India's River Linking Project:
The State of the Debate[1]

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Introduction

For a people reveling in discord, Indians have become increasingly united when it comes to sharing the dread of their water-scarce future. Also visible with this growing concern is a rapidly spreading sense of disenchantment towards the inadequacy and apathy of governments in dealing with recurrent cycles of flood and drought, occurring simultaneously in different parts of the country. So when the President of India, in a speech addressed to the nation on the eve of Independence Day 2003, declared, "The first mission (of my government) is on the Networking of Rivers … This will eliminate the periodical problem of droughts and floods ... and provide both water and power security", he was addressing this popular concern directly.

For a long period of time, the notables in India have argued that the answer to the drought-proneness of western and peninsular India lies in the flood-proneness of the east, and vice versa. Sir Arthur Cotton, who restored the Grand Anicut on the Cauvery and has remained a cult figure in the Deccan villages since the early decades of the nineteenth century, had thought of a plan to link the rivers in southern India for inland navigation. More recently during the mid-1960s, Dr K.L. Rao, a well-respected technocrat, presented a crude proposal for a Ganga-Cauvery Link from a point below Patna. A few years later, Captain Dastur, a pilot, speculated aloud about a lateral Himalayan canal from the Ravi to the Brahmaputra along a constant 400-meter contour interconnected with a Garland Canal girdling peninsular India. But ideas like the Garland canal and the Ganga-Cauvery Link were routinely dismissed as too grandiose for a resource-strapped nation. The Indian psyche was, however, never fully disassociated with the idea; Prime Minister, Mrs. Indira Gandhi constituted the National Water Development Agency (NWDA) to start detailed planning of a mega-project, which no one imagined would ever leave the drawing board.

Implementing the mega-scheme, which required pre-feasibility studies, feasibility studies, environment impact studies and the like, was destined to be a long, drawn out process. But in 2003, acting on an innocuous petition from a lawyer, the Supreme Court of India decided that

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[1]Draft prepared for a book volume of the RFF Press water policy series.

the time had come for the nation to pull its act together on the water front, and enjoined the Government of India to complete all planning required to launch the River Linking Project by 2006, and to complete the project itself, by 2016. Without losing time, Prime Minister Bajpai of the then ruling National Democratic Alliance (NDA) government—who had so far been an avid advocate of local rainwater harvesting - constituted a high-powered, multi-disciplinary task force to embark upon the Project forthwith and asked Suresh Prabhu, a young, highly regarded minister, to lead it. Many expected the idea to be dropped on the wayside when the NDA government fell. Moreover, a groundswell of opposition had emerged from environmental groups and civil society organizations that have begun to question the basic model of water resources planning and management through the use of large-scale dams and canal networks. The new United Progressive Alliance (UPA) government has waxed and waned the mega-project; however, it is hard to tell when the idea will rise from its ashes like the phoenix and bestride the Indian discourse on water scarcity like a colossus.

Resuming the Global Experience

Even as India has been procrastinating, the rest of the world has gone ahead with inter-basin water transfer (IBT) projects at a brisk pace during the past 50 years or so. Global and local opposition notwithstanding, China has steadfastly stayed on course in its own scheme of transferring 48 km^3 of water from the Yangtze River to the Yellow River to improve water availability in the dry plains of North China. Elsewhere in the world, many IBT projects have faced a variety of problems and produced some unwanted side-effects; however, in overall terms, most have turned out to be beneficial on balance. Even a wary global environmental review of IBTs (Snaddon, Davis and Wishart 1999), which advocates using precautionary principles, concluded that:

> *"In many parts of the world, water transfers have become the lifeblood of developing and extant human settlements, for which no alternative is currently perceived to be available."*

