

IRLP or the Ecological Approach to Rivers?

This paper begins by summarising the criticisms of the Indian River Linking Project expressed by scholars from India and other countries of the subcontinent. It then asks the question as to why this project has been launched despite apparent weaknesses. The paper shows that IRLP is a culmination of the commercial approach to rivers that sees rivers as objects to be “conquered” and “consumed”. The paper notes that time and experience have made this approach outmoded, and a new, ecological approach towards rivers has emerged. According to this approach, rivers should be appreciated for what they are, i.e., as progenitor of various ecosystems and cultures. The ecological approach encourages harvesting river resources in a way that does not affect fundamentally the natural course and flow of rivers and the ecosystems and cultures they sustain. The paper notes that, in view of their strong tradition of reverence towards rivers, the people of south Asia can play a prominent role in championing the ecological approach.

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I Indian River Linking Project: A Brief Introduction

The Indian government has recently unveiled a mammoth project to interlink the rivers. Under this project, both the Himalayan rivers and the peninsular rivers will be connected among themselves, and these two river systems will also be connected with each other. The basic premise behind the project is that some river basins are surplus in water while others are deficit, and hence interconnecting them will help better utilisation of the rivers by allowing transfer of water from the surplus basins to the deficit ones. The project envisages transfer of 334 billion cubic metres of water through construction of 30 inter-river links, involving 36 big dams, 94 tunnels, and 10,876 kilometres of canals. The preliminary estimated cost of the project varies between \$ 125 and \$ 215 billion, depending on the source [for basic information on IRLP, see Dhungel and Pun 2004, Khalequzzaman et al 2004 and Hossain 2004b].

Indian River Linking Project (IRLP) is the largest river intervention project ever conceived. In terms of its scope, it defeats even the Three Gorges Project of China (TGPC), which, however big, represents intervention in one river (the Yangtze). In contrast, IRLP proposes simultaneous intervention in several major rivers of the world, such as the Ganges and the Brahmaputra. A second important difference between TGPC and IRLP is that while the former concerns a river that lies entirely within the boundary of the country undertaking the project, the latter involves rivers that are transboundary and hence seriously affects the co-riparian countries. If implemented, IRLP is likely to have serious impact on the ecological landscape of several sovereign countries, including Bangladesh, India, and Nepal.

Historical Background

Some have traced IRLP to ideas expressed in the past. For example, during the British rule, around 1839, Arthur Cotton proposed to use rivers as the major means of inland transportation in India rather than to construct railways. In the more recent period, around

1972, K L Rao the Indian water minister, spoke of a national water grid focused on the Ganges-Cauvery Link.¹ Similarly, around 1974, Captain Dastur put forward the proposal of a garland canal connecting the rivers.² However, upon close scrutiny none of these ideas was found to be sound enough to deserve further attention, and hence these were shelved [Sinha 2004 and Iyer 2002].

The government of India published National Water Resources Perspectives in 1980 and in 1982 it established the National Water Development Agency (NWDA). Over the two decades between 1982 and 2002, NWDA conducted many studies and submitted many reports to the ministry of water resources, but did not pursue the idea of river linking.

The idea of interlinking rivers got suddenly revived when the Indian president A P J Abdul Kalam made a reference to it in his speech on the eve of India's independence day in 2002. Following his speech, Ranjit Kumar, an Indian Supreme Court advocate, filed a public interest litigation in the Indian Supreme Court, whereby the court passed a directive to the Indian government to interconnect the rivers by 2016.³ Following the court order, the then BJP-led National Democratic Alliance (NDA) government of India formed a task force to implement the river linking idea. The task force fleshed out the idea in the form of IRLP and started working on it.

The new, Congress-led United Progressive Alliance (UPA) government that came to power following the defeat of the NDA government in the 2004 general elections, promised to review the IRLP. However, it now seems that the UPA government also intends to proceed with IRLP. In January 2005 it replaced the earlier task force by a high powered inter-ministerial committee, which is now moving forward with the peninsular links and the Ken-Betwa and Parbati-Kalisindh-Chambal links of the Himalayan system.

II Civil Society's Response to IRLP

Lack of Information

It is interesting that IRLP is one of those rare projects the opponents of which are providing more information and analysis than its proponents, at least in the public domain.⁴ It has been

actually one of the criticisms of IRLP that the task force set up for its implementation did not provide enough information for the people to judge the feasibility and merit of this project. This is not a trivial criticism. Given its enormous scope, it is inappropriate for decisions on IRLP to be taken by a narrow circle of people without adequate public discussion based on shared information. The withholding of information is particularly inappropriate for a democracy like India.

The absence of information is more acute for the Himalayan part of the project than for its peninsular part. This is a serious lapse, because while the latter can be portrayed to be an “internal matter” of India, the former is clearly of ‘transnational’ consequence. Furthermore, it is the Himalayan part that is the lynchpin of IRLP, because water augmentation even in peninsular India is to come about from water transferred from the Himalayan rivers. Given this fundamental difference between the Himalayan and peninsular parts, one would expect more information sharing and transparency with regard to the Himalayan part, in order for both to vindicate the soundness of the project and to assuage the concerns of the neighbouring co-riparian countries.⁵

Criticisms of IRLP

In absence of the information, which IRLP implementing agencies were obliged to provide, the opponents of the project have tried to marshal, on their own, as much information as was possible, given the constraints. Displaying considerable maturity of the Indian civil society, Indian scholars and activists themselves have taken the lead in criticising IRLP. Several internet based discussion groups have emerged. A good number of seminars and discussion meetings have been held in India leading to publication of monographs and edited volumes.⁶ An International Conference on Regional Cooperation on Trans-boundary Rivers (ICRCTR) was held in Dhaka, Bangladesh, on December 17-19, 2004, focusing on possible impacts of IRLP. This conference, which drew large participation of scholars and activists from India and other countries of the subcontinent, as well as from the rest of the world, led to the publication of a volume [Ahmed et al 2004] containing about 50 scholarly papers addressing the subject. As a result of this intense intellectual activity, going on for about two years now, the weaknesses of IRLP have become quite well known, and these can be summarised in the following nine points.

(i) *Erroneous basic premise*: IRLP’s basic premise, according to which certain river basins are surplus while others are deficit is unsound, because each river, over geological eons, has given rise to a specific ecosystem and culture in its basin. Specific to its ecosystem and culture, a particular river’s water is neither ‘surplus’ nor ‘deficit.’ Any large-scale transfer of water from one basin to another cannot but irreparably affect the ecosystems of both the basins.

