The vast majority of rich and middle-income people live in urban areas, which are also centres of power and influence. As urbanization increases rapidly (Table 2.2), the unmet water demands of the major Asian urban centres will become a serious political and social issue. While water scarcity is already a contentious issue in many Asian mega-cities, it is likely to become one of the most serious socio-political problems during the early part of the twenty-first century. Considering the long gestation period of capital-intensive water development projects, the current stringent environmental requirements for getting loans from international development banks, and the national debate on the desirability of constructing new large-to medium-scale water development projects in many Asian countries, the problem is likely to get significantly worse before it gets better.

Escalating Costs of Water Projects

The quantity of freshwater that can be used by any country at any specific time is basically a function of economics, technology and availability of investment funds. Not surprisingly, in nearly all the Asian countries, the

Table 2.2. Population of major cities in Asian developing countries, 1992–2000

City, Country	Population in millions	
	1992	2000
Shanghai, China	14.1	17.4
Bombay, India	13.3	18.1
Seoul, South Korea	11.5	12.9
Beijing, China	11.4	14.4
Calcutta, India	11.1	12.7
Jakarta, Indonesia	10.0	13.0
Tianjin, China	9.8	12.5
Manila, Philippines	9.6	12.6
Delhi, India	8.8	11.7
Karachi, Pakistan	8.6	11.9
Bangkok, Thailand	7.6	9.9
Dhaka, Bangladesh	7.4	11.5
Madras, India	5.5	6.6

vast majority of the water sources that could be developed comparatively easily are already being used, or are in the process of development. Accordingly, as a general rule, the new sources which could be developed in the future are technologically more complex, economically less attractive, and often less environment-friendly, when compared to the earlier generation of completed water projects. This hypothesis is confirmed by a recent analysis of domestic water supply projects that are being currently considered by the World Bank for possible financing. This review clearly indicates (World Bank, 1992) that the cost of development of each cubic metre of water for the next generation of water projects is often two or three times higher than that of the present generation. Figure 2.2 shows the current as well as the projected future costs per cubic metre of water in 1988 constant dollars for certain major urban centres of Asia as well as for a few other cities of the developing world.

Escalating costs of water development projects will have many ramifications for the Asian countries in the future. The foremost implication of course is the availability of investment funds, both from internal sources and from external borrowings. The competition for internal and external funds between different sectors is already intense, and is likely to become even more so in the foreseeable future. This means that obtaining adequate financing to construct increasingly expensive capital-intensive water development projects would become a very difficult task in the future.

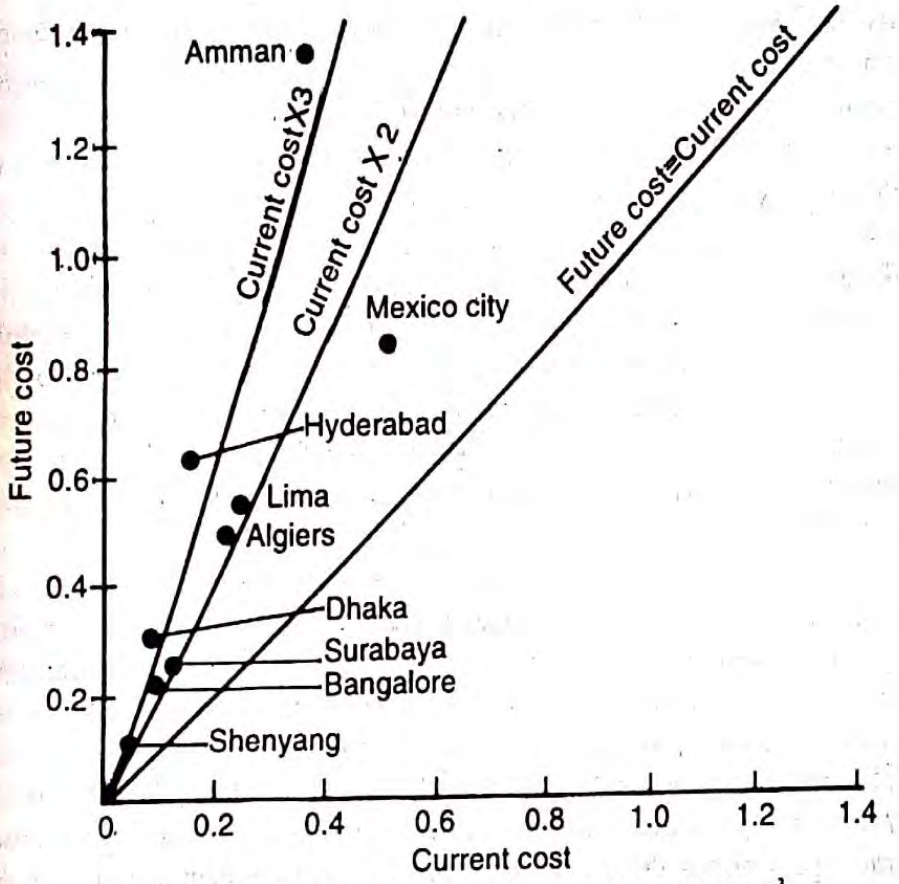


Figure 2.2. Current and projected future water costs per m^3 (US $ at 1988 prices).

Water Quality Deterioration

With the substantial increase in human population in all Asian developing countries, and the concomitant exponential increase in human activities, the waste products generated have increased very significantly as well. While both collectively and on a per capita basis, waste products generated in the Asian developing countries are substantially less than in the western countries, the fact remains that more and more waste products are contaminating available sources of water. Among the major contaminants at present are untreated or partially treated sewage, agricultural chemicals and industrial effluents. These contaminants have already started to seriously affect water quality, especially in terms of domestic use.

While many Asian countries have made notable progress in terms of environmental legislations, sadly, the overall performance in terms of their implementation has been uniformly poor. One would indeed be very hard-pressed to find even a single river near any major urban centre of a major South or Southeast Asian country that is not heavily polluted at present. While in some countries attempts are being made to clean up specific rivers

at certain locations like the Ganges in India and Chao Phraya in Thailand, it has to be admitted that the overall progress thus far has been very slow.

In addition, in spite of the official rhetoric, good water quality monitoring programmes in all the Asian developing countries are either in their infancy or even non-existent. It has generally not been realized that water quality monitoring is a very complex process, and the efforts required to develop a functional national water quality monitoring programme, in terms of conceptual framework, expertise required, and regular availability of funds, is several orders of magnitude higher than any water quantity monitoring programme. The situation is even worse when one considers that monitoring is not a very productive exercise, unless information obtained could provide direct feedback to the overall water management process. Such feedbacks are simply lacking at present.

The major problem facing nearly all the Asian developing countries in this regard is the sad lack of realization that a water quality monitoring programme that may work in the United States, Canada or UK is unlikely to be appropriate in Asia. Equally, even among the Asian countries, what may be a good approach for Thailand is unlikely to be cost-effective and efficient for Nepal, and vice-versa. As a Senior Advisor to 19 governments, many of which are in Asia, and all the major multilateral and bilateral organizations that deal with water and environmental issues, I am saddened to see too much reliance being placed on attempts to duplicate water quality monitoring programmes of the West in Asian, African or Latin American developing countries. On the basis of the numerous evaluations carried out for the various multilateral and bilateral aid agencies, one can only conclude that hundreds of millions of dollars have already been ineffectively spent on water quality monitoring programmes, which have at best had a marginal impact in improving the water quality management processes in the countries concerned.

In this regard, one needs also to consider the overwhelming reliance placed by the Asian governments and by aid agencies on water quality experts from the West to design the national monitoring programmes. Very few western experts realize that a water quality monitoring programme that may work in the developed countries of the temperate region has to be radically redesigned to suit the developing countries of the tropics and subtropics. In addition, the institutional, cultural, financial and educational frameworks of the temperate countries, as they relate to water quality monitoring, differ in some fundamental ways from those pertaining to the tropical regions. Until this fact is clearly recognized by all the parties concerned, the vast majority of western experts will continue to remain a

part of the problem rather than its solution. Sadly, there are no visible signs of this realization at present.

Water quality is an important issue in terms of water requirements. If water quality is impaired, its use for various purposes may have to be restricted. While technologically it is possible to improve the quality of any water source, such treatments may sometimes not be cost-effective. For example, excessive use of fertilizers could increase the nitrate content of groundwater above safe levels for drinking, a fact which has been observed in many parts of the world. While denitrification is technologically possible, it is a very expensive process. Hence, from a management viewpoint, it is far preferable to have an effective water quality monitoring programme which could provide early warning of an impending problem for which appropriate preventive measures could be taken, than to find an expensive solution after the problem has already occurred. Thus, any assessment of future water requirements in Asia needs simultaneous considerations of quantity, quality and cost.

CONFLICTS BETWEEN DIFFERENT WATER USES

In all the countries of South and Southeast Asia, under the existing management conditions, water requirements for various uses often exceed the total available supply, at least at certain times in specific years. While considerable potential exists to increase water use efficiencies, especially for the agricultural sector which is by far the largest user of water in this region, such improvements are likely to occur slowly due to many socio-political and institutional reasons. Accordingly, as water requirements continue to increase in the coming years, conflicts between different uses are likely to be norms rather than exceptions. Equally, existing conflicts are likely to be intensified. In about a decade, the total quantities of water demanded by people in many regions are likely to be much higher than the supply available, especially as demands will continue to increase steadily due to the reasons discussed earlier, while supplies cannot be increased as fast as in the past due to economic, technical and environmental reasons. This will undoubtedly lead to a more and more complex water management process, within which some hard economic, political and social choices have to be made.

Overall, in all the Asian countries that are directly concerned with the three international rivers which are being discussed at the present Forum—Mekong, Ganges-Brahmaputra and Salween—irrigation is the dominant water demand, ranging from a high of 96 per cent for Bangladesh to a low

of 78 per cent in Vietnam (Table 2.3). Depending on the country concerned, either industrial or domestic water use is the next important component.

Table 2.3. Water use by sectors in selected South and Southeast Asian countries

Country	Water use (%)		
	Irrigation	Domestic	Industrial
Bangladesh	96	3	1
China	87	6	7
India	93	3	4
Laos	82	8	10
Myanmar	90	7	3
Nepal	95	4	1
Thailand	90	4	6
Vietnam	78	13	9

Estimates of water requirements for large-scale energy production are simply not available in any of the Asian countries at present, even though large quantities of water are essential for such production processes. This is likely to contribute to the further intensification of conflicts between the various water uses in the future.

Based on development experiences from all over the world, it can be predicted with considerable certainty that in the South and Southeast Asian 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. This trend has been witnessed globally throughout the twentieth century: the total global agricultural demand declined from a high of 90.5 per cent of all water uses in 1900 to 63.6 per cent in 1990. During the corresponding period, industrial water use increased from 6.4 per cent to about 22.2 per cent (Figure 2.3).

To the best of my knowledge, 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. In addition, issues like water pricing, cost recovery, and the involvement of the private sector can no longer be ignored. Such comprehensive studies are now critically needed to formulate long-term viable national water strategies for South and Southeast Asia.

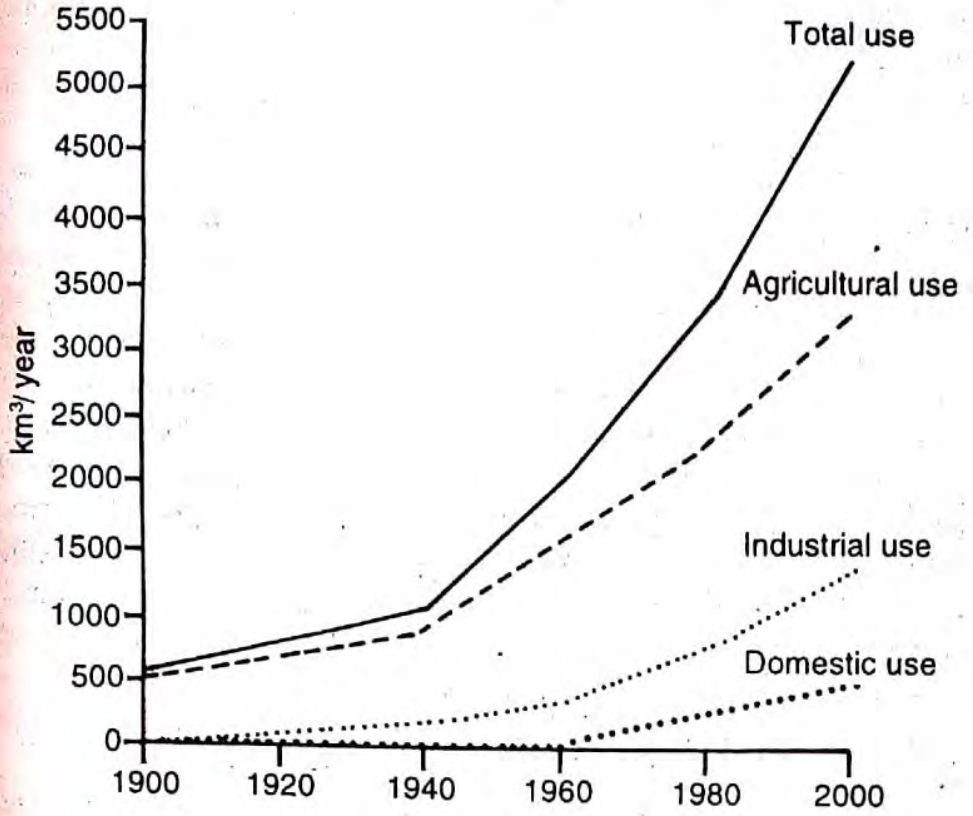


Figure 2.3. Increase in global water use, 1900–2000.