If an IBT is viewed as 'the mass transfer of water from one geographically distinct watershed to another' (ibid), IBT has been the central theme in the story of human development over the last 6,000 years. Inter-basin water transfers are nothing new, even in India. Colonial irrigation works in the Indus and Ganga basins were early successes in large-scale inter-basin water transfers. Elsewhere in the world, we find much older cases. China's Grand Canal, Roman aqueducts and *quanats*, or sub-surface water galleries from Spain through the entire Middle East down to Baluchistan, are some such cases. Diversion of the Periyar River in 1985 to augment the waters of the Vaigai in Tamil Nadu, the Krishna-Cuddapah (Pennar basin) Canal and the Telegu Ganga Canal that provide water to the Krishna resulting an increase in the drinking water supply to Chennai are some recent cases where IBT has been successful. In the case of the Indira Gandhi Nahar (IGN) or the Rajasthan Canal, each carries over 9.362 km^3 (7.59 million acre feet) of Ravi and Beas waters through the Bhakra for irrigation in the Thar Desert. The Sardar Sarovar Project carries the Narmada waters across seven basins to the arid areas of North Gujarat, Saurashtra and Kutch (Verghese 2003). With the growth of science and engineering and the intensity of water scarcities, IBT projects during the past century have become increasingly large in the volumes handled and bold in their design. Moreover, with water and environment issues increasingly entering the public discourse, planning and executing IBT projects have involved not only considerable engineering and technological experience, but complex social management as well. We illustrate these issues with the help of two examples, one from a rich country context and another from an emerging economy context.

The first is the 50-year old Colorado Big Thomson, USA, which illustrates the life-cycle of a water infrastructure project over a period of rapid socioeconomic change. Relative to the scale of water transfers India is contemplating, the Colorado Big Thomson is a minor intervention, yet it diverts approximately 0.284 km^3 /annum (0.23 million acre-feet) of water from the upper reaches of the western flowing Colorado River, one of the most 'closed' basins in the World, and sends it eastward into the South Platte River basin, which is part of the Mississippi-Missouri basin. This project, implemented by the United States Bureau for Reclamation (USBR), was constructed between 1938 and 1957. Its primary purpose was to provide water for irrigation, and for municipal and industrial use along the front range of the Rocky Mountains in northern Colorado. It provides water to 29 municipalities, including Fort Collins, Boulder, Loveland, and Longmont; over 100 ditch and reservoir companies (water users associations), and 251,000 hectares (620,000 acres) of irrigated land (Colorado State University 2006). The water that flows down the Big Thomson River is also used to generate hydropower, which inter alia drives the pumps that lift the water on the western slopes into the diversion tunnel. In implementing the project, the USBR included the key stakeholders, particularly the irrigation districts (water users associations) which were to benefit from the increased and more reliable water supplies, and the relevant municipalities, all of which collectively formed into the Northern Colorado Water Conservation District (NCWCD). Even when this project was developed, the implementation had to navigate arguments between government agencies, protests from environmentalists concerned with the preservation of a National Park, disputes between the communities in the western and eastern slopes, heated arguments over water rights, and such things as labor and materials shortages brought on by World War II (Autobee 1996). Over the years however, the project has evolved. The NCWCD, effectively the water users, now operates the entire system. Also, growing awareness and new legislation have resulted in increased attention to the environmental needs in both the receiving and 'donating' river systems. Finally, while there remains a vibrant irrigated agricultural economy in the area that utilizes the bulk of the water supply, the relative role of agriculture in the regional economy has significantly diminished, and in the past two decades or so, municipalities, including those further to the south in the urban conurbation of greater Denver, have acquired certain water rights from farmers in order to meet growing domestic and industrial demands. Even today, decades after it was developed, the Colorado Big Thomson project has its detractors. To take a quote from a local newspaper:

> *"New generations take an ample water supply for granted, and political clout has passed to environmental lobbies that have made water providers the goats instead of heroes."* (Hornby 1993).

The second example is the well-known Lesotho Highlands Water Project (LHWP), which, built and managed by Lesotho and South Africa, illustrates the dynamics of IBT in a developing country context. This was developed to divert water from the relatively economically poor, yet water-rich country of Lesotho, to the prosperous but water-short South Africa, specifically to the wealthy province of Gauteng. The project transfers water from the upper reaches of the Orange/Sengu rivers and diverts it into the Vaal River. Initial investigations for this project began in the 1950s, but subsequent attempts to implement it failed as the two countries could not reach an agreement. In the early 1980s, after much deliberation and planning, feasibility studies were undertaken with the involvement of both Lesotho and South Africa, and the project as conceived at that time formed the basis of the treaty between the two governments, which was signed in 1986.