(ii) *Faulty concepts*: The concepts of ‘surplus’ and ‘deficit’ are relative and not absolute. In particular, they depend on demand and supply side conditions. On the demand side, a water-sufficient agricultural region producing wheat may become water-deficit if it wants to grow rice. A water-deficit industrial enterprise can become water-sufficient if it decides to recycle the water that it uses instead of just discharging it. An otherwise water-sufficient township can become water-deficit if its households want to have private indoor pools. On the supply side, a water-deficit village can become water-sufficient if it implements a successful rainwater harvesting programme. A water-sufficient agricultural programme based on groundwater can become water-deficit if it does not care for adequate replenishment of the

groundwater aquifers. Therefore, simple augmentation of river water may not solve the perceived deficit in a particular area and may even aggravate the problem by encouraging wasteful use. Furthermore, there may be other ways to augment local water supply than to transfer water from a far away river.⁷

(iii) *Doubtful technical feasibility*: Even if certain river basins are thought to be ‘surplus,’ and it is agreed in principle to transfer part of its water to another basin, the actual transfer may not be a technically sound proposition. This seems to be particularly true with respect to transferring water from the Brahmaputra, which according to IRLP is the surplus basin, to south and west India. With Bangladesh not agreeing to such a transfer, India can do so unilaterally only by having the canal pass through her ‘goose neck,’ (the narrow passage between Bangladesh and Nepal that connects the rest of India with her seven north-eastern provinces) and cutting across such major river basins as of Teesta, Dharla, Mahananda, and Atrai. Such a trajectory will accentuate the engineering at cross-purpose with engineering problem that is endemic with most of the link canals envisaged by IRLP. Capital created by IRLP will annihilate a lot of capital already in place in the form of water development structures and other infrastructures. The project will also entail the problem of engineering begetting engineering.⁸

(iv) *Doubtful financial feasibility*: Even if all the engineering might be marshalled and the proposed dams-barrages-reservoirs-lifts-tunnels-canals are actually built, the benefits of the project may not justify the financial costs. IRLP is claimed to expand irrigation by 35 million hectares and generate 34,000 MW of additional power.⁹ However, most of the hydro-power generated will actually be spent up in lifting water across hills and mountains, so that there will be little, if any, net gain in power supply. So far as irrigation is concerned, previous record shows that publicly financed surface water irrigation projects led to misdirected crop choice and waste in the short run and problems of waterlogging and salinity in the long run. Hence, financial benefits from expansion of irrigation to be achieved through IRLP are doubtful.

(v) *Doubtful flood mitigation*:¹⁰ IRLP’s flood mitigation effects are doubtful too. Flood mitigation through inter-basin transfer in South Asia is made difficult by the fact that the months of heavy precipitation (from south-westerly monsoon winds) are basically the same for all parts of the region.¹¹ Meaningful flood mitigation would therefore require storage of monsoon water in the east on such a huge scale that is difficult to achieve.¹² Also, there is much misconception regarding flood. Overflow of river water on its flood plains is a normal natural phenomenon. In fact, such overflow is necessary for the economy and ecology of the flood plains, and should not be obstructed.¹³ Ironically, much of flood aggravation in recent period has been caused by ill-conceived attempts to prevent such overflow. Thus instead of transferring water through IRLP, the best way to mitigate flood is to remove the structures that separate river channels from adjacent floodplains.

(vi) *Doubtful economic feasibility*: The benefits of IRLP will fall short when broader economic costs are taken into consideration. Among these are the costs of annihilated capital, costs arising from obstruction to flows of water, people, animals, etc, costs of land and forests being used up, the costs from displacement of people, costs from the damage done to the livelihood of the people in the donor basins and of the people living in the downstream areas. More importantly, economic cost benefit analysis will require consideration of opportunity costs of the resources to be used up in the project.

(vii) *Irreparable ecological damage and other non-economic costs:* The benefits of IRLP will certainly fall short of the costs if the damage done to the ecosystems and cultures and other non-economic costs of the project are taken into consideration. As mentioned earlier, each river gave rise to a unique ecosystem in its basin, with its unique flora and fauna, and unique material and spiritual culture of the people who live in that basin. The diversity of ecosystem and culture has a value that cannot be measured in economic terms. The damage that IRLP will do to this diversity is therefore too great to justify the financial and economic benefit that this project may yield.¹⁴

(viii) *Exacerbation of conflicts:* IRLP will proliferate and aggravate interstate conflicts that already exist within India over river-sharing. More importantly, IRLP will aggravate conflicts among co-riparian countries of south Asia. Water diversion from the Ganges by India at Farakka is already a serious obstacle to improving the relationship between India and Bangladesh. Additional transfer of water from the Ganges and the Brahmaputra, as envisioned by IRLP, will poison this relationship further.¹⁵ Aggravation of such bilateral relationships has real economic costs. For example, absence of a warmer relationship between Bangladesh and India is costing these two countries in terms of missed opportunities in transportation, use of natural resources, trade, etc.¹⁶

(ix) *Unintended consequences and possible redundancy:* A major river-intervention project such as IRLP cannot but have many unintended consequences of negative nature. Many of the dams and reservoirs of IRLP are to be built in seismically active regions of south Asia. The Indian Ocean earthquake of December 2004 gives some indication of the terrible consequences that may follow if dams of IRLP crumble under the impact of earthquakes. More importantly, climate changes resulting from global warming and other such processes can soon make IRLP's calculations obsolete. Hundreds of billion dollars of investment, which could have been directed to more worthy causes, can then become simply redundant.¹⁷

The proponents of IRLP can dispute the quantitative dimensions of these criticisms. However, it is difficult for them to deny their qualitative validity. Also, given that IRLP-proponents are opaque about quantification of their own arguments, it is unbecoming on their part to complain about precise quantitative dimensions of these criticisms.

III Philosophy behind IRLP

Given the above listed weaknesses of IRLP, why was it then proposed, why is it being pursued, why the Indian president, Abdul Kalam, continues to be one of its most enthusiastic champions, and why the learned judges of the Indian Supreme Court thought it right to issue a directive to implement the mammoth IRLP in just 10 years?

Commercial Approach to Rivers

All this could happen because of a philosophy regarding rivers that is prevalent among the elite of developing countries. This philosophy, which is basically a product of the industrial commercial era, finds its embodiment in the commercial approach to rivers. The main feature of industrialisation is substitution of manual power by machine power. Availability of machine power resulted in a qualitative leap in human ability to 'deal with' the nature. Using a commonplace expression,

industrialisation enabled human beings to 'conquer' the nature. Early industrialising societies embarked on this conquest with considerable gusto.