An attempt was made in India to estimate water demands for the year 2025. Table 2.4 shows this estimate along with the demand pattern for 1985. While the directions of changes predicted 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 per cent of all available water sources of the country because of high development costs, environmental

Table 2.4. Water demands in India: 1985 (actual) and 2025 (projected)

Sector	1985 Demand (billion cubic meters)	%	2025 Demand (billion cubic meters)	%
Agriculture	470	94	770	83
Livestock and domestic	17	3	40	4
Industry and Urban	14	3	120	13
Total	501	100	930	100
Total demand as percentage of total availability		24		45

constraints, interstate political rivalries and other associated reasons. Thus, alternatives such as supply and demand management have to be considered simultaneously in order to develop a more feasible water utilization scenario of the future.

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 demands of Manila are creating water shortages for irrigation in Central Luzon. In India, water demands of the city of Hyderabad are having an adverse impact on irrigation in the neighbouring areas. Similarly, in Indonesia, municipal water requirements for the Jakarta region and Surabaya are now in direct conflict with the existing irrigation arrangements of the surrounding areas. In all the above cases, the situation deteriorates significantly during the low flow years. Similar conflicts between different water demands are now visible in many different parts of Asia. Since Asian countries generally have either an officially established or 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 some 50 per cent of the continent's total population. 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 accept, and the sooner the better, since up to now there is no indication that this trend has been factored in preparing long-term national water management plans or strategies. Since farmers in most countries are a potent political force, the political implications of this potential conflict should not be underestimated.

FUTURE TRENDS IN SOUTH AND SOUTHEAST ASIA

On the basis of the above analysis, the following overall prognosis can be made on future water resources problems and trends in South and Southeast Asia.

— In order to support an increasing population in terms of national food sufficiency, more and more water will be required for irrigation in nearly all the Asian countries, unless irrigation water use efficiency can be radically improved within a decade or so.

— Simultaneously, water demands for other purposes, domestic and livestock, industrial development and electricity generation, will increase steadily.
— Water for ecosystem preservation will become an increasingly important socio-political issue in the region.
— 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 will take more time to construct than the current or the past ones.
— For environmental and social (primarily resettlement) reasons, it will take significantly more time than what most governments currently expect to develop their next generation of water projects.
— Considering realistic growth rates for new water development projects in the coming decades, it is now evident that nearly all Asian countries will have insufficient water to satisfy the demands for all the different uses, at least in the medium term.
— 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 will have to become increasingly efficient in the future: there is simply no other alternative.
— On the basis of the present trends, irrigation management is unlikely to improve as fast as would be necessary to compensate for the percentage loss of water which this sector is likely to experience in the future.
— 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. This will undoubtedly contribute to the intensification of socio-political tensions.

ENVIRONMENTALLY—SOUND WATER MANAGEMENT

Like many other societal concerns, there is currently no general agreement on this complex issue. There are many developmentalists who would like to develop as many water projects as soon 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 are mostly lobbying for no development under any condition. This group has now gone beyond the NIMBY (not in my backyard) syndrome to what can be called the BANANA (build absolutely nothing anywhere near anything) mentality. Generally speaking, this group is now receiving more attention than the developmentalists, primarily because of the widespread media coverage of their activities.

The views and objectives of both groups are fundamentally wrong. The days when major development projects, for water or any other infrastructure, could be constructed without any serious environmental and social assessments are now clearly over, and no objective individual can miss their passing. It is essential that all new water development projects be planned 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 water sources which could be developed effectively and economically. It is equally essential that the existing operational projects be carefully managed so as to ensure continued water availability from these sources for many more 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, environmental degradation on a medium-to long-term basis. This is because if all the new projects are stopped or delayed significantly, irrespective of their desirability, 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 for the alleviation of the water scarcities, the political situations and law and order conditions in the countries concerned could 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 and long-term economic benefits. In the present international political climate, this scenario is likely to be a real possibility, which in my view would be disastrous to our efforts for long-term environmental protection. In the final analysis, the ultimate objective of the two interest groups on environment and development issues has to be the same: how to ensure environmentally-sound development. If this objective is not

accepted, the problem can only become more serious and complex in the future than it is at present.

ASIAN INTERNATIONAL WATERS

The discussion thus far has been primarily on the present status and future potential for water availability in the countries of South and Southeast Asia. Since the main focus of the Asian Water Forum is on international waters, that is those water sources that are shared by two or more countries, let me outline my views on the importance of international water bodies to these two regions in the future.

The importance of properly managing international water bodies has been grossly underestimated thus far, and so has the extent and magnitude of the problem. This observation is valid not only for Asia, but also for the rest of the developing world.

Nearly half of the area of Asia falls within international river basins. For some countries like Bangladesh, most of its area lies within international basins. One can identify at least seven Asian countries in which at least 80 per cent of the total area is within international river basins.

No reliable studies exist at present on the number of international river and lake basins in Asia. The only available study which was carried out in 1976 by the now defunct Centre for Natural Resources, Energy and Transport (CNRET) of the United Nations, identified 40 such basins in Asia. The estimates of this study have been quoted and requoted so many times that these are now accepted as 'facts'. This study can at best be considered a very preliminary analysis of the extent and magnitude of the issue. A careful review of the report (CNRET, 1978) would indicate that it suffers from very serious methodological flaws and factual shortcomings, which have been discussed elsewhere (Biswas, 1994). Furthermore, with the break up of the former Soviet Union, the number of international river and lake basins in Asia has increased further. While the CNRET desk-study was a useful contribution when it was first published, it has had the unfortunate side-effect of downplaying the magnitude of the problem. An authoritative study is now urgently needed on this subject, not just for Asia but for the whole world.

Whatever the actual magnitude of the problem, the fact remains that most of the major international river systems of this region, like the Mekong, Brahmaputra and Salween, now constitute the main new sources of water and hydropower, which could be considered for future sustainable development of the countries concerned. This is because, as the demands for water in the countries increased in the past, the exclusively

national sources of water were considered first for development. The political complexities due to the absence of mutually agreeable treaties between the co-basin countries have meant that the international rivers have been generally left untouched.

International funding agencies have also declined to provide loans for development of international waters, unless the countries concerned reach a mutually acceptable treaty. Without external financial assistance, developing countries have been unable to construct capital-intensive water development projects on international rivers, even if they had so wanted unilaterally. While one regrets that major funding agencies have shown a general lack of leadership on the resolution of disputes between the co-basin countries of international rivers, as was shown by Eugene Black, President of the World Bank in the 1950s to settle the dispute on the Indus River System between India and Pakistan (Biswas, 1992), the current policy of not supporting projects on international rivers in the absence of treaties has considerable merit.

Herein will lie one of the fundamental challenges to water management in the twenty-first century: how to ensure sustainable development of these river systems with the full cooperation and agreement of all the concerned co-basin countries. Equally, during the past two decades, we have learnt many lessons as to why some of the water projects have not delivered all the benefits the planners had expected. Another critical challenge of the coming decades will be to ensure that the errors of past planning and management practices are not replicated. If we can successfully meet these challenges, our profession would have made a significant contribution to the future sustainable development of the region.

WATER IN THE INTERNATIONAL POLITICAL AGENDA

From an Asian perspective, water will become an increasingly scarce resource in the future: certainly much more than it is at present. Accordingly, politicians and decision-makers will have to realize that water can no longer be considered a cheap, or even a free, resource, which can be used, abused or squandered without any consideration of the economics of supplying the resource on a regular basis, environmental and social implications of developing and managing the projects, and long-term requirements of the society. Like oil some two decades ago, the time when water could be considered a cheap and plentiful resource is now virtually history for the Asian countries. During the next decade or so, water will

unquestionably be considered an essential and critical resource for the future sustainable development of not only South and Southeast Asia, but also other arid and semi-arid countries of the developing world.

If, as argued in this chapter, water is an essential resource for the developing world, and is likely to become an even more critical resource within the next decade, one question that can be legitimately asked is why is it absent from the international political agenda? Equally, why are certain issues like climate change at the top of the political agenda, when one considers the fact that climate change has not even killed a single person thus far, and is unlikely to do so within the next several decades, even if the most pessimistic predictions turn out to be correct? It is now common knowledge that in developing countries millions of people die each year due to the absence of clean water or for drought-related reasons. Under these considerations, should water not receive at least as high a priority as climate change in the international political agenda?

An objective analysis of the various recent discussions at different international fora will clearly indicate the present 'orphan' status of water. Water was at best a bit player at the UN Conference on Environment and Development in Rio de Janeiro in June 1992, where the centre stage was taken up by issues like climate change, biodiversity and ozone depletion, which were the main interests of the western world (Biswas, 1993). The International Conference on Environment and Development, which was convened by the UN in Dublin in January 1992, and which was expected to influence the Rio programme, was considered by the distinguished participants of the Stockholm Water Symposium in 1993 to be 'at best ineffectual, and at worst a total disaster'. The overwhelming view at this symposium was that the Dublin Conference seriously failed the water profession in general, and developing countries in particular, by marginalizing the importance of water in the international political agenda. Unfortunately, the expectations from this conference were exactly the reverse. Not surprisingly, Chapter 18 of the 'Agenda 21' of the Rio Conference, which deals with water, was poorly formulated. While much lip-service is being given to this chapter at present, especially by the international organizations, it has to be admitted that it is not even as good as the overall Action Plan of the UN Water Conference in Mar del Plata, which was prepared 15 years before the Rio Conference.