As intended, the LHWP became one of the largest water transfer projects in the world, which was estimated to cost US$8 billion. Phase 1, which was completed in 2004 at a cost of approximately US$2 billion, diverts approximately 750 million m^3 of water per annum. It comprised three storage dams in the upper reaches of the Orange/Sengu river system, 110 km of transfer tunnels leading to the Vaal River via a hydropower station, 300 km of access roads, and, while not included in the original design, a number of environmental and social mitigation and enhancement measures too, have been put in place (Earle and Turton 2005). Royalties and hydropower revenues from Phase 1 contributed approximately US$31 million to Lesotho in 2004, which was about 5% of their GDP.

The location of the major works of the project is sparsely populated. The treaty allowed for the management of the environment, sustaining of existing livelihoods and set up compensation mechanisms for those negatively impacted by the project. The implementation of Phase 1, included environmental impact assessments and environmental action plans, which included resettlement and development, public health and natural environment, and heritage components (Mochebelele 2000). However, a thorough environmental flow analysis was not initiated until 1997, by which time part of the construction activities in phase 1 was already completed (IUCN 2003). The initial concept had been to maximize the quantity of water transferred with limited regard for in-stream flows, but the results from the environmental feasibility assessment (EFA) required that the releases from the already built facilities be increased and design changes be made to Phase 1, at least as much as could be done as the project was already at an advanced state of implementation by the time the results were available (IUCN 2003). The project had assumed that those most affected by its development were the few people located within the inundation pools of the reservoirs, and that there would be little impact on the downstream dwellers. The EFA, however, concluded that there would be significant hydrological, ecological and socioeconomic effects on the people living downstream as well as on the riverine ecosystem. The EFA allowed compensation for these impacted persons, resulting in a doubling of the portion of implementation funds used for environmental-related works from Phase 1 The EFA also contributed to a major re-consideration of the next phases i.e., 2 to 5 of the project (IUCN 2003).

The LHWP however, became infamous for corruption, due to accusations leveled at it and subsequent high profile court cases, some of which are on going. While the presence of corruption is not new in large-scale infrastructure developments and the victims are more often than not, those who are already marginalized, the only positive outcome here is that the offenders have or are being prosecuted, which in turn has improved the overall efficiency and transparency of doing business in Lesotho (Earle and Turton 2005). Earle and Turton (2005) concluded that civil society needs to be equipped and empowered to report corruption; that the authorities need the capacity to investigate; and that the institutional arrangements made should be up to the task at stake, including anti-corruption arrangements such as those that have been established in Lesotho at present. These arrangements included mechanisms to ensure that the contractors entrusted with work have not been involved in any form of corrupt practices in the past.

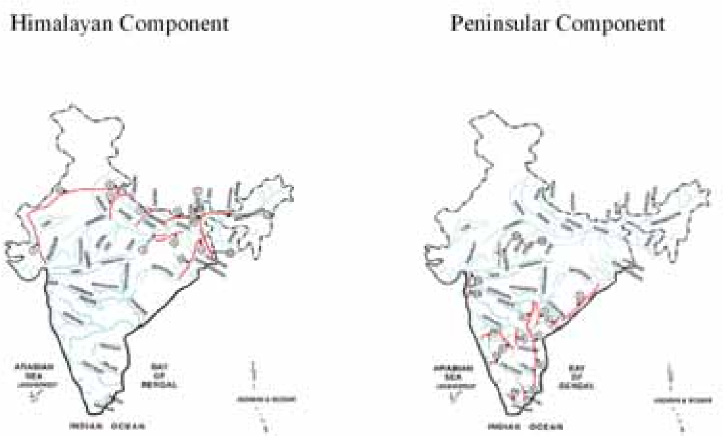
These two examples illustrate that implementing IBTs is a considerable challenge in social and political terms, even in the best of environments. Nevertheless, if planned and executed in a participatory manner that takes into account the suggestions made by various stakeholder groups, sound IBT projects can truly become 'the lifeblood of developing and extant human settlements'. The major challenge that India's ILR project faces is how to negotiate with and reconcile the conflicting needs and aspirations of stakeholders to welcome a water enterprise that is of a scale, scope and socio-ecological complexity that the world has never encountered before.