One of the nature's objects which became the target of the human industrial might is rivers. Reflecting the commercial underpinnings of industrialisation, rivers were considered as a resource to be utilised in a commercial sense. This gave rise to the attitude that "any river water passing to the sea is a waste". It is not surprising that the commercial approach to rivers and its associated philosophy found its most energetic implementation in the US, the pre-eminent industrial country. The fate of the Colorado river provides the quintessential example of the commercial approach put to practice. This fabled river has been so thoroughly dammed and abstracted that it now dries up in the south Californian desert and fails to reach the sea. Thus every drop of the river water has been used up, either for boosting agricultural production in central California, for sustaining casinos of Las Vegas, or for expansion of settlement in the deserts around Los Angeles. Human beings have thus conquered the Colorado river by literally 'consuming' it up.¹⁸

The commercial approach to rivers was not limited to capitalist industrial countries. Even countries following the socialist model of industrialisation embraced this approach in their eagerness to outpace the capitalist world in terms of production and industrial accomplishments. Thus the former USSR dammed and diverted significant amount of water from the Amu Darya and Syr Darya rivers in order to promote cotton cultivation in the steppes of Kazakhstan. There was also the talk of reversing the northward flows of the Siberian rivers, Ob, Yenesee and Lena, in order to use these flows for production purposes.

With such examples in place in developed industrial countries, it is only natural that developing industrialising countries rushed to emulate. Thus China built numerous dams, so much so that she alone now accounts for about half of all large dams in the world. In the south-Asian subcontinent there was almost a competition between India and Pakistan about who had the taller and mightier dam. Egypt constructed the massive Aswan dam on the Nile. All over the world, there was a wave of dam and barrage construction and of abstraction of water from natural river flows. This enthusiasm to conquer rivers continues to this day, primarily in developing countries. Thus China is going ahead with her Three Gorges Dam Project. The Indian River Linking Project is a logical culmination of the commercial approach.

In view of this dominance of the commercial approach to rivers, it is not surprising that the scientist president of India has become a champion of IRLP. To him IRLP probably appears as a great application of science and technology in the service of the people. The dominance of the commercial approach also explains why the learned Indian Supreme Court judges accepted the merit of IRLP so unquestioningly and went to such an extent as to issue a directive to the government not to consider the project but to implement it, and that too within a very tight time frame.

Cordon Approach

In areas where rivers pass through flood plains, the commercial approach takes a particular form, which is best called the cordon approach. Under this approach, flood plains are cordoned off from river channels by solid, unbroken embankments. This is done in complete defiance of the fact that the channel and the flood plain of a river constitute one organic whole, so that it is counter-productive to try to separate the two. This is particularly true in a delta, where free flow of water between river channels

and flood plains is crucial for the sustenance and development of a delta.¹⁹

Experience has shown that cordons are a 'lose-lose' proposition. People outside the cordons lose, because they now have to suffer more floods. However, the people inside the cordons lose too. Residents of urban cordons have to face new problems of waterlogging, sewage, etc, in addition to the perennial possibility of a Noah's deluge.²⁰ Residents of rural cordons have to face deterioration of soil quality, increased difficulty in dry season irrigation, etc. They often have to suffer actual deluge, because less attention is paid to the protection of rural cordons than to the protection of urban cordons.²¹ The nation as a whole loses, because huge financial outlays on the cordon projects ultimately prove to be counterproductive.

In south Asia, the experience of Bangladesh and various Indian states (particularly Bihar, West Bengal and Assam) confirms the generally counterproductive nature of cordon projects. By reducing the area over which the monsoon flow can spread out, cordons have increased the intensity of floods in areas outside the cordons. On the other hand, frequent breaches in the cordons are causing havoc when suddenly river water enters unprepared localities. The increased intensity of floods in Bangladesh and eastern India is, to a great extent, a result of the projects inspired by the cordon approach. It is therefore an irony that these same floods are now being used to argue for IRLP.

Commercial Approach: Colonial Heritage and Foreign Lenders

Some authors have suggested that developing countries' inclination towards dams, barrages, and cordons is a legacy of the colonial rule. There may be some truth to this view. The process of (deformed) industrialisation in today's developing countries was indeed initiated during the colonial rule. However, the source of the commercial approach is more general, and the approach continues to hold sway even after many decades of the end of the colonial rule. This could happen because of the overall dominance of the developed industrial economies in the contemporary world. It is the commercial approach to rivers that engineers of developing countries have been learning from textbooks originating from developed industrial countries. It is the commercial approach that they have been imbibing during their higher studies in developed countries. And it is this approach that they become prone to implement, upon their return in their own countries.

It is futile to look upon donors (multilateral and bilateral lending agencies) for correct directions regarding rivers. Being based in developed industrial countries, donor agencies themselves have served (at least until recently) as the carrier of the commercial approach for developing countries.²² Apart from the wrong philosophy, there is also a material reason why donors are (or at least have been until recently) the promoters or supporters of commercial approach-inspired big river intervention projects. Donor agencies have generally created a very cozy world for themselves by de-linking the repayment of their loans from the actual performance of the projects that their loans finance. The repayment of their loans is made by the central bank from the nation's overall foreign exchange earnings, no matter whether or not the actual projects perform well and contribute to these earnings. Under this type of a risk-free arrangement, donor agencies are only too happy to promote big commercial approach-inspired water projects, because these projects create for them bigger lending opportunities. It is the symbiosis of interests of donor

agencies and their direct domestic beneficiaries that often serve as the driving force behind water projects involving dams, barrages, and cordons. Narrow material interests add an additional layer to the wrong-headed philosophy to cloud the judgment of many bureaucrats, politicians, contractors, engineers, architects, economists, and other professionals, who hope to get a slice of the huge budget of the mega river intervention projects. That may also be one reason why it is proving so difficult to stop IRLP from moving ahead despite the long list of its shortcomings.²³

IV A New Approach Toward Rivers

Ecological Approach in Developed Countries

While in developing countries the commercial approach continues to be the reigning paradigm for thinking about rivers, in the developed countries, a significant shift has meanwhile taken place. First of all, a realisation has dawned that rivers have been polluted enough, as was amply demonstrated by the Cuyahoga river fire incident in Ohio in 1969. The Clean Water Act enacted in the US in 1972 and amended in 1977 started a new phase of the American treatment of her rivers and other surface water bodies. As a result of the series of activities following this act and other subsequent acts, rivers and other surface water bodies in the US are now much cleaner than they were before. A similar movement away from pollution of rivers has progressed in other developed industrial countries too.

However, the shift in attitude is not confined to river pollution. A realisation has dawned that rivers themselves need to be set free. As World Commission on Dams (WCD) notes in its report, "Momentum for river restoration is accelerating in many countries, especially in the US, where nearly 500 dams, mainly relatively old, small dams have been decommissioned. Since 1998, the decommissioning rate for large dams has overtaken the rate of construction in the US. Experience in North America and in Europe shows that decommissioning dams has enabled the restoration of fisheries and riverine ecological processes" [WCD 2000: 10]. The report further notes that, even in the 1950s, conservationists were able to resist plans to construct the 175 metre high Echo Park dam on a tributary of the Colorado river. In the following decade, conservationists were able to thwart plans for construction of two more dams on the main Colorado river in the Grand Canyon.