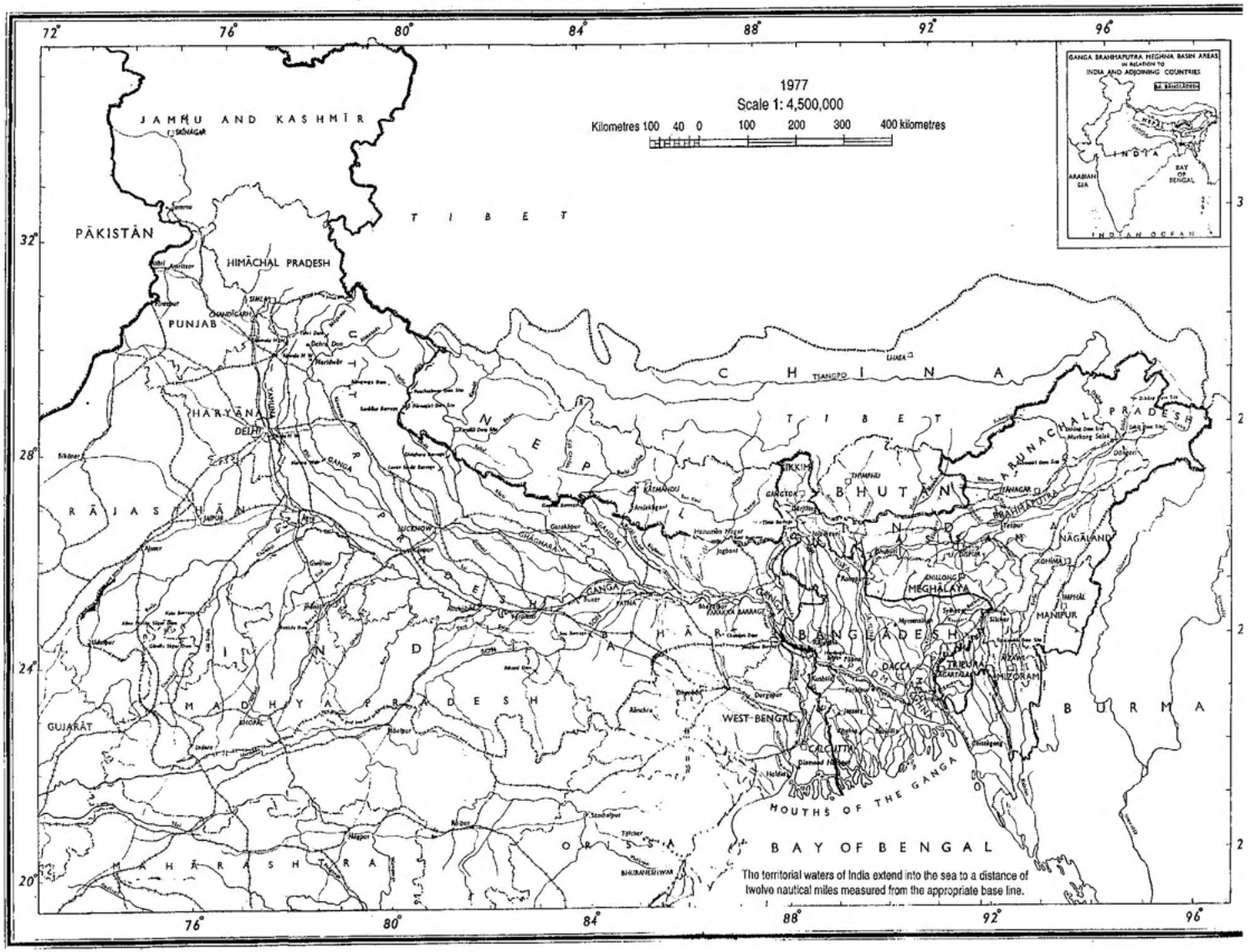
The overall failure of the Dublin Conference also indicated three striking facts. First, the institutional interests and responsibilities of the various UN agencies are different. Each has its own interest, and some

times its own turf, to protect. The UN system was unable to speak with one voice since some organizations had their own agendas. Second, developing countries need to realize that water is a much more critical resource to them in terms of their future development than it is for the developed countries, to whom water is neither a serious issue at present, nor likely to be one in the foreseeable future. Thus, only if developing countries make a concerted attempt to put water on the international political agenda, they may succeed. It is highly unlikely that the West will give water a high priority on its own volition or self-interest. Third, if water is to be an important international issue, water ministries of the developing countries need to convince their own foreign ministries first of this fact, since generally it is the foreign ministries that play the leading role in the preparation of the international political agenda at major international fora and at the highest decision-making level.

The lack of attention to water in the international political agenda can be clearly demonstrated by another fact. Exactly two decades after the UN Conference on the Human Environment was held at Stockholm in 1972, the UN Conference on Environment and Development was organized in Rio de Janeiro to take stock of the global environmental situation. Similarly, two decades after the World Population Conference was convened by the UN at Bucharest, another on Population and Development was convened at Cairo in 1994. Furthermore, in 1996, the UN is organizing a major conference on Human Settlements in Istanbul, which would come 20 years after the last similar gathering in Vancouver. And yet, there has been no serious discussion in the UN to review the world water situation 20 years after the last high-level meeting at Mar del Plata in 1977. Considering the short time available, and that a decision to convene such a meeting can only be taken by the UN General Assembly, it can now be assumed with certainty that there will be no water conference at a high decision-making level in 1997, two decades after Mar del Plata, to take stock of the global water situation. The failure of the Dublin Conference thus has had a serious adverse effect on the global status of water so far. A realistic assessment has to be that it will not be an easy task to put water on the international agenda in the near future.

A similar 'orphan' status can be observed for 'international waters', which is one of the four main areas of the Global Environmental Facility (GEF), along with ozone, climate change and biodiversity. Because global conventions exist on ozone, climate change and biodiversity, the bulk of the GEF funds has been used for these three sectors only. By early 1995, the operational strategy for international waters of GEF had yet to

GANGA BRAHMAPUTRA MEGHNA BASIN



be formulated properly, even though the first tranche of GEF funds was used up quite some time ago. Thus, unless the governments of the Third World and water profession make a serious concerted attempt to put water on the international political agenda, it simply will not happen automatically.

SUMMARY

Water has always been considered to be a vital ingredient for sustainable development in South and Southeast Asia in the past, and all current trends indicate that it will continue to remain a critical resource in the foreseeable future. With the steadily increasing population, and more and more people reaching higher standards of living, water demands in the region will increase significantly in the coming decades. Due to economic, environmental and political reasons, it is highly unlikely that the present approach of continually expanding supply to meet increasingly higher water requirements would continue to be a realistic solution. Various approaches to demand management need to be seriously considered in the near future, but it should be realized that it would not be an easy process to implement certain policies like water pricing, due to existing socio-political constraints.

One of the few major sources of water that can be developed in the future are some of the international rivers of the South and Southeast Asian region. Absence of agreements between the co-basin countries have often meant that these sources could not be developed in the past. The management of international waters has been a neglected issue in the past, and generally the extent and magnitude of the problem have also been grossly underestimated. Properly managed, the waters of international rivers like the Brahmaputra, Mekong and Salween could play a vital role in the future sustainable development of the region.

Finally, it should be realized that the interests of developed and developing countries are different at present, at least in terms of the priority that should be accorded to water in the international political agenda. For developing countries, water is a critical issue, but for developed countries, it is not so important. The Dublin Conference on Water and Environment failed to put the issue of water higher up on the political agenda at the UN Conference on Environment and Development at Rio de Janeiro in 1992. Where water attracted very little attention. Considering that millions of people are dying in the developing world every year due to lack of clean water, and flood- and drought-related causes, it is essential that both the

developing world and the water profession make a concerted attempt to put water higher up on the international political agenda. We simply do not have any other choice.

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3 / Towards an Eastern Himalayan Rivers Concord

B. G. VERGHESE

The great rivers that drain the Eastern Himalaya define a natural resource region whose logic is not effaced by political frontiers. Floods, erosion or pollution may originate in one area but affect another. There may be hydro potential in one country while the market lies in another. Traditional waterways that provided easy communication have been segmented by accidents of history, creating problems of transit. Water shortages threaten millions though, carefully harnessed, the available quantities could meet the reasonable needs of all. In all this, regional cooperation can provide national solutions.

If the nations that share the Ganga-Brahmaputra-Meghna basin are to roll back poverty, ignorance and disease and ensure a better quality of life for a large part of humankind, they cannot turn their backs on the wealth that they have only to reach out to grasp. The differences that divide them and the quantitative values involved in their water disputes are relatively small compared to the far greater benefits that each of them could realize through cooperation. Numerous trade-offs can be considered in order to even out specific gains and losses. In the end none need be a loser. Everybody can gain, and South Asia will emerge a stronger, better and happier region in which to live.

—*Harnessing the Eastern Himalayan Rivers*

The vision of SAARC would perhaps be most strongly embodied in a collaborative endeavour to harness the potential of the Ganga-Brahmaputra-Barak (Meghna) waters. These are waters of hope.

—*Waters of Hope*

INTRODUCTION

The Indian economy shows signs of moving on to a fast track after the liberalization measures initiated a few years ago. With infusions of investment and technology, and spurred by deregulation and fiscal reform, production and employment are on the rise in a more global, innovative, market-oriented environment. Within this framework, however, the lower Ganga-Brahmaputra-Barak/Meghna (GBM) basin, encompassing a huge swathe of the eastern region remains depressed, deprived and destitute. It has as

yet been only lightly touched by the winds of change. This bodes ill; for marked regional disparities are inimical to political stability and social transformation and could operate as a brake on national progress, especially in view of the electoral weightage enjoyed by a quarter of the country's entire population living in that basin.

Add Bangladesh, Nepal and Bhutan to define a vast poverty sink characterized by high agricultural dependency, increasing demographic pressure, a falling land-man ratio, low productivity, a deteriorating environment, distress migration and mounting ferment. This is a powerful paradox as the region is intrinsically well endowed and potentially rich. Indeed, Bihar was the hub of the earlier Gangetic civilizations and Bengal of industrial leadership in the more recent colonial period. What explains the decline?

SETTING THE SCENE

The Indo-Gangetic plain is one of the largest and most fertile alluvial tracts anywhere, and the Ganga basin is one of the earliest beneficiaries of modern irrigation. The Western Jamuna Canal was originally built in 1355 and remodelled 400 years later under the Mughal rule. The Upper Ganga Canal constructed in the middle of the last century, was a feat of engineering at the time and ushered in a great era of irrigation development to combat famine and produce 'superior' crops for export to the west.

With this early start in agricultural modernization, why should there have been a falling away and how does one explain the present lament of relative agricultural stagnation? The facts are simple. Nepal and Bhutan were closed societies until the 1950s, with the malarial swamp along the entire length of the sub-montane springline acting as a moat guarding the Himalayan ramparts. The semi-arid upper Ganga basin was amenable to water regulation and registered steady gains in terms of agricultural productivity and stability despite warnings of malaria, waterlogging and salinity, all of which had to be addressed and were, by and large, overcome.

It was the lower Ganga, Brahmaputra and Barak/Meghna basins that posed a problem. With increasing precipitation as one moves down the Ganga and into the Brahmaputra-Barak valleys, and an ever larger discharge with major influents disgorging their silt-laden waters into a narrowing funnel, river management and regulation, with alternating flood and drought, is the primary concern in the moist monsoonal plain which is subject to the highest rainfall found anywhere in the world.

The rivers in this region have been jacketed within embankments for hundreds of years and have built up their beds above the surrounding plain

in several stretches. Breaches and spills can therefore cause devastating floods. The construction of roads, railways, cities and embankments have impeded drainage, while increasing population has resulted in widespread encroachment of the flood plains. Inevitably, the periodicity, extent and destructive potential of floods have increased as water-bodies and natural depressions have been reclaimed. At the same time, the beneficial effects of annual depositions of silt and of fertilizing algal blooms have been lost. So also the stocking of flooded water-bodies with fish spawn which mature in quiet waters and are washed back into the rivers with the receding flood.

Farm risks have been compounded by adverse agrarian relations which have become a major impediment to innovation and investment. The tenurial pattern of land ownership that prevailed under the Mughal rule underwent major change with the so-called permanent settlement introduced by Lord Cornwallis in 1813. Under this, revenue was fixed, subject to periodic revision, with lands farmed out to feudal intermediaries who exacted exorbitant rents from the peasantry, whatever the condition of the crop. While these zamindars (landlords) did invest in land improvement and flood control measures up to a point to safeguard their vested interests, a major part of the risk was left to be borne by the impoverished cultivator harried by debt and fearful of ejection.

Zamindari was abolished soon after Indian independence as part of a pledge to restore the land to the tiller. But, given the layering of sub-infeudation that had developed over generations, landlordism has not yet disappeared. Records of rights are outdated and erroneous. Unrecorded and clandestine transactions have further supervened, while share-croppers constitute an army of tenants-at-will over large areas. The geographical extent of permanent settlement covers the lower Ganga and Brahmaputra basins including what is now Bangladesh. Agrarian reform remains a key to imparting agricultural dynamism to this entire region.

Floods remain an annual hazard in Bangladesh as much as in eastern and northeastern India. Virtually all the irrigation developed prior to Independence was in the semi-arid tracts and was based on diversion, not storage. Tubewells were developed in upper India and helped to control waterlogging, with pumping being a prime support for early hydroelectric development along a series of falls on the Ganga canals. The lower Ganga and Brahmaputra-Meghna basins, on the other hand, were for the most part dependent on rainfed agriculture or on wells and other traditional works. Agriculture was therefore veritably a gamble in the monsoon. Uncertainty aggravated risk. Moreover, mono-cropping was extensive, as was late sowing, in order to avoid early floods, and a correspondingly late harvest

left little residual moisture in the soil for crops to withstand the dry winter and long, hot summer without irrigation.

East Pakistan did take up some diversion and river-lift irrigation schemes which Bangladesh has continued to exploit with groundwater development. Corresponding post-Independence irrigation development in India saw the construction of storages on all the major south bank tributaries of the Ganga and further diversions from the Himalayan rivers, especially the Kosi, Gandak and Karnali (Ghaghra) in Bihar and Uttar Pradesh. Himalayan storages are, however, yet to be developed on any scale, whether in India or Nepal.