The Indian ILR Project

The project that the Supreme Court and the President have enjoined the Government of India to implement may well be the largest infrastructure project ever undertaken in the world, transferring water from surplus river basins to ease the water shortages in western and southern India, while mitigating the impacts of recurrent floods in eastern India (NWDA 2006). The project will build 30 links and approximately 3,000 storages to connect 37 Himalayan and Peninsular rivers to form a gigantic South Asian water grid. The canals, planned to be 50 to 100 meters wide and more than 6 meters deep, will facilitate the navigation of water. The estimates of key project variables-still in the nature of 'back-of-the-envelope calculations'—suggest that it will cost a staggering US$123 billion (or Indian Rs. 560,000 crore at 2002 prices), handle 178 km^3 of inter-basin water transfer/per year, build 12,500 km of canals, create 35 giga watts in hydropower capacity, add 35 million hectares to India's irrigated areas, and generate an unknown volume of navigation and fishery benefits (Mohile 2003; Institution of Engineers 2003; GOI 2003). Approximately 3,700 MW would be required to lift water across major watershed ridges by up to 116 meters. Far from 2016, most observers agree that this project may not be fully complete even by 2050. Verghese (2003), one of its few champions outside the government, suggests it should be viewed as a 50 to 100 year project.

The ILR project is conceptualized in two distinct components: the Himalayan and peninsular (Figure 1). The former will transfer 33 Km^3 of water, and the latter will transfer 141 Km^3 of water through a combined network of 14,900 km long canals (NWDA 2006). The Himalayan Component (HC), with 16 river links, has two sub-components: the first will transfer the surplus waters of the Ganga and Brahmaputra rivers to the Mahanadi Basin and from there the water will be relayed to Godavari, Godavari to Krishna, Krishna to Pennar and Pennar to the Cauvery basins. The second sub-component will transfer water from the eastern Ganga tributaries to benefit the western parts of the Ganga and the Sabarmati river basins. Altogether, these transfers will mitigate floods in the eastern parts of the Ganga Basin, and provide the western parts of the basin with irrigation and water supplies. The Himalayan component needs several large dams in Bhutan and Nepal to store and transfer flood waters from the tributaries of the Ganga and Brahmaputra rivers, and also within India to transfer the surplus waters of

Figure 1. Himalayan and peninsular component of the ILR project.



Source: NWDA (2006)

the Mahanadi and Godavari rivers. The peninsular component has 16 major canals and four sub-components: 1) linking the Mahanadi-Godavari-Krishna-Cauvery-Vaigai rivers; 2) linking west flowing rivers that are south of Tapi and north of Bombay; 3) linking the Ken-Betwa and Parbati-Kalisindh-Chambal rivers; and 4) diverting the flow in some of the west flowing rivers to the eastern side. The en route irrigation under the peninsular component is expected to irrigate a substantial area as proposed under the NRLP. This area to be irrigated is situated in arid and semi-arid western and peninsular India. The total cost of the project includes three components: 1) the peninsular component will cost US$23 billion (Rs.1, 06,000 crore); 2) the Himalayan component will cost US$ 41 billon (Rs.1, 85,000 crore); and 3) the hydroelectric component will cost US$59 billion (Rs. 2, 69,000 crore). The quantity of water diverted in the peninsular component will be 141 cubic kilometers and in the Himalayan component it will be 33 cubic kilometers. The total power generated via the hydroelectric component will be 34 gega watts (GW) – 4 GW in the peninsular component and 30 GW in the Himalayan component (Rath 2003).

What makes ILR unique is its unrivalled grandiosity. If and when completed, ILR will handle four times more water than China's South to North water transfer project, which is one of the largest inter-basin water transfer projects implemented in the world at present (Stone and Jia 2006). ILR will handle four times more water than the Three Gorges Dam; five times all inter-basin water transfers completed in the U.S.A; and more than six times the total transfer of the six inter-basin water transfers projects already operational in India namely, Sharda-Sahayak; Beas-Sutlej; Madhopur-Beas Link; Kurnool Cudappa Cana; Periya Vegai Link; and Telgu Ganga. The ILR cost, as presently 'guesstimated', would be three times the cost of China's South-North water transfers scheme; six times the cost of Three Gorges Project, and twenty times the estimated costs of the Red-Dead connection in the Middle East. ILR will require a larger investment than the sum total of all irrigation investments made by the governments of colonial and free India since 1830. And this cost is based on numbers that are little more than a conservative 'guesstimate' that more than likely excludes the cost of land acquisition. When the cost of land acquisition and rehabilitation and resettlement, besides the endemic cost and the inevitable time overruns, are factored in, ILR will most likely cost several times more than the present US$123 billion estimate.