The movement for ensuring and restoring the natural flow of rivers has spread to developed countries in other parts of the world too. In Japan, for example, the opposition to the Nagara river Estuary dam in the 1980s sparked a nationwide movement against construction of dams. In January 2000, opposition to the Yoshino river Estuary dam led to the first ever peoples' referendum, which led to suspension of the project. The newly elected governor of the Nagano prefecture issued a declaration opposing new dam construction in the prefecture. This stopped the Asakawa dam even though construction was underway, and half of the budget was already spent. Similarly, the plans for dams on the Yodogawa river system were abandoned even though construction had already commenced. Japan has also embarked on dismantling existing dams. For example, the Arase dam on the Kumagawa river is to be dismantled in five years.

The above shifts in the attitude and actions represent a new, ecological approach to rivers. According to this approach, rivers need to be valued for what they are, namely, pro-genitors of ecosystems and cultures in their basins. Rivers need not be 'conquered' and 'consumed'. The direction and quantum of the

river flows should not be disturbed inordinately. Instead, river resources should be harvested in a way that ensures continued health of the ecosystems and cultures of the river basins.

Reasons for Rise of Ecological Approach

What are the reasons for the growing movement for restoration of natural flows of rivers in developed industrial countries? First of all, the enthusiasm for conquering nature, for demonstrating human capacity to impose its will on rivers through engineering prowess, has run its course. Human beings have 'won' over rivers, so to speak. However, victory makes it possible to be magnanimous. Once conquered, one also often laments the beauty of the vanquished when it was free! This applies not only to rivers. With the progress of industrialisation, human beings have acquired so much power over nature that in some respects nature now finds itself at the 'mercy' of human beings. The US 1969 Environmental Protection Act and the 1974 Endangered Species Act symbolise this changed relationship. This fundamental shift in the balance of power between human beings and nature has been at the bottom of the shift in the attitude toward nature, in general, and toward rivers, in particular. It is this changed relationship and attitude that have been one reason for rise of the ecological approach to rivers.

Another factor that has contributed to the rise of the new, ecological approach is disappointing long-term results of structural interventions that have been made in rivers in past decades. The World Commission on Dam Report, mentioned above, provides an extensive documentation of this disappointing outcome. Several previous works also drew attention to this fact.²⁴ In view of the deleterious effects of large-scale river intervention projects, Manibeli Declaration of 1994, signed by 326 activist groups and NGO coalitions from 44 countries, called for a moratorium on World Bank funded large dams until a comprehensive and independent review of the already implemented bank funded dam projects was completed. In fact, it was this popular resistance to large dams that, in part, led to the formation of the World Commission on Dams.²⁵

The World Commission on Dams itself conducted in-depth case studies of eight large dams across the world, two country studies (on India and China), 17 thematic reviews, and a global (cross-check) survey of 125 dams. Based on the knowledge base thus developed, it offers a detailed evaluation of the 'technical, financial, and economic performance', 'environmental performance', and 'social performance' of dams.²⁶ Among other things, it observes that "... irrigation dam projects ... have all too often failed to deliver on promised financial and economic profitability – even when defined narrowly in terms of direct project costs and benefits" (p 47).²⁷ It documents how surface water irrigation often leads to waterlogging and salinisation (p 66). The report shows that hydropower is neither clean (for example, when carbon emissions from reservoirs are taken into account) nor cheap (when all indirect costs are into consideration). WCD notes that some dams have actually "increased the vulnerability of riverine communities to floods" (p 58). Using the US as example, it shows how as more money is spent on building flood protection structures, the flood damages increase. With regard to the ecosystem, WCD finds that dams have fragmented 60 per cent of the world's river basins, and the impact on ecosystem "are more negative than positive, and they have led, in many cases, to irreversible loss of species and ecosystems" (p 93). With regard to the social performance, WCD finds that "the construction and operation of large dams has had serious and lasting effects on the

lives, livelihoods, and health of affected communities, and led to the loss of cultural resources and heritage" (p 129). The WCD report makes the important point that "the true economic profitability of large dam projects remains elusive as the environmental and social costs of large dams were poorly accounted for in economic terms". Overall, WCD concludes that whatever positive contribution dams and barrages made to development, this contribution "has been marred in many cases by significant environmental and social impacts which, when viewed from today's values, are unacceptable" (p 9).

Experience with River Intervention in South Asia

The people of south Asia do not have to go too far to be convinced of the findings of WCD. There are many dams in India, Pakistan, Nepal and Bangladesh that have resulted in the submergence of large tracts of tribal homelands. Large-scale displacements of tribal population resulting from such submergence has been a major source of tribal insurgency in many parts of these countries. Many lives have been lost, and many resources have been spent that could have been directed to more productive purposes. It remains an open question whether a true cost-benefit analysis covering all these financial, human, and environmental costs can justify whatever benefits these dams have yielded.

Similarly instructive is the experience of the Farakka barrage in India. Withdrawal of the Ganges water at Farakka is causing severe damage to the ecosystem of the downstream areas in Bangladesh. The rivers Padma and its distributaries, such as Garai, Madhumati, Arial Khan, and numerous other smaller rivers are drying up. The flora and fauna of Bangladesh's south-western districts are under threat. Many fish species have already become extinct. Salinity has intruded deep into the north. Reduced discharge along these distributaries is causing decay of the Sundarbans, the unique mangrove forests along the shores of the Bay of Bengal. By some accounts, Farakka has aggravated the arsenic contamination of groundwater in Bangladesh. This list of negative effects of Farakka on Bangladesh can be made longer.²⁸

Do the benefits measure up against these costs? The professed main objective of Farakka was to flush away silt so that Kolkata could serve as a deep port. Unfortunately that has not happened. The augmented flow in the Bhagirathi river has not made any significant contribution to the economy and ecology of the area either. Instead the augmented flow is now often causing waterlogging. Also, by creating upstream water pressure, Farakka has now become an additional cause of flooding in Bihar, so much so that the affected people are now frequently coming out in processions demanding that Farakka be dismantled.