The older protective or famine-oriented irrigation schemes were based on modest water allowances. They are now supplemented by groundwater, but are in need of remodelling. The entire system is in the process of being modernized and supported by storages in stages to meet the requirements of the water-intensive hybrid seed technology and of multiple cropping tc sustain a burgeoning population.

The area of arable land in Nepal is limited on account of its mountainous topography, and only part of this is irrigable, mostly in the terai region. This is even more true of Bhutan and the hills flanking the narrow Brahmaputra and Barak Valleys in Northeast India like giant horse-shoes. Early Indo-Nepal cooperation resulted in diversion barrages on the Kosi and Gandak, the largest benefits going to India on account of the vast areas available for irrigation in the plains but also, Nepalese would argue, because of the mal-siting of these structures on the border rather than further up to give larger irrigation and flood-control benefits to Nepal. India disputes this and disowns any malevolence. It saw such diversions as no more than the first phase of an ongoing development process leading on to the construction of large, multipurpose dams further up the Nepalese rivers. That promise was, however, stalled by political disputes, international and internal, and awaits fulfilment.

This rapid thumbnail sketch of agrarian and water resource development in the eastern part of the subcontinent over the past 150 years is essential to an understanding of its present position. What is involved is the unhappy condition and future well-being of close to half a billion people inhabiting what is probably the greatest, and certainly the most populous, water-resource region in the world. Here is a case of what must truly appear as poverty amidst plenty, something that may be explained but not extenuated.

The Ganga, Brahmaputra and Meghna have a common terminus which constitutes the major outfall of a huge delta, with its apex some 300 kilometres from the sea. A mass of braided channels and tidal spills makes up

the estuarine web known as the Sunderbans, a vast mangrove swamp straddling West Bengal and Bangladesh. The main outfall of the Ganga has been steadily moving east from the Bhagirathi-Hooghly, on which the port of Calcutta stands, to the Padma which is the name the river takes after the confluence of the Ganga with the even larger Brahmaputra until it meets the Meghna. Through this delta is discharged nearly 1100 million acre-feet of runoff and 2.4 billion tones of silt annually, rills of sediment or Bengal fans thrusting 1500 kilometres into the mid-Indian Ocean seabed. The western part of the Sunderbans in India is moribund; the middle portion is beginning to show signs of decay; while the eastern segment remains dynamic. Cyclones and tidal surges sweep up the Bay of Bengal seasonally with devastating effect. The interplay of sea water and tidal ingress build, erode and remodel the delta through a continuing process of land formation and submergence or relocation through fresh deposition. One such formation, South Talpatty or New Moore island, has been the subject of an Indo-Bangladesh border dispute which has also become an added impediment to the demarcation of the maritime boundary.

The Ganga-Brahmaputra-Meghna can be either regarded as a single, integrated system with a common terminus, or as three distinct river basins. The argument is academic as definitions cannot alter ground realities.

With increasing water needs on account of growing population numbers, rising living standards and development requirements, the fixed stock of available freshwater in the GBM system(s) is progressively unable to meet demand. Yet, a great deal of water flows unharnessed and unutilized to the sea, much of it in destructive floods, while water management leaves much to be desired in terms of use-efficiency and maintenance of water quality.

In the water dispute between India and Pakistan, which almost led to war in 1950, the Indus system could be neatly divided between the two countries under the Indus Treaty of 1960, brokered by the World Bank. This gave the entire waters of the three western rivers, namely the Indus, Jhelum and Chenab to Pakistan, and all the waters of the three eastern rivers, namely the Ravi, Beas and Sutlej, to India in a ratio of approximately 80:20. The Treaty provided for a transition period of 10 years for the completion of 'replacement works' in Pakistan to make good supplies hitherto drawn from the 'Indian' rivers. The world community and India joined to contribute towards the cost of these link canals and two major storages on the 'western rivers' at Tarbela (Indus) and Mangla (Jhelum). The accord enabled each country to go ahead with planned water resource development on their respective rivers, which in turn made possible the

green revolution in both parts of the Indus basin. The Indus Treaty survived two wars in 1965 and 1971, and the two Indus Commissions continue to meet regularly to review progress and iron out any differences that arise through an elaborate mechanism set out in the Treaty.

The eastern Himalayan rivers, alas, are not geographically amenable to a similar division. Tibet is an upper riparian in the case of the Brahmaputra (Tsang-po) and (marginally) in respect of the Ganga, while Bangladesh is the lower riparian in the case of all the three rivers. Nepal is an upper riparian in the Ganga system and Bhutan likewise in respect of the Brahmaputra. India is, however, both an upper and middle riparian in the case of the Brahmaputra and Barak and an upper, middle and lower riparian in the case of the Ganga. Since these rivers cannot be divided, they must be shared.

This poses no difficulty with regard to India's relations with Tibet, Nepal and Bhutan. Irrigation possibilities are extremely limited in these mountainous regions and the arable area in the Nepalese terai (sub-montane plain) is so modest that India has no problem with Nepal using all the water it wants. Moreover, all regenerated and return flows will travel to India. The major use in Nepal and Bhutan is for generating hydropower which is non-consumptive and has no real bearing on water availability unless water is diverted outside the basin. The only irrigation problem Nepal and India have is limited to the siting of dams and diversions and the tapping of smaller rain-fed rivers which serve local needs and which may entail a minor element of cross-border competition. Pollution is not yet an issue but is something that should be brought under observation and regulation to safeguard the future. The sharing of costs and benefits for storages in Nepal and Bhutan and the pricing and management of such energy sources are negotiable issues though they do provide room for contention.

The essential problem of water allocation is between Bangladesh and India. They are currently sharing (seasonal) shortages, although it lies in their power to cooperatively augment lean season supplies and enjoy reasonable sufficiency, if not relative plenty. The context in which such a resolution must be found needs first be understood.

BASIN PARAMETERS

The average annual freshwater resources of India have been estimated at 1854 km^3 in round figures (Central Water Commission, 1992). Of this, over 1098 km^3 are generated in the Ganga, Brahmaputra and Barak basins with an annual run-off of 502 km^3, 537 km^3 and 60 km^3 respectively.

The total geographical area encompassed by the Ganga, Brahmaputra and Meghna (GBM) basin is 326.62 million hectares, with over 170 m ha in India, 122 m ha in Tibet, 14.75 m ha in Nepal, 4.65 m ha in Bhutan and 14.40 m ha in Bangladesh (Table 3.1). A look at the population figures (Table 3.2) shows that 535 million people, the largest concentrations of the

Table 3.1. Basin area of the Ganga-Brahmaputra-Meghna river system

Country/State	Total geographical area of country/state	Basin area in each country/state (million hectares)			
		Ganga	Brahmaputra	Barak/ Meghna	Total
India					
Arunachal Pradesh	8.37	—	8.37	—	8.37
Assam	7.84	—	7.11	0.73	7.84
Bihar	17.39	14.39	—	—	14.39
Haryana	4.42	3.45	—	—	3.45
Himachal Pradesh	5.57	0.44	—	—	0.44
Madhya Pradesh	44.34	19.90	—	—	19.90
Manipur	2.23	—	—	0.97	0.97
Meghalaya	2.24	—	1.17	1.07	2.24
Mizoram	2.11	—	—	0.89	0.89
Nagaland	1.66	—	1.08	0.07	1.15
Rajasthan	34.22	11.21	—	—	11.21
Sikkim	0.71	—	0.71	—	0.71
Tripura	1.05	—	—	0.47	0.47
Uttar Pradesh	29.44	29.44	—	—	29.44
West Bengal	8.88	7.16	1.06	—	8.22
Delhi	0.15	0.15	—	—	0.15
Subtotal	170.62	86.14	19.50	4.20	109.84
Bangladesh	14.40	4.60	4.70	3.60	12.90
Bhutan	4.65	—	4.50	—	4.50
Nepal	14.75	14.00	—	—	14.00
Subtotal	204.42	104.74	28.70	7.80	141.24
Tibet (China)	122.20	4.00	29.30	—	33.30
Grand total	326.62	109.80	58.00	7.80	174.54

Notes:

(1) Figures have been rounded off.

(2) The total geographical area of India is 328.726 million ha.

Table 3.2. Estimated population of the GBM basin, 1990–91

Country	In millions
Tibet (China)	3.00
Nepal	19.00
Bhutan	1.40
Bangladesh	106.00
Indian basin:	
Arunachal	0.85
Assam	22.30
Meghalaya	1.80
Nagaland	1.20
Manipur	1.80
Mizoram	0.70
Tripura	2.75
Total for Northeast	31.40
Sikkim	0.40
West Bengal	68.00
Bihar	85.00
Uttar Pradesh	138.75
Madhya Pradesh	35.00
Himachal	2.50
Haryana	8.00
Rajasthan	24.00
Delhi	9.35
Total for Indian basin region	405.40
Grand total for basin	534.80 or 535.00

Note:

Only part of Rajasthan, Madhya Pradesh, Himachal and Haryana are within the basin. A small part of South Bihar also lies outside the basin as does a part of Mizoram and the Chittagong Hill Tract in Bangladesh. Parts of western and northern Tibet lie outside the basin, too.

Source: Figures from World Development Report, 1992, and Census of India, 1991.

world's poorest, live in the GBM basin (1991), a figure that could double by the years 2025–40.

Bangladesh accounts for no more than 7.39 per cent of this vast drainage basin through which over 1100 km^3 of run-off and 2.4 million tones of sediment are annually funneled into the sea, almost 75 to 80 per cent of this during the monsoon floods between June and September. The eastern part of the subcontinent, including Northeast India, Bhutan, eastern Nepal,

Bangladesh and West Bengal, represent the highest rainfall region in the world, with Cherapunji in Meghalaya, India, receiving over 12,500 mm of rain annually!

The Himalayan region, too, experiences heavy rainfall which diminishes as it moves westwards . The winter rains are slight but the so-called western disturbances bring precipitation, mostly snow, declining in intensity as they move east along the Himalaya in reversal of the south-west monsoonal pattern. However, snow and ice-melt feed the major Himalayan rivers as summer temperatures rise, while the small rain-fed rivers shrivel or run dry. The central and upper Gangetic plain and plateau are characterized by medium to low rainfall regions, shading into semi-arid and desert tracts with brackish groundwater as one moves westwards.

Two other features are noteworthy. First, the Brahmaputra with an annual run-off of a little over 537 km^3 is a bigger river than the Ganga (502 km^3). With the Barak (60 km^3), it accounts for 30 per cent of the entire waters of the subcontinent, excluding Pakistan. Such is the distribution of population and culturable area within the three river basins, that the average annual run-off in cubic metres per capita within India is 1473 in the Ganga basin, 18,417 in the Brahmaputra basin, and 9447 in the Barak basin. The corresponding average run-offs per hectare of culturable area in the three basins within India are 8727, 44,232 and 53,680 cubic metres (Verghese and Iyer, eds, 1993). It must also be noted that the headwaters of 54 rivers accounting for some 95 per cent of Bangladesh's run-off originate in or beyond India.

To the surface waters of the region must be added groundwater. The groundwater resources of the Ganga basin in India are considerable and have been generously augmented by surface irrigation recharge which has spawned large groundwater development in the western semi-arid belt. Groundwater use in the lower Ganga basin in India is significantly less, though it is now being promoted, while its use in Bangladesh and in the Nepalese Terai is growing to match the potential. Here too, care needs to be exercised, especially in coastal regions and where multilayered aquifers exist, to prevent saline ingress or depletion or contamination of shallow aquifers on which traditional well irrigation and domestic water supplies are crucially dependent.

It must also be clearly understood that groundwater is not something apart, but constitutes part of a single hydrological resource, feeding rivers during the lean season and being recharged by them as well as by surface irrigation at other times. Excess pumping in eastern India could, therefore, deplete surface flows in Bangladesh.

Estimates of groundwater in the lower Ganga basin in India and in Bangladesh are still being refined. While mining of groundwater is obvously a bad practice, the potential for groundwater storage by pre-monsoon pumping to create pore space for infiltration and reduce the quantum of rejected recharge should not be ignored. Careful studies of what this dynamic component might be (after calculating evaporation losses) are necessary, together with suitable cropping patterns and conjuctive use to develop optimized crop-water systems.