Only nine of the 30 proposed links are independent, and can be executed without working on other links. In the first stage of this mammoth project, which won government approval last August, a 230-kilometer canal will be dug to divert water from the Ken River to the Betwa River in the northern Madhya Pradesh Province. A dam and small hydroelectric plant will be built in the Panna Tiger Reserve. Work on this US$1.1 billion costing first component of the NRL project is underway and is scheduled to be completed in 8 years (Bagla 2006).

Justification of ILR

The most significant question being raised about ILR by critics is its justification. The *raison d’etre* of the project is the accentuating water scarcity in western and peninsular India. The low per capita availability of utilizable water, high spatial and temporal variability of rainfall and the associated droughts and floods are other major factors. By 2050, the per capita water availability in India is expected to fall from the present 1,820 m^3 to 1,140 m^3, far less than the water scarcity thresholds of 1,700 m^3/person/year defined by Falkenmark et al. (1994) as necessary for civilized living. Spatial inequality too is extreme: the Ganga-Brahmaputra-Meghna basins, which cover one third of the country’s total land area, are home to 44 % of India’s population, but drain more than 60 % of the country’s water resources.[2] In contrast, the Krishna, Cauvery and, Penner river basins and the eastward flowing rivers between Penner and Kanyakumari cover 16 % of the total land area, host 17 % of the population, but drain only 6 % of India’s water resources (Amarasinghe et al. 2005). In India’s 19 major river basins, only 55 % of the total water resources are utilizable. As a result, more than 220 million people have a per capita water supply that is below 1,000 m^3/ per year, indicating the emergence of severe regional water scarcities according to Falkenmark et al. (1994).

Owing to these unequal endowments, India’s river basins are at different degrees of ‘closure’. The Indus Basin withdraws more than 1,600 m^3 per person/year, whereas the Brahmaputra Basin withdraws only 290 m^3 per person/year. The Indus, Penner, Tapi, Sabarmati — the west flowing rivers in the Kutch, Saurashtra and Rajasthan (Luni) regions, and the east flowing rivers between Pennar and Kanyakumari suffer over-development (Amarasinghe et al. 2005) and are physically water-scarce (IWMI 2000). The needs of these areas can be addressed, it is argued, by augmenting their natural flows through the transfer of surplus waters from the Himalayan rivers.

It is argued that diverting a portion of the surplus flood waters from the Himalayan rivers into the drought-prone areas can only be a win-win proposition. Annual floods, on average, affect more than 7 million ha of the total land area, 3 million ha of the cropped area and 34 million people, mostly in the eastern parts, and inflicts an annual damage of well over US$220

[2]The Brahmaputra subbasin alone, with only 6 % of the land area and 4 % of the population, drains 31 % of the total water resources. And due to geographical restrictions, only 4 % of the Brahmaputra Basin’s vast water resources are potentially utilizable within the basin.

million (Rs.1,000 crores) (GOI 1998). In contrast, recurrent droughts affect 19 % of the country, 68 % of the cropped area and 12 % of the population (Nair and Radhakrishna 2005).The reservoir storages and the canal diversions in ILR are expected to reduce flood damages by 35 % (Sinha et al. 2005) and ease drought-proneness in semi-arid and arid parts, besides making 12 km^3 of water available for domestic and industrial water supplies in these drought-prone districts.

India is also blamed for having neglected storage creation, resulting in *economic* water scarcity that may impede its economic growth. Other arid and semi-arid regions of the world have invested heavily in storage creation; the U.S.A has a per capita storage capacity of 5,961 m^3; Australia has 4,717 m^3, and Brazil has 3,388 m^3. Even China has increased its per capita storage capacity to 2,486 m^3 while India's per capita storage capacity is a puny 200 m^3/person at present and declining with increasing population. It is imperative that India increases its storage for regulating the vast amount of runoff that otherwise cannot be beneficially utilized. The NRLP water transfers of 178 km^3 will increase utilizable surface water resources by 25 % and improve water accessibility in water-scarce regions.

As a concept, the ILR has been doing the rounds for over a century; however, as a serious proposition, it has "not been recommended by anyone" (Iyer 2003). Even the National Commission on Integrated Water Resources Development (NCIWRD), which considered the proposal in great detail, was lukewarm towards its implementation, and actually suggested caution in considering the project as a solution to water-distribution problems. Who then are the proponents of the ILR Project? This is a difficult question because besides a small group of large-scale irrigation proponents, the Supreme Court and the President of India, the votaries for the NRLP are far less vocal than the growing lobby of antagonists of the project.