Ironically, because of constant shifts of the river channel, Farakka barrage itself has become a perennial problem in terms of engineering and financial costs. In fact, the river now appears to be set to completely bypass the barrage, making it redundant. In view of this outcome, it is tragic that Farakka has been a major source of tension in the India-Bangladesh bilateral relationship. It is true that there have been treaties over Farakka, creating the appearance that the issue has been settled. However, most people in Bangladesh continue to view withdrawal of Ganges water at Farakka as unfair, and in Bangladesh's popular psyche, Farakka continues to be a symbol of India's hubris and maltreatment of her small neighbour.²⁹

The example of Farakka and of similar dams and barrages elsewhere in the world also show that there is an important postscript to the human victory over nature mentioned above.³⁰ These examples show that this victory may be more illusory than

real, more ephemeral than permanent. While human beings with their industrial might can apparently subdue rivers, the rivers themselves find ways to subvert human designs and come back with a vengeance. The process of nature taking 'revenge' is subtle and may show up only in the long run, but it is a process that proves to be inevitable nevertheless. These examples suggest that human beings should better consider themselves as a part of the nature and not the master of the nature. They may try to influence the nature, but not defy the nature in a cavalier manner. Thus, the shift of the Ganges from the Bhagirathi to Padma as the main channel was a natural geological process occurring over a long period of time. The Farakka experience shows that it is not wise to try to reverse this natural course of events just because there is the engineering capability to do so.³¹

Sustainable Harvesting of River Resources

Adoption of the ecological approach however does not mean that one has to cease seeing rivers as a resource to be benefited from. Rivers are indeed one of the most important natural resources that human beings have. What the ecological approach urges is to harvest river resources in such a way as to preserve the natural flow and course of rivers so that the ecosystems and cultures they support are sustained in their health. Actually, in some respects, the ecological approach can prove even better than the commercial approach in reaping the benefits from rivers. Consider the following few examples.

One of the most important uses of rivers is as a means of transportation/navigation. In this regard, dams and barrages in many cases prove rather as impediments. By contrast, restoration of the unchecked river flow through adoption and implementation of the ecological approach may facilitate the use of rivers as a means of navigation.

The second important use of rivers is as a source of fresh water fish. Fragmentation of river basin brought about by dams and barrages often adversely affect rivers' capacity to sustain fish stock. Many fish species cannot simply survive such fragmentation. For example, in the US, dams on the Snake river led to almost depletion of the salmon fish in this river. With the removal of dams and restoration of the natural flow, salmon have now returned to this river. In south Asia, for example, Farakka withdrawal has adversely affected the spawning and maturation of the hilsa fish. A barrage on the Padma river will further endanger this fabled fish species.

The third important use of rivers is in generating power. As noted earlier, contrary to popular beliefs, hydro-electricity is neither cheap nor clean. Hence, damming rivers to produce hydro-electricity may not always be a good use of rivers. First, there are often other alternative ways to generate power (including use of renewable resources). Second, there are often many opportunities for conservation in the use of electricity (thus minimising the necessity for additional power generation). Third, there are alternative, ecological approach-conforming, small-scale technologies that allow generation of hydropower without damming rivers.³² Using these new, innovative technologies may be a better way to generate electricity using river currents.

The fourth important use of rivers is as a source of water for domestic use, industrial use, and irrigation in agriculture. Unlike the previous three uses (which represent use of rivers in situ or non-consumptive), this fourth use requires abstraction of water from river flows (and hence regarded consumptive). In general, the ecological approach emphasises conservation of river flow and avoidance of abstraction. As noted earlier, the amount of

water necessary for domestic purposes can be reduced by appropriate choice of settlement pattern and living style. The water necessary for both domestic and industrial use can be reduced through recycling. The amount of water necessary for irrigation can be reduced through appropriate choice of crops and through optimum use of whatever water is abstracted for irrigation. Finally, efforts may be made to facilitate the return to rivers whatever amount of water is abstracted for the above purposes.

The very necessity of irrigation expansion can sometimes be questioned. Attainment of self-sufficiency in food is often put forward as an argument for irrigation expansion, as is done prominently to justify IRLP. Unfortunately this argument is a throwback into the past rather being forward looking. In view of many, in this era of globalisation, food security depends more on the capacity of a country to buy the necessary amount of food on the world market than on the ability to produce all the required food inside the country. According to this view, if the comparative advantage requires India to utilise her English language proficient workforce to man the backstop offices of US banks than to produce rice, it is better to do so. A back stop office on an acre of land can probably produce more income required to buy grain that can be produced on a thousand acres of irrigated land. Thus the appropriate paradigm for thinking about food self-sufficiency might have changed. The necessity for river water abstraction for irrigation expansion may not appear that pressing once this paradigm shift is taken into proper cognisance.³³

The unfortunate trend so far has been the opposite. Guided by the philosophy that "any river water passing to the sea is a waste", the tendency has been to abstract as much river water as possible. In case of trans-boundary rivers, this philosophy has often led the upper riparian countries to wasteful irrigation and other water-diversionary projects in order just to 'grab' as much water as possible before the rivers enter the lower riparian countries. The lower riparian countries, in their turn, have often chalked up and implemented equally wasteful irrigation and other water-abstraction projects in order to show to the upper-riparian countries that they are not getting enough of the river flow. This has often led to a "beggar thy neighbour" type of situation.³⁴

This type of "race to withdraw water" ultimately proves to be a 'race to kill' the rivers. The net flow of river water to the sea dwindles, affecting the coastal ecosystem. The immediate brunt of such a dwindling flow is borne by the lower riparian country through which the river ultimately passes to the sea. However, if all countries tried to dry up their rivers before they reached the sea, the marine life all across the world would be affected in the long run. Avoiding such as "Tragedy of the Commons" situation³⁵ requires cooperation of all the nations. While the commercial approach inhibits such cooperation and exacerbates tensions, the ecological approach can facilitate the required cooperation. Once countries shun the view that "any water passing to the sea is a waste", a virtuous cycle can replace the current vicious cycle with regard to abstraction of water from trans-boundary rivers by co-riparian countries.

Open Approach as a Derivative of the Ecological Approach

In regions consisting mostly of flood plains, the ecological approach suggests a particular form, which is best known as the open approach. Under this approach, connections between river channels and flood plains are expanded and deepened, instead of being severed. The open approach, following from the ecological approach, is therefore the opposite of the cordon approach, which

derives its inspiration from the commercial approach. In contrast to the cordon approach, the open approach is a 'win-win' proposition. On the one hand, it mitigates the flood intensity by allowing the monsoon flow to spread over larger areas. On the other hand, it allows the flood plains to benefit from regular river inundation with regard to soil revitalisation, navigation, surface water availability for irrigation and other purposes in dry season, recharge of the groundwater reserves, achieving temperature and moisture balance around the year, overall cleansing of the environment, etc.