Groundwater pumping requires energy. This raises issues of some importance in the utilization and management of the water resources of the eastern Himalayan region. The known groundwater resources in the three basins have been tapped at several levels, but no deeper than 200–500 metres. It has however been recently hypothesized that in addition there are certain deep aquifers under artesian pressure going down to 1000–2500 metres, underlying the middle and lower Ganga plain in India and Bangladesh, some pockets in the Nepalese Terai and the Old Brahmaputra basin in eastern Bangladesh. Initially inferred by petro-geologists (Jones, 1986), an examination of core drilling samples from Petro Bangla and India's Oil and Natural Gas Commission have given credence to the theory which now awaits confirmation through exploratory drilling. The governments have been dismissive of it on theoretical or other grounds but groundwater authorities in India are now more favourably inclined to test the hypothesis. However, there is some unstated reservation on the score that, should the deep aquifer hypothesis stand confirmed, this might undermine the current negotiating positions adopted by India and Bangladesh with regard to their ongoing dispute over sharing the lean season flows of the Ganga below Farakka. This is fanciful and would be unscientific if true.

THE FARAKKA FACTOR

When Calcutta was founded by the East India Company as a major port and 'factory' in 1790, it was sited on the western most spill of the Ganga, then the main effluent of the river, and as near the apex of the delta as possible. An inland port provided easier access to a vast rich hinterland, and safety from the pirates who ravaged the coast and lower estuarine waters of Bengal. Within a hundred years, the main arm of the Ganga had begun moving east to join the Brahmaputra at Goalando, after which the combined stream is named the Padma, which in turn empties into the Meghna at Chandpur. As mentioned earlier, the Ganges continues to press eastwards, a factor as much as any other that may have resulted in the gradual deterioration of its western effluents in Bangladesh, such as the Gorai which waters the south-western region of the country around Khulna.

The deterioration of river and port conditions along the Hooghly, with reduced drafts at Calcutta and increasingly destructive tidal bores, set off a series of alarms even in the last century as shipping interests and the port authorities agitated for ameliorative measures. A subsidiary port lower down the river was established at Port Canning but proved unsuccessful. Various other solutions were bruited over the decades. Nothing followed. By 1947, when India became independent, the Bhagirathi (as the upper Hooghly is known) had become moribund. Its entrance channel was blocked by a silt dam which the Ganga could only top during high stages of the river. Saline intrusion with tidal ingress had also begun to affect domestic and industrial water supplies to the Calcutta metropolitan region.

As Calcutta was a major industrial hub and India's busiest port in the early 1950s, serving a vast hinterland in eastern, central and north-eastern India as well as Nepal and Bhutan, pressures to save it steadily mounted. The Farakka project was seen as the answer, with an ancillary port being sited down-river at Haldia, where larger vessels could lighten or top-up as they sailed to and from Calcutta.

The Farakka project envisaged constructing a barrage across the Ganga just above the point where it forms the border with Bangladesh (then East Pakistan) before finally entering that country, and diverting up to 40,000 cusecs through a feeder channel into the Bhagirathi-Hooghly to flush the river, improve drafts and water quality, and resuscitate the port of Calcutta. A lock in the barrage would restore a navigation link from Calcutta to Patna and Allahabad on the main stem of the Ganga. Discussions with Pakistan proved infructuous. Construction commenced in 1968 and the barrage was completed by 1975 when diversions were effected. Bangladesh protested when trial diversions assumed a more permanent character.

With abstractions for irrigation all along the upper and middle Ganga and its main tributaries in India, the lowest flow at Farakka in 1975 was estimated at 55,000 cusecs in the last ten-day segment of April. Thereafter, the discharge tends to rise with increasing snow melt (which commences in late February and April in the case of the Brahmaputra and Ganga respectively). India has developed a capability to divert up to 40,000 cusecs at Farakka (though actually forcing a lesser quantum into the Bhagirathi-Hooghly during the lean season to match reduced availabilities). With both sides claiming 55,000 cusecs and more as their minimum demand, there was an impasse which has yet to be resolved.

Sharing the shortage permanently would be a poor solution. Augmentation of lean season supplies appears to be the more promising option. A five-year accord in 1977 (with Bangladesh getting 34,500 cusecs and India taking 20,500 cusecs during the last ten days of April), was coupled with

an undertaking by both sides to come up with suitable augmentation measures. Bangladesh proposed seven very high dams in Nepal whereas India proposed constructing a barrage across the Brahmaputra in lower Assam to divert anything up to 100,000 cusecs through a massive canal across northern Bangladesh to a point above Farakka in West Bengal from where it could be distributed. The Indian plan was linked to major storages on the Brahmaputra (so that only flood waters would be diverted), and envisaged major hydropower, flood moderation, irrigation and navigation benefits for both countries.

The tragedy is that, rather than sit down and discuss these options and explain their feasibility and rationale, each side vetoed the augmentation package advocated by the other. India said it was not prepared to trilaterlize an already complex bilateral issue. Moreover, it had been engaged in prolonged discussions over the past quarter century for cooperative efforts to harness Nepal's water resources and its immense hydro potential. Should this materialize, India could beneficially utilize all the waters stored to irrigate thirsty acres awaiting the gift of water. It assured Bangladesh that it was not unmindful of its legitimate needs, but argued that these could be served by an optimal development plan that tapped the virgin waters of the Brahmaputra with its huge surplus.

Bangladesh, in turn, felt that the Brahmaputra diversion plan proposed by India was technically and economically unsound. It would result in large-scale displacement of its people, divide the country by a massive moat, and enable India to regulate the Brahmaputra to its disadvantage at will. Further, if there was a monsoon surplus in the Ganga at hand, there was no reason to ignore this and think of an inter-basin transfer.

Both sides appealed to emotion rather than to reason, derailing the discussions which have continued fitfully but unproductively to this day. Political relations had soured following the assassination of the Bangladesh President, Sheikh Mujibur Rahman in 1975, and though they improved off and on, these windows of opportunity were never exploited (Crow and Lindquist, 1990). For India, augmentation from the Brahmaputra has become the touchstone. For Bangladesh, the Brahmaputra-Ganga link proposal is politically anathema. Each side has ignored its own true long-term interests, engaging in avoidable polemics and unmindful of the opportunity costs of delay.

It is Bangladesh's case that diversions at Farakka have caused desertification, hardship and loss of production in south-west Bangladesh. In the absence of any sharing agreements over the past few years, it has been

receiving *ad-hoc* releases that shrank to as little as 10,000 cusecs at one point in 1993. The salinity line has moved above Khulna. Industry; agriculture, navigation and fisheries have been affected and the best mangrove species in the Sunderbans are dying. Substantial production losses have been computed and it is now being argued by some that the cumulative impact of all this has been to trigger distress migration into India.

The Indian response is that while there may have been some distress in Bangladesh, especially during lean years, this has been exaggerated and has in any event been shared by India. A joint approach to Nepal in 1987 on storages to augment flows at Farakka yielded no result. Meanwhile, with India's own water demands increasing, it cannot continue to suppress its legitimate needs, when plentiful supplies are available for supplementation from the Brahmaputra to make good diminishing Ganga flows.

There was a moment in the late 1980s when there might have been a breakthrough. The then Bangladesh Water Resources Minister came to the conclusion that while the country was fighting for larger lean season releases, it was technically not in a position to utilize even the existing lean season flows unless it built a structure on the Ganga to pond the river and divert headwater supplies into the Gorai. Whereas augmentation of the Ganga from storages in Nepal would take 20 to 50 years from commencement to completion (assuming that all financial and environmental hurdles were overcome without delay), the country's need was urgent and immediate. Moreover, in view of the magnitude of the investments involved in building a Ganges Barrage and related works in Bangladesh, no multilateral financial agency or donor would be prepared to make an investment without ascertaining the views of the upper riparian and some certainty about the quantum of water available. Hence, while augmentation was a futuristic proposition based on another's goodwill, water-sharing was a clear and present right.

Based on this logic, the minister informally proposed that India guarantee Bangladesh 25,000 (or even 20,000) cusecs of water from the Ganga during the lean season. The Brahmaputra could be consumptively shared to the extent of 25 per cent by either country, leaving the remaining 50 per cent flow untouched for ecological purposes. The remaining trans-border rivers might be shared on a 50 : 50 basis. This was an interesting proposal that offered a basis for negotiation. Unfortunately, it was neither pursued by India nor formally pressed by Bangladesh which in any event discarded it later.

The Ganges basin accounts for only a third of Bangladesh. The lower

Ganges basin directly influenced by Farakka up to Gualando, where the Brahmaputra meets it, is even smaller. Bangladesh's stakes in the Brahmaputra and Meghna basins are clearly larger and an early accommodation with India could trigger water resource developments on those systems benefiting the regions concerned in terms of irrigation, flood moderation, energy and navigation. Likewise, India has ignored its vital interests in the Northeast which was geo-politically isolated, indeed virtually landlocked and marginalized by partition, losing its traditional markets and arteries of communication by land and inland water in and through Bangladesh, and access by rail and road to Chittagong which served as its entrepot. The Indian Northeast is a troubled region, but very richly endowed with vast hydro resources, oil, gas, coal and other minerals, forests and biodiversity, and has a huge potential for plantations and horticulture. Development of the region would be greatly facilitated by cooperation with and transit through Bangladesh, from which the latter too stands to benefit in terms of investment, employment and income. Northeastern storages and water regulation could moderate floods in Bangladesh, while cheap hydro power could assist its development. The benefits are clearly large and mutual and both sides have a great deal to gain.

Productive solutions are available on the Ganga too, given a new and more positive frame of reference. But before discussing the outlines of an eastern Himalayan concord, it is necessary to complete the picture by turning to water issues in the northern tier.

NEPALESE CAUTION

Nepal, like Bhutan, is landlocked, but all its rivers drain into India to which it is closely tied by geographical compulsions. In turn, eastern UP and all of Bihar north of the Ganga are, with Nepal, a single hydraulic entity. There is no escaping these facts which suggest the closest cooperation in water resource development for optimal advantage and mutual benefit. Unfortunately, political misunderstandings have stalled progress, despite some earlier joint projects on the Kosi and Gandak. Nepal has a vast 83,000 MW hydroelectric potential, 42,000 MW of which has been assessed to be techno-economically feasible. This has yet to be tapped.

There is a section of opinion in Nepal which believes that India exploited its innocence in the 1950s to design and construct the Kosi and Gandak projects in a manner that gave Nepal relatively small benefits. This is not really so, and was certainly not intended despite certain operational and maintenance problems. But it did create a psychological block and

aggravated the small-country syndrome in the face of seeming Indian imperviousness to Nepalese sensitivities on a range of issues concerning trade, transit, security and medium to small water resource projects and which would benefit Nepal and for which external assistance was linked to Indian concurrence. All these might have been overcome by a somewhat more accommodating approach, of giving in order to get through confidence-building.

Political relationships have more recently mellowed, and with the restoration of parliamentary democracy in Nepal, an agreement was reached in December 1990 on a range of large, medium and smaller multipurpose, hydro and flood storage projects. This has been impelled by Nepal's need to impart dynamism to its economy, grow more food, generate more employment for its rapidly growing population, and reverse the process of migration from the hills to the Terai with the degradation of its mountain and forest environment. India has correspondingly pressing requirements for peaking power, stabilizing irrigation and moderating floods by harnessing the Nepalese rivers.

Even so, several constraints remain. Nepalese opinion is still divided on the merits of mega projects. Since Nepal's own energy demand is modest, the huge blocks of power generated must and can only be sold to or through India. Some fear that this will increasingly lock the Kingdom into the Indian economy which could derogate from its sovereignty. This is an exaggerated view, for Indian dependence on Nepalese energy will create a degree of real interdependence that will, if anything, enhance Nepal's independence. With grid connections, Nepal could in time sell power to Bangladesh and even Pakistan, given an improved political environment in South Asia. The regional imbalance created by diverting huge investments into any given valley can be balanced by quicker-maturing projects in other regions and by ploughing the large returns from any initial mega project into programmes that ensure regional development in the next round. There is also understandable caution about undertaking single investments larger than its GDP, with annual outlays in excess of the national budget. However, there always is a first time, and suitable technical, administrative and managerial expertise can be assembled to ensure that the job is done not just adequately, but well. Indeed, any such project would trigger very considerable development of infrastructure, trained personnel and a host of capabilities which would by itself constitute a substantive development programme. Whole new valleys would open up.

Sensitive to the popular belief that India got the best of the bargain in some of the earlier projects, Nepalese negotiators have been anxious to

establish cost-benefit parameters even before broad project profiles have been translated into detailed engineering, environmental and financial proposals packaged into investment decisions. There is by now a sufficient body of principles and experience with regard to cost-benefit sharing around the world and even within the subcontinent to safeguard Nepal's interests as much as India's through international agreements that neither side could unilaterally disregard.