The NCIWRD report, which is widely viewed in lay circles as the first cut justification of the NRLP idea, emphasized self-sufficiency in food production and improved rural livelihoods as two key justifications for the ILR project. Assuming the criticality of maintaining national food self-sufficiency and agricultural exports, the Commission projected a grain demand in the range of 425 to 494 million tonnes for India by 2050 and argued for the need to increase the country's irrigation potential to 160 million ha, which is 20 million more than what can be achieved without basin transfers. Thus, it is stated "….one of the most effective ways to increase the irrigation potential for increasing food grain production, mitigate(ing) floods and droughts and reduce(ing) regional imbalances in the availability of water, is the interlinking of rivers to transfer water from the surplus rivers to deficit areas..." (NWDA 2006). The surface irrigation of the river linking project alone expects to add 25 million ha of irrigated land. However, the NCIWRD commission was not unanimous in its support for river linking; some of the members issued a dissenting view that is included in the report itself.

Improving rural livelihoods is advanced as another justification for the ILR project. The rural population in India is projected to peak at about 775 million by 2015 (UN 2004). The commission projects that the rural population will decrease to about 610 million by 2050, which will be similar to the rural population levels in 1988. The agriculturally active population estimated in 1988 was 488 million (FAO 2006). With the present level of economic growth however, one would expect that the population whose livelihood depend solely on agriculture to be inevitably much lower than today's level (548 million in 2001). Thus it is not clear how total agriculturally dependent livelihoods in the future can be a justification for the NRLP irrigation transfers.

None of the critics undermine the seriousness of the specter of water scarcity in western and peninsular India. But, according to them, just because the Brahmaputra, which accounts for the bulk of India's water resources, flows rather inconveniently in a remote corner of the country, does not constitute a good enough reason for a canal and dam building spree on the scale proposed. Critics argue that there are other solutions besides ILR, which have not been properly considered. A strong and strident army of 'water-warriors' argue that if the precipitation within the watersheds or subbasins is harvested and conserved properly, meeting domestic water needs will not be a problem in most parts of the country. They also argue that dams waste more water than meet the requisite water needs. While the whole country needed about 30 km^3 of water for meeting annual domestic needs in 1997-1998, India experienced a loss of 36 km^3 in that year alone through evaporation from the reservoirs.

Some critics point to desalination as a viable component in creating an alternative to the NRL project, especially as desalination is no longer considered prohibitively expensive. The capacity for desalinating water has increased globally from 1.5 million m^3 per day to the current figure of more than 20 million m^3 per day. This has reduced the cost-price of desalinated water to less than US$1.00/$m^3$ for seawater and less than US$0.50/$m^3$ for brackish water (Bandyopadhyaya and Praveen 2003). Arid countries such as Saudi Arabia already depend heavily on desalination for meeting a substantial part of their non-irrigation water demand. Closer to home, companies are now ready to market drinking water at a price of 5 paise per liter. The emerging technology of rapid spray evaporation (RSE) is likely to cut costs further. However, with the recent escalation in energy costs, desalination also needs to be looked at with a more critical eye.

Water demand management in agriculture offers enormous scope that remains untapped for meeting future water demand. According to Bandyopadhyaya and Praveen (2003), "Irrigation is no longer 'watering the land' but supplying water for growth of crops…"; and Iyer (2003) argues that "the answer to the sharing problem in the Cauvery lies in both Tamil Nadu and Karnataka learning to reduce their excessive demands on the waters of the river through a combination of measures; the 'shortage' will then disappear."

Emerging Critique of the ILR Proposal

ILR has generated a highly polarized debate on its pros and cons, with its supporters—a small band—coming largely from government advocates of large-scale irrigation and the political class, and a much larger, vocal and strident group of critics and opponents from civil society and academia. In a single issue of *Himal*, a South Asian journal, Verghese (2003) found ILR described in a variety of ways such as 'frighteningly grandiose', a 'misapplied vision', 'extravagantly stupid' 'annihilatingly wrong', a case of putting the 'cart before the horse', a 'sub-continental fiasco', 'a flood of nonsense', a 'dangerous delusion' or a case of 'hydro-hubris'. According to Iyer (2003), "It amounts to nothing less than the redrawing of the geography of the country." According to Bandyopadhyaya and Praveen (2003), the proposal claims to package an uncertain and questionable idea as a desirable one. Some of the major criticisms of the project are about its socioeconomic viability, environmental impacts, displacement and rehabilitation of affected people, the challenge of resource mobilization, geo-political constraints as well as domestic political dynamics.