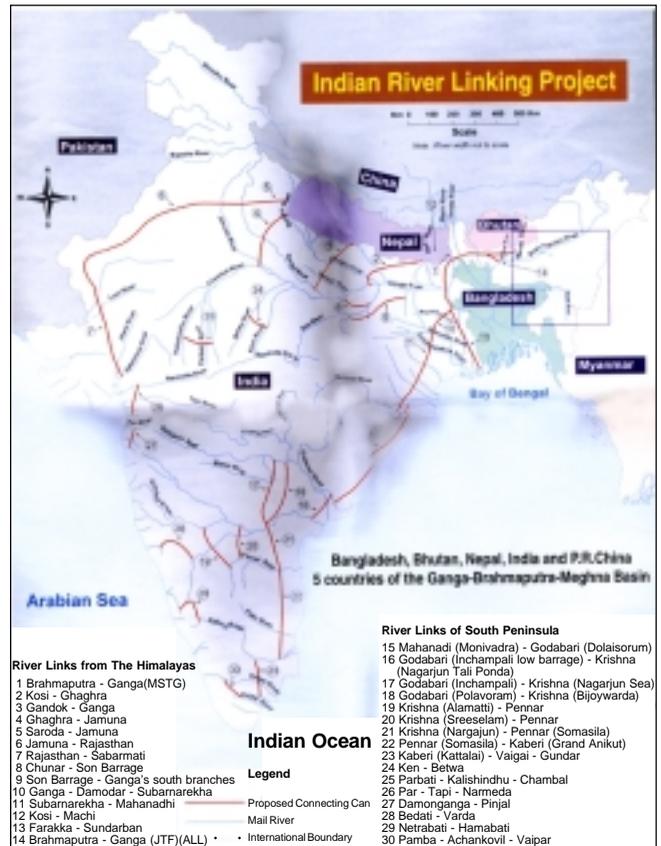
It needs to be noted that the open approach is not a prescription for inaction. Instead, implementation of this approach requires considerable efforts. For example, the open approach suggests the removal of numerous man-made barriers that have arisen over time between river channels and adjoining flood plains. In addition, the approach requires excavation and re-excavation of channels and other surface water bodies so as to help passage to and retention of the monsoon overflow in flood plains. The open approach recommends some consolidation of the rural settlement pattern so as to reap better the benefits of monsoon inundation of the flood plains.³⁶ Finally, the open approach suggests efforts to stabilise river channels, a task that requires considerable engineering prowess and innovative thinking.³⁷

Potential Role of South Asia

It is true that there are examples of river interventions in the pre-industrial ages. One can point to the irrigation works of the bronze age civilisations of Mesopotamia and of the Nile, Indus, and Huang Ho river valleys. One can point to the water works of the antiquity, the aqueducts of the Roman empire. Finally, one can point to the water works of the middle ages, the Great Canal of China, connecting Yangtze and Huang Ho, or the Jamuna-Ganga canal of the Mughal India. However, these interventions did not have either the design or the capacity to alter the ecosystems of the river basins.³⁸ Rarely did these interventions take the form of dams over major rivers. Mostly, these were gravity flow diversions of modest dimensions from existing river flows.³⁹ By contrast, the interventions of the industrial age are designed and/or capable of having fundamental effects on the ecosystems.

One can say that the ecological approach suits post-industrial developed societies, who have already reaped the benefits of the commercial approach, but does not suit developing countries, which are just industrialising. Needless to say, many apply similar arguments to advocate inaction in developing countries with regard to environmental protection in general. However, it has been shown that this argument is deeply flawed.⁴⁰ Developing countries do not have to repeat the mistakes that early industrialised countries have made, and instead can make fruitful use of the accumulated experience. So far as rivers are concerned, the above argument is even more untenable, because developing countries have already tried out the commercial approach to a great extent.⁴¹ As noted above, developing countries' own experience with the commercial approach suggests that a new approach is needed.

In fact, because of their special history, the south Asian countries can play a special role in promoting the ecological approach. The people of south Asia have a long tradition of reverence toward rivers. In the vedic literature, the mythic god Indra is often referred to as the "liberator of rivers," as the one "who frees up rivers".⁴² The river Ganges is considered as mother, as sacred, and is still worshipped by many in India. The name Brahmaputra means 'Son of Brahma', the Hindu god of creation. These are just a few indications of the high standing that rivers occupy in the south



Asian culture. The commercial approach that inspires projects to chain and shackle rivers, fragmentise their basins, confine them to reservoirs and canals, drain them to death, and uproot and unsettle the people who have been living in river basins since time immemorial, simply does not fit well with this culture. By contrast, the ecological approach that urges that rivers be respected as progenitors of ecosystems and cultures matches well to the south Asian tradition.

The common people of south Asia are therefore more receptive to the message of the ecological approach. Unfortunately, it is the elite, having imbibed the ideas of the commercial approach from the industrial west, who impose this approach from above. It is therefore not surprising that a people's movement from below is emerging in south Asian countries in favour of the ecological approach. Mention has already been made of the National Alliance for Peoples' Movements Resolution [NAPM 2004] that advocates an approach to rivers similar to the ecological approach presented in this paper. The South Asian Network on Dams, Rivers and People (SANDRP) has been active for quite some time now in disseminating information on the adverse consequences of the commercial approach-inspired river projects and in spreading the arguments for an alternative, ecological approach. The South Asian Solidarity for Rivers and Peoples (SARP), based in Nepal, has taken a position similar to the one implied by the ecological approach. In January 2005, Bangladesh Poribesh Andolon (BAPA) (Bangladesh Environment Movement) adopted a Resolution on Rivers [BAPA 2005] arguing for abandonment of the commercial approach and adoption of the ecological approach. BAPA has urged for a subcontinent-wide people's movement in support of the ecological approach.

Many scholars involved in the IRLP critique have realised that it is necessary to go beyond IRLP and take a deeper look into

the philosophy that gives rise to IRLP-type projects. For example, Iyer (2004c), in his remarks at ICRCTR, urged to look into "... what lies behind it (IRLP) and behind similar projects in other countries, namely, the spirit of gigantism, an adversarial approach to nature and a certain definition of development." Iyer (2004a) offers an elaborate critique of the thinking that underpins projects such as IRLP and presents a 'transformation' of thinking that is necessary for better utilisation of the water resources. He ends his paper by offering a 25-point declaration, which is very similar in spirit to what has been described as the ecological approach in this paper.

Thus the ecological approach has already found a foothold among activists and scholars of south Asia. It is possible that, with more efforts, the approach will capture the minds of the people and persuade the authorities to embrace it too. The region as a whole can then emerge as an example of noble treatment of rivers for the rest of the developing world to follow. Such a role will be befitting for the river-revering culture of south Asia.

V Conclusion

People advocating IRLP may have good intentions. However, their reasoning is misplaced. Ecosystems are part of the nature; they need not be human-engineered. Also, ecosystems need not be made uniform. Diversity is a part and parcel of nature and perhaps its main attraction. As they occur in nature, mountains, are elevated and marshes are low lying. However, this does not mean that mountains should be characterised as being 'surplus' in elevation and marshes as being 'deficit,' and that mountains be cut down to fill up marshes, even if there is the engineering capability to do so! IRLP is based on the commercial approach to rivers. The time for this approach has run out, and a new, ecological approach has emerged. Given their deep tradition of reverence toward rivers, the people of south Asia should champion this approach.