Perhaps the principal blockage of late has been the internal political differences within Nepal leading to the incorporation of Article 126 in the country's new constitution two years ago which requires any 'treaty' pertaining to natural resources and certain other matters to be ratified by the National Assembly by a two-thirds majority. It stemmed from a desire to safeguard against inequitable arrangements and was immediately applied to stymie the Koirala government on the Indo-Nepal Tanakpur agreement. This pertains to a 120 MW hydro project just completed by India on the Mahakali at a point where this boundary river loops into Indian territory, but with an afflux embankment that occupies 2.0 hectares of land in Nepal by consent. A few hectares in Nepal will be submerged during the rainy season, though a somewhat larger area will be protected from flooding. It is to get 150 cusecs of water for irrigation, 20 million units of energy annually free of charge and a road link with several bridges joining the Tanakpur barrage with Mahendranagar, the present terminus of Nepal's East-West Highway. Contrary to what critics say, Nepal clearly benefits from the bargain. Nevertheless, with the opposition in full cry, the Koirala government could not get the treaty ratified by the last national assembly before it was dissolved. The ensuing elections in November 1994 have not given the new government a two-thirds majority.

The moral of the story is that India needs to ensure earlier and more transparent consultations with Nepal in respect of all new water resource and other agreements. The Nepalese in turn will need to build a national consensus on the strategy, priorities and modalities of water resource development, especially when mega and medium projects are being negotiated in the Nepalese heartland.

Three mega projects have been under discussion. First, the Karnali High Dam with an installed peaking capacity of 10,800 MW, and flood and irrigation benefits as spelt out in a north American feasibility study—the fifth in 30 years. Next, the Pancheshwar project (1500–3000 MW or more) which is being designed as a joint border project on the Mahakali. And, third, the Sapta Kosi High Dam, a multi-purpose scheme initially conceived of in the early 1950s as a follow-up to the Kosi barrage-cum-

flood embankment project. These may each entail investments of $3–5 billion and a gestation period of 8–10 years. India will absorb the vast bulk of the power. Certain medium schemes like Burhi Gandak (600–1000 MW), Kali Gandaki and others are also under consideration as more quickly-maturing Nepal-benefit projects to bridge the looming power deficit confronting the kingdom. Negotiations should pick up with the new government in place.

Nepal currently has an installed generating capacity of no more than 250 MW and buys some power from India. The power shortage in the country is likely to increase to over 200 MW by the year 2003 when the 201 MW run-of-the-river Arun-3 was earlier scheduled to be commissioned. This project has been virtually cleared by the ADB and World Bank for funding as a purely Nepalese project, but has stalled following criticism both within the country and abroad on environmental and cost considerations. This underlines the urgency of taking firm decisions expeditiously and moving forward purposefully, as the environmental and development costs of the worsening energy crisis will be considerable.

BHUTAN MOVES AHEAD

The dramatic transformation possible through water resource development is evident in Bhutan. This was an even more sequestered hermit kingdom than Nepal when it opened its doors to the world in 1960, launching on its first five-year plan the following year. Yet, despite the late start and possessing a relatively more modest 20,000 MW hydro potential compared to its western neighbour, Bhutan has rapidly pulled ahead. Hydroelectric generation has wrought an economic and social transformation and has become the primary engine for development and an improved quality of life.

This process was not triggered until around 1980 when Bhutan initiated plans to harness the Wangchu (Raidek) cascade at Chukha through a 336 MW run-of-the-river project, financed and built by India on a 60 per cent grant, 40 per cent loan basis, at an estimated cost of Rs 245 crores.

Successive units were commissioned between 1986 and 1989. A 66 KV transmission line linked Thimpu, the capital, and Phuntsholing on the Indian border, with a 220 KV line evacuating all the power surplus to Bhutan's small but steadily rising requirements to India for peaking purposes. The initial tariff differentiated between firm and secondary power, but was equalized and then raised again and now yields the kingdom over Rs 40 crores of revenue per annum in sales to four Indian states

through India's eastern grid. The internal price of electricity in Bhutan (previously based on micro-hydro and diesel generation), has been lowered, and there has been a diversion from firewood and kerosene to more eco-friendly, import-saving Chukha power. The accruing revenues have enabled Bhutan to service its loan from India and to finance other developments, improve salary scales and invest in new power projects.

Bhutan's load had risen from 12 MW to 25 MW by the early 1990s with the beginning of a carefully regulated programme of selective industrialization. But, in view of its own increasing load and India's insatiable requirements of peaking power, the kingdom has planned a number of new hydro projects that will develop its own backward regions and augment power exports to India. A 45 MW run-of-the-river hydro station on the Kuri Chu is being sited in eastern Bhutan to service a cluster of industries (cement, gypsum and lemon grass processing) and to meet other local needs. This again is being fully funded and assisted by India which has also been invited to prepare feasibility reports for a run-of-the-river Chukha II (1000 MW) and Chukha III (a 900 MW storage dam). Meanwhile, an agreement has been reached for Indian assistance in the construction of a small storage upsteam of Chukha I at Bunatha to generate 120 MW. The tail-race waters will incidentally firm up generation at Chukha I by another 33 MW.

A much larger storage dam on the Sunkosh river is also under investigation. An agreement to take up this 1,525 MW project with Indian assistance was signed in early 1993 and will, on fructification, constitute a major leap in Bhutan's water resource development. If the Chukha cascade and the Sunkosh project are brought on stream, Bhutan's installed capacity will exceed 4000 MW. With electricity tariffs likely to increase over the current 37 paise per unit, Bhutan can look forward to earning over Rs 500 crores per annum from power sales to India by the end of the first decade of the twenty-first century.

The King of Bhutan is anxious to prevent economic development from outpacing the country's social and cultural absorptive capacity. He is also deeply concerned to protect the environment and ensure that all development is basically eco-friendly. These parameters have been built into the perspective plans for water resource development. Rather than go in for excessive tourism or industrialization, Bhutan sees its future in keeping out pollution and maintaining its traditional culture and way of life, while markedly improving living standards by developing its hydro resources. India is willing to assist this process and buy all of Bhutan's surplus power. Such storages as are developed on the Subkosh and, subsequently, the Manas will help to regulate floods and augment lean season flows in

Assam, and Bangladesh to some extent, and provide the opportunity for westward diversion without affecting natural dry weather flows. Such developments open up interesting possibilities.

There has been little or no friction between Bhutan and India in the joint development of the kingdom's hydroelectric potential. Comments about the initially low tariff paid for power by India are misplaced as they ignore the very large element of Indian grant assistance and soft terms of repayment on the smaller loan component. Nevertheless, periodic tariff revisions have, and will continue, to raise the sale price of power to India within a collaborative framework that ensures the smooth and steady harnessing of Bhutan's power resources in accordance with its priorities and aspirations. These power projects are beginning to take on the character of area and infrastructural development programmes, turning out trained manpower and generating employment.

Nepal's approach earlier was to demand a tariff equivalent to the replacement cost of thermal or nuclear power at the Indian border, at which price India found it cheaper and more expeditious to develop its own considerable Himalayan hydro resources. Bhutan, on the contrary, has studied Indian load forecasts and sought to capture a share of its expanding energy market. It has looked at the future rather than getting lodged in the past. However, attitudes in Nepal are changing as the opportunity costs of delay begin to tell and internal pressures for more rapid development manifest themselves.

LOOKING AHEAD

Opinion in India and Bangladesh too is beginning to change in favour of more accommodative policies that better serve the national interest. Past rigidities have yielded nothing. Easier options have been exhausted and Nepal and Bangladesh, as much as India, now confront the reality that they face penury or even disaster separately if they cannot forge a new cooperative relationship. Accommodation is far removed from surrender, and mutual concessions can convert what has seemed a zero-sum game into a highly positive sum game with an element of synergy that confers an additional bonus on each of the players.

The Bhutanese example illustrates an essential mutuality of interest that should also bind India and Nepal and India and Bangladesh. How?

THE INDO-NEPAL CONNECTION

North Gangetic India and Nepal are part of a single hydraulic system, with Nepal controlling the levers. The Ganga irrigation system, among the

oldest and most extensive anywhere, is almost entirely based on diversion of Himalayan flows. There are few storage sites in India other than in the main Ganga, Ramganga and Yamuna valleys. The 'Nepalese' transboundary rivers account for a substantial part of the Ganga's runoff and there is no way India can regulate their waters for flood moderation, irrigation or the generation of hydroelectric power without Nepalese cooperation. Failure to harness this potential entails huge underutilization of a prime natural endowment and has distinctly slowed down progress in eastern Uttar Pradesh and north Bihar. Likewise, Nepal's failure to exploit its water resource potential implies a self-denying ordinance that has left it materially and environmentally impoverished. Neither country has gained. Both are losers.

Nepal has certain discontents and anxieties about past and future outcomes with regard to cooperation with India in water resource development. But the real divide stems from an element of political mistrust engendered by asymmetry in size, difference in stages of development, and a variety of trade, transit and security issues.

The restoration of multi-party democracy in Nepal in the 1990s saw a marked improvement in Indo-Nepal relations and an agreement was reached on cooperation in water resource development across a broad spectrum. Unfortunately, internal political discords within the kingdom intervened. With a new government in office following a general election (November 1994), ways must be found to implement the earlier India-Nepal understanding on water resource development. While a number of projects are on the anvil, it would be advantageous for India and Nepal to go ahead with at least one mega and another medium project. The latter being a quicker-maturing Nepal-benefit scheme could have a large demonstration effect. It could also build in an element of regional balance and earn revenue that could be ploughed back into part-financing Nepal's contribution towards the more ambitious power-export project that would have a longer gestation period. Meanwhile, detailed engineering, environmental and financial studies could be completed in respect of another pair of projects which could be fed into the pipeline.

It is for Nepal to choose the medium project it would wish to pursue. This could, among others, be either the already partly-investigated Bhuri Gandak or Kali Gandaki schemes or the Sun Kosi diversion to generate power and divert water into the Kamla to meet an emerging water shortage in that basin for irrigation within Nepal and India. This project could dovetail into the far larger multi-purpose Sapta Kosi High Dam which is among the agreed proposals for which a Nepalese inception report and

Indian comments thereon have been exchanged. A joint detailed project report is now to be prepared.

The two mega projects most ready to go forward are the Pancheswhar and the Karnali projects, in that order. The Nepalese would prefer the latter but India has some reservations about the proposed design on techno-economic and investment grounds and would rather take up the more advanced Pancheshwar Dam on the Indo-Nepal border, in respect of which costs and benefits would be shared equally. This would overcome some of the funding and management problems still confronting the larger Karnali scheme. The Nepalese are now veering round to the view that since all mega projects are entirely dependent on power exports, it would be best to accommodate India's priorities. A similar Indian accommodation of Nepal's preferences on any 'twin' medium project could prove mutually advantageous in terms of confidence-building and phasing.

Nepal's desire for a satisfactory tariff is perfectly understandable. There is a price below which it will obviously not find it worthwhile to sell power. There is equally a price above which it will not be worthwhile for India to make a purchase. It is within this range that a deal must be negotiated. This should not present an insuperable problem with the provision for periodic tariff revisions. There are also well-established principles of cost allocation as between multiple uses, and for compensating measurable additional benefits from augmented power generation, irrigation or flood moderation downstream, and for determining a fair 'royalty' for the life of the dam site. Once mutual confidence is established, a stipulated mechanism for resolving differences could take care of any problems that might arise. The details could be enshrined in a formal international treaty with self-actuating procedures.

Nepal has time and again expressed deep interest in securing a navigation outlet to the sea via India and Bangladesh through possible river and canal linkages tied to water resource development. Regulated releases from Himalayan storages would augment lean season flows and, with suitable river training works or irrigation-cum-navigation canals or link canals, could perhaps create waterways connecting the main stem of the Ganga to points in or near Nepal. India too is anxious to augment and improve inland water transport. The stretch of the Ganga from Haldia-Calcutta to Patna-Allahabad has been declared a national waterway. The possibility of establishing feeder routes up the Kosi and Gandak is not ruled out and, if feasible, it would be to everybody's advantage to extend them up to the Nepal border. These are as yet concepts awaiting techno-economic investigation and study of the waterway, freight offerings and

comparative cost advantages in relation to other modes of transport by road, rail and pipeline or inter-modal transfers.

In the matter of irrigation works, Nepal has a point when it argues that, being a late starter, it has had to yield to prior appropriations by India. Since the bulk of its irrigable land is in the Terai, where regulation and diversion of the larger rivers would require a major and somewhat unaffordable effort for Nepal to bear on its own, it seeks a measure of indulgence in developing the medium-small rivers which it can independently harness. The point is well taken and is amenable to resolution, with India developing alternative diversions or transfers or groundwater resources as replacement works. Such works could be jointly planned if necessary and would enable Nepal to maximize its irrigation potential. If this requires an informal grouping of transboundary rivers to service given zones, or the creation of something like a boundary rivers commission to oversee water development and usage and reconcile differences, such institutional arrangements could be made.

ENVIRONMENTAL CONCERNS

The environmental impacts of water resource projects, especially in the Himalaya, will require careful assessment and cost-benefit analysis in human and material terms. There could be problems ahead in view of national and global environmental sensitivities regarding displacement and rehabilitation of affected populations, loss of forests and biodiversity, effects on cultural property, health aspects and, not least, dam safety in view of high Himalayan seismicity. There may also be certain ecological impacts specifically associated with the construction phase, including the import of labour, road construction and so forth. The cautions are well taken. But the whole issue can and has sometimes been raised to an emotional pitch defying reason, retreating into nostalgia and questioning the very need and 'pathway' of development.

This has been witnessed in the sharp international controversies over the Aswan High Dam and, lately, the Sardar Sarovar Project on the Narmada and the Tehri Dam on the Bhagirathi (Ganga) in India (Verghese, 1994). Even more recently, there has been criticism of Nepal's 201 MW run-of-the-river Arun-3 which entails the construction of a long approach road into the Himalayan interior. The alternatives suggested should of course be considered. But often these do not measure up to the need or are less efficient and more expensive or may already have been taken into account. The eastern Himalayan region needs very substantial additionality

to overcome mounting poverty, deprivation and ecological degradation as burgeoning populations struggle to survive. Substituting less for more is in fact going to be far more environmentally destructive, improvident and destabilizing on account of increased distress migration of Malthusian refugees. This is not clearly understood, or is callously disregarded, by eco-fundamentalists who do grave disservice to their own cause.

Certain projects, large, medium and minor, might obviously adversely affect environmental and other considerations and must surely be abandoned. But this cannot be routinely said of every project, however carefully designed and implemented, and made a reason to hypothesize every conceivable disaster for which ever more safeguards have to be built in over space and time until it is made impossible. There has to be a more constructive and forward-looking approach to these issues, and industrially-advanced, high-consumption societies with temperate agro-climatic water demands and a very large part of their water resource development behind them, should pause before advising others less fortunately placed lower down the development curve to forego basic options.

All development has costs, including environmental and displacement costs. Himalayan dams also face seismic hazards. A strong anti-dam sentiment has emerged worldwide on ideological grounds. Sustainable development is, however, very different from no development, and large dams are a feasible proposition given careful project designs, catchment area treatment, compensatory afforestation, caring rehabilitation programmes, a concern for equity over space and time, and sound implementation and management practices. There should be no giving in to eco-fundamentalism based on romantic evocations of an imagined past, rather than on hard ground realities. Much has been learnt from past experience, and previous failures cannot be mechanically extrapolated in envisaging future outcomes.

The Himalaya represents a critical global watershed with a fragile ecosystem which must be developed appropriately to provide opportunity for its inhabitants if it is to be saved. The massive investments that go with water resource development could provide the necessary inputs and organization to make this possible. Hydroelectricity could be to Nepal, Bhutan and the Indian Northeast what oil is to the Gulf.

The hills and plains are interactive systems and both can benefit from integrated planning. With the opening up of roads and communications there is no reason for isolated mountain communities to grow cereals and decimate the forests for fuel and fodder. Storages can moderate floods and irrigate the plains, produce from which could feed the hills which should

be enabled to make a transition to more eco-friendly horti-silvicultural cropping patterns for which they are admirably suited. Availability of cheap electricity could also assist in a gradual move away from firewood and encourage agro-processing and ropeways.

Environmental factors should certainly not be disregarded but should equally not be exaggerated beyond their true worth. In fact, the net environmental outcome of any well-conceived and well-executed project should be positive. Some fetishes need to be discarded. Land-for-land need not be the sole or principal means of compensation or rehabilitation. In many South Asian situations there is little surplus land for relocation. Where available, it should of course be relied upon, but the prime mode of resettlement and rehabilitation should be through training and employment, with the cash compensation being used as seed money for investment and entrepreneurship.

The dichotomy between the catchment and command area must be ended. Hitherto, most costs have been debited to those living above the dam with much of the benefits going to those downstream. The area development impact of water resource projects can be exploited to transform the upper catchment area as much as the command area, and it should be possible to institutionalize arrangements whereby downstream benefits through irrigation, flood moderation and power sales carry a cess for funding upper catchment development, thus making dams more a bridge than a divide between catchment and command.

Far from causing ultimate ruin to remote valleys that have traditionally suffered neglect, water resource projects could therefore be their salvation by bringing in the infrastructure and investments that enable them to progress and prosper. All over the mid-Himalaya today, environmental degradation and the burden of increasing numbers of people and livestock are sending streams of able-bodied migrants down to the plains in search of food, work and opportunity. This trend has to be arrested and reversed through a new approach to hill agriculture and development for which water resource projects provide an ideal entry point and trigger.

The concern about seismic risks is justified. The Himalaya is one of the youngest mountain formations in the world, very fragile, and still growing as the Indian tectonic plate continues to thrust under the Eurasian mass, forcing it to crumple, fissure and slip in orogenic labour. The region is highly earthquake-prone and all structures must therefore be designed to withstand the stresses that might be caused by what is determined to be the maximum credible earthquake that could occur during the life of the dam. If the project remains viable and is implemented with due care, it must be

allowed to go ahead. No one can ever guarantee against the last degree of risk in any human endeavour, and all life and progress would come to a near standstill were this to be a mandatory criterion for action. All decisions assume a level of assurance and residually-acceptable risk, and dam construction in seismic zones, with higher safeguards built into the design can be no exception.

The eastern Himalayan region is rich in biodiversity and has some fine stands of prime forest. These natural assets must be preserved and scientifically exploited. Where disturbed by human intervention or submerged under dams, the same cost-benefit calculus must apply and gene banks, biosphere reserves and wildlife sanctuaries established to ensure against unrequited loss. Given zones or stretches of river and tributary streams may be preserved in pristine purity in designated wilderness areas. All this is possible. But there would need to be an overwhelming justification to bar whole regions from limited, controlled and benign intervention. Exclusively run-of-the-river development may not suffice as storages are required not only to correct seasonal and spatial imbalances, but to generate additional cheap peaking power and provide for pumped storage where feasible.

AUGMENTING THE GANGA

The Farraka dispute may appear more intractable but is equally capable of resolution. It would, however, first be necessary for both sides to overcome certain mental blocks and adopt a more rational approach, looking at a broader canvas than just water so as to allow for multiple trade-offs to mutual benefit. India has somewhat peremptorily dismissed Bangladesh's water requirements for its south-western region as being unduly exaggerated. Bangladesh (like East Pakistan before it) has similarly tended to read sinister meaning into Farakka diversions as less intended to benefit Calcutta port than to hold Bangladesh to ransom, and to interpret India's pleas for augmentation from the Brahmaputra as an attempt to gain similar control over that river. Further, Bangladesh has been somewhat simplistic in supposing that the two sides have only to agree on a series of Himalayan storages to augment the lean flows of the Ganga at Farakka for Nepal to readily fall in with the proposal. India has been no less facile in claiming that there is virtually no scope for augmentation from the Ganga at any time and that it will need all the releases from future storages for its own beneficial uses.

The ground realities are rather more complex. The fact is that Farakka

has worked. It has improved drafts at Calcutta port and reduced salinity and bore tides. However, the potential for further improvement is nearly exhausted, and were even better drafts to be achieved, the size of vessels visiting Calcutta would be limited to a little more than at present by the dimensions of existing dock gates and the river's bends and bars. When the Farakka barrage was commissioned, it was believed that up to 14 years of flushing might establish a stable fairway which could perhaps be subsequently maintained with reduced headwater diversions from the Ganga. Two decades later, the time has come to conduct model experiments to test these assumptions and see whether, and by how much, diversions can be reduced during the lean season without impairing the efficiency of the port.

With the changed character of international shipping, involving large bulk carriers and tankers and containerization, all river ports have moved nearer the sea. Haldia has grown from an auxiliary port to becoming the major partner, with vessels lightening and topping-up there (or elsewhere) on their way to or from Calcutta. Another satellite port is now planned on the lower Hooghly opposite Haldia at Kalpi to handle four to five million tonnes of traffic. With the restoration of the Ganga waterway through the Farakka navigation lock, Calcutta has the makings of a great inland water port rather than an ocean terminus with containerized barge-trains moving up and down river and even along the coast, serving a vast hinterland as part of a new inter-modal transport network.

Decongestion and decentralization of the port up and down river could resuscitate the Calcutta metropolitan area and give it fresh impetus as a nodal distribution centre and resurgent industrial hub.

Further savings of the Ganga water should be possible over time through improved irrigation efficiencies in upland reaches from the current 40 per cent (average) to something nearer 60 per cent, which is the national objective. Likewise, there is scope for conservation through bulk retailing of irrigation supplies from lower outlets through water-user associations and by rotational releases, volumetric pricing, agrarian reform (including consolidation of fragmented holdings), changed cropping patterns and crop calendars, greater groundwater and conjunctive use, and better maintenance and modernization of irrigation systems. None of these is going to be achieved in a day, but will be a process spread over time, in India as much as in Bangladesh. Exploratory drillings to confirm the deep aquifer hypothesis should also be undertaken so that this possibility, if established, becomes part of an overall water resource development strategy.

Meanwhile, it should be possible to augment flows below Farakka (without necessarily setting any firm figure or given source) from new storages in Nepal as and when they materialize, especially from the Kosi. Any Sapta Kosi High Dam, currently under negotiation, would store waters surplus to India's immediate needs, while further Himalayan storages could add incrementally to augmentation possibilities below Farakka.

This is not to suggest that India has been disingenuous in laying claim to more water from such storages. Its requirements within the basin are indeed growing, and the National Water Development Agency is working on a National Water Perspective Plan or National Water Grid to transfer the flood surplus waters of the Ganga system west and south to meet the substantial water storages already evident and steadily growing in those parts of the country (with supplementation). However, significant trans-basin diversions may not materialize before 20–25 years, and any national grid, incrementally developed, is likely to take from 50 to 100 years to complete. To some extent, therefore, India's current conservatism in regard to immediate commitments for augmented releases below Farakka is related to more distant prospects in respect of which it desires to keep its options open.

Nor is this to say that India is unmindful of Bangladesh's needs, but it feels that these can well be met from the far larger Brahmaputra which runs totally waste into the sea. Considering that the Brahmaputra and Barak/Meghna account for almost a third of the combined run-off of all the rivers in Nepal, Bhutan, India and Bangladesh, this is not a consideration that can be lightly set aside. The solution lies in marrying the two approaches.

Bangladesh has long toyed with the idea of constructing barrages on the Ganges and Brahmaputra in order to divert such bank storage or pondage as might be feasible within its own territory. Opinions on the feasibility and need have varied and there was never any firm decision. Easier options have been developed through groundwater use and river-lift pumping. With rising population and increasing agricultural requirements, there is growing pressure on Bangladesh to utilize more effectively its available water resources. It was this reasoning that impelled its Water Resource Minister to propose in 1987–88 an overall water sharing agreement with India covering all rivers, primarily to enable it to design a structure on the Ganges to divert a quantum of water that might be realistically available for the service of the south-west region.

Bangladesh's National Water Plan, 1985–2005, prepared by the Master Plan Organization (1986) in collaboration with foreign consultants, suggested a three-phase water resource development programme to provide

an additional 3.52 m ha of irrigation to ensure a grain output of 27.5 m tonnes by the year 2005. It envisaged intensified groundwater use and underground storage, a programme to improve the offtakes of smaller streams and channels and augmented lifting of water from them as well as from the main rivers. A third post-NWP phase would see the completion of barrages across the Ganges and Brahmaputra within Bangladesh to expand irrigation from 72 to 91 per cent of the total irrigable area country-wide.

Bangladesh is now actively preparing to commission a feasibility study for a Ganges Barrage (GB) near Pangsha with subsidiary structures to force headwaters into the moribund Gorai channel. This could be the starting point for a constructive dialogue with India regarding certain minimum guaranteed flows to meet the designed requirements of the proposed barrage for irrigation and salinity-control in the south-west region during the critical lean season. A movement from generalized claims and demands to projectized uses for quantified benefits could for the first time lend specificity to hitherto open-ended discussions.