Adoption of the ecological approach will help in reducing tension among co-riparian countries of south Asia. Intergovernmental negotiations in this region over trans-boundary rivers have not been that fruitful over the last decades. It is true that there are bilateral treaties concerning various rivers among south Asian countries. However, these treaties are often symbols more of contention than of amity and goodwill. The main reason for this disappointing outcome is that the south Asian governments have conducted these negotiations proceeding from the commercial approach to rivers. Mutual adoption of the ecological approach can create an entirely different, positive context for reaping the benefits of trans-boundary rivers, and can thus convert these rivers from sources of contention into bonds of friendship and good neighbourhood.

It is clear that, on their own, the governments will not abandon the commercial approach. Apart from the mental inertia, there is the barrier of vested interests in this regard. Only a subcontinent wide, popular movement from below can force this barrier open, shake up the inertia, and cause the governments to abandon the commercial approach and embrace the ecological approach.

In giving directions for the future, the World Commission on Dams suggests that water development projects should be viewed in the context of the UN Declaration of Human Rights (1948), UN Declaration on the Right to Development (1986) and the Rio Principles agreed to at the UN Conference on Environment and Development (1992). WCD thinks that development (that water projects are intended for) should have five objectives,

namely, equity, sustainability, transparency, efficiency, and accountability (p 9). Proceeding from this general context, WCD suggests that decisions regarding water projects should be guided by seven principles, namely, (i) gaining public acceptance; (ii) comprehensive options assessment; (iii) addressing existing dams; (iv) sustaining rivers and livelihoods; (v) recognising entitlements and sharing benefits; (vi) ensuring compliance; and (vii) sharing rivers for peace, development, and security (pp 32-35).

These are all commendable principles. However, to what extent these principles are adhered to depends largely on how strong is the mobilisation of social forces in support of these principles. Moreover, as Medha Patkar, the distinguished member of the World Dam Commission from India points out in her comment, large dams are often "a symptom of the larger failure of the unjust and destructive dominant development model" [WCD 2000: 321]. Of course, social mobilisation of an even larger scale is needed to change the development model.

It is encouraging that a peoples' movement advocating the ecological approach to rivers has already emerged in various countries of south Asia. It is now necessary to connect these movements so that they can mutually reinforce, and a subcontinent-wide strong movement for the ecological approach to rivers can develop. Such a movement is necessary because of the further fact that many of the important rivers in question are trans-boundary. The recently (December 2004) concluded International Conference on Regional Cooperation on Transboundary Rivers (ICRCTR) held in Dhaka, Bangladesh seems like a good step forward in that direction. The people-to-people contact and the exchange of views and information attained through this conference can provide a foundation for further efforts in developing the subcontinent-wide movement. Direct interaction among experts and activists from different countries of south Asia has become more urgent in view of the apparent paralysis of SAARC as the intergovernmental forum for regional cooperation in south Asia. It seems that direct people-to-people contact is necessary not only to correct the direction of regional cooperation with regard to rivers, but to sustain any regional cooperation at all. [14]

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Notes

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- 1 Under the Rao proposal, 1,680 m³/sec of the Ganges flood flow was to be withdrawn from near Patna, pumping 1,400 m³/sec of this water to a height of 450 m for transfer to the peninsular region using a 2,640 km long Ganges-Cauvery Link canal (to be constructed) and utilising the remaining 280 m³/sec in the Ganges basin itself. In addition to this major component, the Rao proposal had a few other links.
- 2 Under captain Dastur's plan there would be Himalayan canal, 42,00 km long and 300 m wide, and a southern garland canal, 9,300 km long, and these two systems would be connected through pipelines near Delhi and Patna.
- 3 Details regarding the Supreme Court involvement with IRLP can be found in Krishna (2004) and Alley (2004). Many have commented on the propriety of the role that the Indian president and the Indian Supreme Court are playing with regard to IRLP. See for example Iyer (2002, 2004).
- 4 See Alley (2004), Gujja and Das (2004), and Jairath (2004) for details regarding the civil society response and the interaction between the government and the civil society regarding IRLP.

- 5 For example, Dhungel and Pun (2004, p 27) note, "While the proposed links and their details of the peninsular component are available, no information on the Himalayan component is available. Nonetheless, the proposed project also aims to transfer the Himalayan waters to the Peninsular south through the Subernarekha-Mahanadi-Godavari links. This reveals the grandiose nature of the plan."
- 6 A few initiatives that deserve specific mention are as follows. One is the formation of the National Civil Society Committee on Interlinking of Rivers (NCSCILR) in order to engage the government of India in a dialogue with the civil society on the issue of IRLP. Gujja and Das (2004) provide the details of the activities that NCSCILR has undertaken so far. Another initiative has been the formation of the internet discussion group riverlink@yahoo.com, which has been instrumental in drawing the non-resident Indians and Bangladeshis in the discussion of IRLP and in facilitating events with participation of both residents and non-residents. Finally, various civil society groups in India have united to form the National Alliance of People's Movements (NAPM), which along with the Ecological Foundation, South Asia Network on Dams, Rivers, and People (SANDRP), and several other organisations, held a national convention on 'Interlinking Rivers – Feasibility and Justifiability' in Delhi on December 2-3, 2004. The convention adopted a resolution opposing IRLP [see NAPM 2004].
- 7 This has been well demonstrated by the example of the Alwar district of the Indian state of Rajasthan, where small-scale water-harvesting structures (johads) to store rainwater went a long way in solving the water deficit problem [see WCD 2000, p 144]. See also Diwan (2004) for a discussion focusing on Maharashtra.
- 8 Vombatkere (2004a) provides a perceptive analysis of these issues taking Manas-Sankosh-Teesta-Ganges link as an example. See also Dutta (2004).
- 9 These claims are disputed, however.
- 10 Flood mitigation effects do come under fiscal and economic effects and hence can be subsumed under them. However, we treat it as a stand alone issue because of its special importance.
- 11 Hence, "flood" months of the east are also the months when there is precipitation and hence not much need for additional water elsewhere. On the other hand, dry months of the west are also the months when rivers run low in the east. (The only exception is the Eastern Ghats, which receive some rainfall from north-easterly monsoon in winter too.)
- 12 Vombatkere (2004b)'s analysis taking Ganges-Subernarekha link shows the inadequacy of IRLP with regard to flood mitigation.
- 13 Historically in Bangladesh for example, flood years have also been the years of bumper crop.
- 14 See Bandopadhyaya and Parveen (2002) for a discussion of the economic and environmental aspects of IRLP. See also Ganguly (2004).
- 15 For discussions of possible negative effects of IRLP on Bangladesh, see Azad, Iqbal, and Sultana (2004), Azad and Alam (2004), Chowdhury and Dutta (2004), Haq (2004), Hossain and Madina (2004), Hossain and Nasreen (2004), Saha (2004) and Sultana (2004).
- 16 Indrajit (2004) provides a good discussion of the external issues involved with IRLP. Of course, relationship is a two-way affair and is not confined to river sharing. From the Indian viewpoint, for example, Bangladesh's alleged lack of help to India in dealing with tribal insurgencies in her north-eastern provinces is a major obstacle to improved relationship between the two countries.
- 17 See Nianthi and Husain (2004) for a discussion of the implications for IRLP of possible climate changes.
- 18 The World Commission on Dams (WCD) puts the sorry condition of rivers in the following way: "Even degraded rivers seldom totally run, but loiter in a chain of reservoirs. In some years our mightiest rivers – Africa's Nile, Asia's Yellow, America's Colorado, and Australia's Murray – do not reach the sea" [WCD 2000, p ii].
- 19 For more detailed critiques of the cordon approach in the context of Bangladesh, see Islam (1993, 1999 and 2002) and Khalequzzaman (1994).
- 20 The deluge of Dhaka city in the summer of 2004 serves as an alarming example of the negative consequences of urban cordons. The experience of the Dhaka-Narayanganj-Demra (DND) project has been illustrating these negative consequences for quite some time now.
- 21 The breach of the Brahmaputra Right Hand Embankment and the collapse of the Gomti and Kikri embankments in Bangladesh in the summer of 2004 illustrate the negative consequences of rural cordons.
- 22 According to the World Commission on Dams (WCD), "Both the multilateral and bilateral development banks played a significant facilitating role in getting Asia, Africa, and Latin America started in the dam business" [WCD 2000, pp 170-71].
- 23 As the World Commission on Dams (WCD) notes, "Once a proposed dam project passed preliminary technical and economic feasibility tests and attracted interest from the government or external financing agencies and political interests, the momentum behind the project often prevailed over further assessments" [WCD 2000, p 168].
- 24 Earlier works drawing attention to the deleterious effects of dams include the report, *Position Paper on Dams and the Environment* by the International Commission on Large Dams [ICOLD 1997]; the report, *The Role of Dams for Irrigation, Drainage, and Flood Control* by International Commission on Irrigation and Drainage [ICID 2000]; and Patrick McCully's (1996) book, *Silenced Rivers*, which is based on the report by Goldsmith and Hildyard (1984).
- 25 In response to the Manebeli Declaration, the World Bank had its Operations Evaluation Department (OED) conduct a review of a sample of 50 Bank funded large projects. However, this review was severely criticised by the NGO community on various grounds, including the process in which it was conducted. Similarly, Morse report, which was commissioned by the World Bank to conduct an independent review of the Sardar Sarovar project of India, offered deep criticism of the World Bank's internal decision-making. The situation led to an atmosphere of 'mistrust' and 'stalemate' that was affecting the world 'dam industry'. In order to resolve this stalemate, the World Bank, together with IUCN, took initiatives that led to the formation of the World Commission on Dams. The Commission's Report itself documents this process. See WCD (2000, pp 17-28).
- 26 This is not a place to summarise the WCD report that runs more than 400 pages. Interested reader can read this report, which is available for free from the website www.dams.org.
- 27 It also finds that large dam projects "often incur substantial cost overruns," (p 39) (the problem being most serious in south Asia) and "schedule delays" [WCD 2000, p 42].
- 28 For more detailed accounts of the effects of Farakka barrage, see Khatun (2004) and Sultana and Azad (2004). For a general discussion of Farakka, see Islam (1993).
- 29 See www.farakkacommittee.com, the website of International Farakka Committee (IFC), for one outlet of Bangladeshi popular sentiments on Farakka. Communal forces in Bangladesh regularly make use of Farakka to whip up anti-India sentiments.
- 30 See also Nandi (2001) for his excellent discussion of the experience of the Damodar Valley Project.
- 31 Even with respect to the mammoth Hoover Dam, there are now signs that seeping water of the Colorado river is overtime weakening the rocky sidings of the Dam, so that sometime in the future this Dam will also either have to be knocked down or will crumble on its own.
- 32 These are also sometimes referred to as micro-hydro technologies. See WCD (2000, p 32).
- 33 It may not be entirely out of context to note here that India is already self-sufficient in food, so far as the aggregate amount is concerned. Yet a large percentage of the Indian population continues to suffer from hunger and malnutrition. This points to major problems elsewhere, including that of distribution, which may in turn reflect lack of education among large masses of people. Thus instead of expansion of irrigation, expansion of education may be a more worthy developmental goal. As Sen keeps on reminding [see for example, Dreze and Sen 1995], it is unfortunate that, even after half a century of independence, the south Asian countries remain mired in illiteracy. Perhaps, a fraction of the investment envisaged for IRLP, if well spent, could eradicate illiteracy. One also wonders why the learned Indian Supreme Court judges preferred river linking over promotion of education as worthy of judicial intervention. Iyer (2002, 2004b) rightly argues that developmental goals, particularly how those goals are to be achieved, be better left to the administrative and legislative branches of the government. However, assuming that the Supreme Court had to make a development intervention, a directive to eradicate illiteracy within the next 10 years probably would have generated less controversy and earned more appreciation than the directive to interlink rivers!
- 34 However, unlike the situation in international trade, in the race to withdraw water, the lower riparian country generally finds itself in a structurally disadvantageous situation.
- 35 The reference here is to the health and state of common seas which are under the common ownership of all nations, so to speak.
- 36 As an additional benefit, such consolidation may help in conserving land

and in extending various infrastructural, utility, administrative, development, social, and cultural services to the rural population.

37 The engineering community therefore need not view the ecological approach as adverse to its skill and interests.

38 As is known, the purpose of the Chinese Grand Canal was to transport tax grain from southern China to the capital in north China.

39 In that sense one can talk about an ecological approach of the pre-industrial age too. However, there is a qualitative difference between the ecological approaches of the pre- and post-industrial ages. The Ecological Approach of the pre-industrial societies was predicated more on the technological inability to 'conquer' the rivers. By contrast, the ecological approach of the post-industrial phase is a conscious choice made despite the engineering ability to 'conquer' rivers. Thus, the pre-industrial ecological approach was a result of the position of weakness, so to speak. The post-industrial ecological approach is from the position of strength, from the apparent fragility of rivers in face of human industrial strength. However, there is also the other side of the relationship. As noted earlier, when grossly intervened, the rivers come back with a vengeance, and in the long run prove to be unconquerable. The post-industrial ecological approach is partly rooted in this realisation too. In this sense, there is a subtle similarity between the sources pre- and post-industrial ecological approach.

40 For a discussion of this issue, see Islam (1997, 1999, and 2000).

41 As noted earlier, China and India alone account for more than half of the world's large dams.

42 See Kosambi (1956).

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