India should be willing to assure Bangladesh requisite releases below Farakka to operationalize its Ganges Barrage when completed, with a sharing agreement during the interim period. It should also be willing to share its technical experience with regard to the design, construction and operation of the Farakka Barrage which Bangladeshi engineers would find of value.

As a quid pro quo, Bangladesh should be willing to offer India transit rights by road and rail from the Indian Northeast to Chittagong, with the further assurance of discussing collaborative arrangements for harnessing the waters of the Barak/Meghna and the Brahmaputra to their mutual benefit, while fully safeguarding its own interests.

India is readying to commence work on the Tipaimukh High Dam on the Barak, at the trijunction of Mizoram, Manipur and Assam. This will have an installed capacity of 1500 MW, store over 9000 million m^3 of water (live), and provide a considerable cushion for moderating floods in Assam (Cachar) and Bangladesh (Sylhet). The tail-race waters will be trapped at a barrage at Fulertal, 100 km downstream, to irrigate large areas in Cachar and, if so desired, in Bangladesh. Improved river drafts would benefit navigation along an extended waterway from the far end of the Tipaimukh reservoir to Calcutta via Bangladesh along the existing international IWT route. An offer of joint collaboration in developing the Tipaimukh project has been made to Bangladesh.

The purpose of Bangladesh's Brahmaputra barrage, envisaged under

the National Water Plan, is not merely to irrigate the area commanded but also, in time, to divert Brahmaputra surpluses into the Ganges through an internal inter-basin transfer. The logic of such a transfer is admitted and establishes the need and practicality of a Brahmaputra-Ganges link in principle. The favoured site for a Brahmaputra barrage in Bangladesh is at Bahadurabad from where a transfer could be made to the Ganges above the proposed Ganges Barrage by gravity flow through existing spills and link channels, thus minimizing ecological hazards and displacement. All this is subject to detailed investigation and environmental impact studies. However, it does establish a conceptual basis for discussion.

The Farakka Barrage influences no more than 20 per cent of the arable area in Bangladesh, and the Ganges Barrage, lower down, would serve even less. The upper Ganges basin in Bangladesh is drained by the Mahananda and other streams, while about 65 per cent of the cultivated area of the country falls within the Brahmaputra and Meghna basins which are also in need of flood protection and irrigation. At one stage, Bangladesh had pinned large hopes on an autonomous solution by embanking all its rivers with controlled flooding within polders in a 25-year, $25 billion Flood Action Plan (FAP) that was conceived after the devastating 1988 floods. A series of 26 studies spread over three years at a cost of $145 million has been followed by proposals for further studies. The FAP concept has aroused considerable controversy and opposition on a variety of counts and it is an open question as to how much of it will ultimately materialize.

OPTIONS AND TRADE-OFFS

It is against this background that a number of options for meaningful Indo-Bangladesh collaboration can be constructed, with the proposed Ganges Barrage as the starting point. While it would be mistaken to push any comparison with the Indus Water Treaty beyond a point, it is possible to draw on that analogy to conceive of a water concord embracing the eastern Himalayan rivers, with a transitional period for undertaking works to augment lean-season availability below Farakka from the Ganga itself and by increasing replacements from the Brahmaputra. Such a long-range integrated water plan with joint development and management of certain key elements could be subject to an international treaty. Such an arrangement could be underpinned with international funding and technical assistance to the extent required.

All this would require the development of an optimized basin plan in

phases in accordance with certain priorities. The proposed Brahmaputra Barrage could divert certain quantities of water to the Ganges Barrage from which a canal could perhaps also lead into India to irrigate parts of the region east of the Hooghly. Storages in the Brahmaputra basin (Dihang 20,000 MW, and Subansiri 4500 MW) in Arunachal would moderate floods in Assam and even in Bangladesh by holding enormous quantities of monsoon flows for diversion during the lean season without depleting the natural flow of the Brahmaputra. India had in 1978 proposed diverting some of this water from a barrage at Jogighopa in lower Assam, through Bangladesh and into the Ganga above Farakka. Bangladesh had strongly opposed that giant link canal. That suggestion stands withdrawn. However, Jogighopa is a favourable barrage site from where Brahmaputra waters could be diverted within India itself to India's Teesta Barrage and canal system and thence to the Mahananda barrage along a planned alignment. But, it could also be diverted into Bangladesh to augment its Teesta project, and thence further south-west to feed other streams in the relatively drier part of northern Bangladesh before falling into the Ganges Barrage. This would augment and improve irrigation, navigation and fisheries in Bangladesh, and could be conceived of as a joint project with cost-benefit projections and environmental studies to establish its feasibility. A Jogighopa-Bangladesh diversion could be an additional interbasin link or may even take priority over the Brahmaputra Barrage should it appear to be more cost-effective.

Going further west, both India and Bangladesh have constructed barrages on the Teesta to irrigate large tracts for which there is insufficient water during the lean season. Apart from a possible Teesta High Dam in the Darjeeling district in West Bengal, which would augment Teesta flows, there are possibilities of diverting some of the surplus monsoon flows stored behind the proposed Sunkosh Dam (1525 MW) and any subsequent Manas Dam (both in Bhutan) into the Teesta and Mahananda.

Within the Ganga basin itself, a Sapta Kosi High Dam would save the existing Kosi barrage, moderate floods and provide increased irrigation in the Nepalese Terai in North Bihar (given better drainage in the Kosi command). It would generate a large quantum of power to lift water and promote industrialization within Nepal and north Bihar. It would also be in a position to augment the lean season flows of the Ganga below Farakka whose pondage extends almost to the Kosi's confluence with the Ganga.

The potential of even now constructing a left bank irrigation canal from Farakka into Bangladesh is another possibility that merits techno-economic examination. This would command large areas above the projected

Ganges Barrage, and could even obviate its construction if the Farakka-Bangladesh link could empty into the Gorai to service the south-west region around Khulna. The Farakka-Gorai link could, in those circumstances, be managed as a joint project under an international agreement.

Indian critics might exclaim that were these proposals to fructify, they would entail major concessions to Bangladesh for little gain. Not so. Partition converted India's Northeast into a virtually landlocked region, the third in South Asia after Bhutan and Nepal. This is the governing reality of that otherwise rich region which faces immense problems of development, integration and security on account of its geo-political isolation. It seems absurd to think of a Rs 450 crore rail link to Agartala, the capital of Tripura, over 2300 km from Calcutta, when the Bangladesh railway and highway lie just 4 km across the border, barely 150 km from Chittagong. The Northeast's supply centres and markets lie in and through Bangladesh which could provide outlets for its plantation products, and hydro and gas surplus. The development of the full potential of the Northeast and access to its wealth would be greatly facilitated by cooperation with Bangladesh. The cost of non-cooperation is high and growing.

Bangladeshi critics who may feel that they might be conceding too much would be equally mistaken. The country has a great deal to gain from cooperation with India. It has a market in the Northeast and needs the larger Indian market. It could use cheap Northeastern hydropower and cannot fully develop its land and water potential without Indian cooperation. The grant of transit facilities to the Indian Northeast would augment employment, revenues and infrastructure which would open up new investment opportunities as well. India is willing to upgrade and augment the capacity of the road, rail and navigation links it might use in Bangladesh as well as Chittagong port. This would again create new investment opportunities, including joint ventures with India.

The employment generation implicit in such cooperation is most important for Bangladesh and no less for India which otherwise must face the prospect of a continuing, and even growing, influx of distress migrants from Bangladesh. On every count, the mutuality of interest is very strong.

The opening up of a road and waterway from Mizoram to Chittagong through the Chittagong Hill Tracts could promote development in this backward and troubled tract and encourage the Chakma refugees now in Tripura to return home to a more assured future. Transit rights for India by road, rail and inland waterways and for gas and electricity transmission could be linked to similar rights for Bangladesh through India to Nepal and Bhutan.

The agreement on Indo-Myanmar border trade (and, in due course, a similar agreement between Bangladesh and Myanmar) is likely to stimulate development on both sides, leading ultimately to trade linkages between Yunnan, Szechuan and Tibet in south-western China and Thailand with the eastern region of South Asia. Road, rail and water connections are being forged that could knit ethnic cousins within the middle-lower Ganga, Brahmaputra, Irrawaddy, Upper Yangtze, Salween and Mekong basins into an emerging economic community.

The huge hydro potential of these hitherto remote basins and their immense biodiversity mark them out as future growth centres. Not least among the treasures of this region is the fantastic 50,000–75,000 MW hydro potential locked in the great U-bend of the Brahmaputra as it cascades down 7500 feet from the Tibetan plateau to the Indian plains of Assam.

CONCLUSION

The past should not be allowed to become the enemy of the future. Cooperation in the harnessing of the eastern Himalayan rivers is far removed from being a zero-sum game. There are great prizes in store for all the players in the region. Mechanisms for investigation, implementation, management and conflict resolution can be devised and there are a variety of non-water related trade-offs that could be negotiated to ensure that all the parties have something tangible to show to their people. Investment costs will be large, but the long-term profitability of these projects is not in doubt.

India, Nepal and Bangladesh have already lost a great deal of time and cannot afford further delay in harnessing one of the great natural assets they share in common in the Ganga-Brahmaputra-Meghna system. The eastern Himalayan region constitutes the most backward part of a subcontinent that is itself weighed down by poverty. The basic requirements of food, water, energy and employment have to be met to insure against hunger, disease, environmental degradation and distress migration and provide its large and growing population with a better quality of life.

The differences that have come in the way of regional cooperation are based on past grievances, possibly more imagined than real in some cases. These have diverted attention from present and future opportunities. Since the basic divide is more political than technical, it would be desirable to take a holistic view of overall relations instead of looking for purely

engineering solutions. The appointment by the Prime Ministers of high level special envoys in place of departmental functionaries, who would be able to negotiate bilaterally across the board and explore a variety of trade-offs and options, could provide a mechanism for meaningful discussions. These envoys would need to be persons of standing who command wide public confidence and can speak for the government as a whole and keep in touch with all strands of national opinion so that whatever solutions are worked out enjoy a wide consensus. As the issues involved have got highly embroiled in domestic politics in all three countries, they must be addressed in a non-partisan manner as national questions. All sides are likely to discover that certain intractable national problems have regional solutions.

Nor need India be unrelenting in its insistence on bilateralism. In practical terms, most of the discussion will primarily be bilateral. But if keeping the third party informed precludes room for misunderstanding and could reinforce the will to constructive action, there is no reason to back away from wider consultation even if it is informal. India's very size awes its smaller neighbours. They cannot 'gang-up' against India, but might jointly be persuaded to act more boldly for the common good. In all these matters, India will lose nothing by dealing generously with its partners. What it can gain through regional cooperation is likely to outweigh the seeming 'concessions' it may be called upon to make initially. A basin approach, coupled with joint consultation, would enhance transparency and greatly facilitate international funding and support.

In course of time, it is very probable that a series of interlocking bilateral agreements could be the making of a regional mechanism which could be given more formal shape as and when necessary, even extending to China. SAARC (the South Asian Association for Regional Cooperation), has so far excluded contentious bilateral issues from its purview. But once water resource cooperation gets under way, SAARC itself could become a forum for dovetailing this into a wider framework of overall cooperative development.

The moment is opportune for a new beginning. The path of economic liberalization on which the nations of the region are embarked has also opened up opportunity for private initiatives in water resource development. If India, Bangladesh, Nepal and Bhutan can agree on developing the potential of the eastern Himalayan rivers, the world will not hold back in assisting a concord that could ensure the well-being of a tenth of mankind.

APPENDIX

Conversion Table

Water flows and volumes can be expressed in foot-pound or metric measures. Both are used in South Asia, though India has switched to the metric system. Both measures have been used in this essay, depending on the original source.

Water is volumetrically measured in cubic metres (m^3), hectare-metres, cubic kilometres (km^3) or acre-feet; water flow is expressed in cubic metres per second (cumec) or cubic feet per second (cusec).

The following are foot-pound equivalents of metric measures:

One hectare (ha) is 2.47 acres.
100 hectares make a square kilometre (km^2).
One cubic metre equals 35.315 cubic feet.
10,000 cubic metres make one hectare-metre.
One million hectare-metres equal one cubic kilometre.
1233.48 million cubic metres equal one million acre-feet.
One hectare-metre equals 8.107 acre-feet.
One cumec equals 35.315 cusec.
One litre is equivalent to 0.22 gallons.

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