Benefits and Costs

The ILR project envisages many benefits. It expects to: add 34,000 MW of hydropower to the national grid of which 3,500 MW would be used in various lifts; supply much needed drinking water to several millions of people and industrial water supplies to drought-prone and water-scarce cities in the west and south; mitigate floods in the east and droughts in the west and the south. The large canals linking the rivers are also expected to facilitate inland navigation. Increased irrigation—25 million ha through surface irrigation and 10 million ha through groundwater irrigation—in water-scarce western and peninsular regions is the top benefit envisaged from the ILR project. This is expected to generate more employment and boost crop output and farm incomes, and provide multiplier benefits through backward linkages such as farm equipment and input supplies and forward linkages such as agro-processing industries.

This key plank of the project has come under scathing criticism. The most eloquent has been from Rath (2003). Based on simple, back of the envelope calculations, Rath shows that assuming a 7 % interest rate per year, the annual capital costs and interest to recover the total capital over a period 50 years will be US$110/ha (or Rs.2,015/acre) in the peninsular component and Rs.15,030/acre in the Himalayan component. For irrigating hybrid *jawar* (sorghum) in peninsular India, he shows that the required annual capital recovery cost alone will be US$221/ha (Rs. 4,131/acre). Similarly, the annual capital recovery cost at 7 % interest over 50 years amounts to US$0.30 (Rs.13.3) per watt of hydropower. If we assume a 7 % interest rate to be charged on the capital during the construction period, the total cost of the three components will amount to US$252 billion (Rs.11,47,873 crore), approximately double of what is now suggested. On the further assumption of a 5 % annual rate of inflation, the project will commit India to a project outlay of US$22 billion (Rs.100,000 crore) per year.

Environmental Concerns

Environmentalists are worried about the ecological impacts of the project of such a massive scale. In May 2003, the Government of India’s own Ministry of Environment and Forests raised 23 environmental concerns about ILR. Independent researchers too worry on many counts. Some have pointed to the dangers of the seismic hazard, especially in the Himalayan component (Bandyopadhyaya and Praveen 2003), and many worry about the transfer of river pollution that accompanies inter-basin water transfers. The loss of forests and biodiversity, of course, are recurring themes. Many others have questioned the subjective concept of the availability of ‘surplus’ flows in some river basins that lie at the heart of inter-basin transfers. An extreme view, according to Bandyopadhyaya and Praveen (2003), is “…from a holistic perspective, one does not see any ‘surplus’ water, because every drop performs some ecological service all the time. The ecosystems evolve by making optimal use of all the water available. If a decision is taken to move some amount of water away from a basin, a proportional damage will be done to the ecosystem, depending on the service provided by that amount of water…there is no ‘free surplus’ water in a basin that can be taken away without a price.” Proponents of this view argue that the water flowing into the sea is not waste, but rather a crucial link in the water cycle. With the link broken, the ecological balance of land and oceans, fresh water and sea water, is also disrupted (Shiva 2003). But others argue differently. They opine that some Indian river basins have vast non-utilizable water resources, even after meeting all human and eco-system services needs. The

Brahmaputra River basin's renewable water resource capacity is about 584 km^3, which is about a quarter of India's total water resources. And only about a quarter of that is potentially utilizable within the basin. Water accounting of a few other basins also show significant non-utilizable water resources. A part of this non-utilizable water resource can be beneficially used for the rapidly expanding population, without a noticeable impact on the eco-systems.

The recent groundswell of worldwide opposition to large dams and irrigation projects that interfere with nature in a drastic manner has found a window of expression in the debates on ILR. Shiva (2003) considers ILR to be an act of violence against nature: "Violence is not intrinsic to the use of river waters for human needs. It is a particular characteristic of gigantic river valley projects that work *against*, and not *with*, the logic of the river. These projects are based on reductionist assumptions, which relate water use not to nature's processes but to the processes of revenue and profit generation…Rivers, instead of being seen as sources of life, become sources of cash. In Worster's words, the river ends up becoming an assembly line, rolling increasingly toward the goal of unlimited production. The irrigated factory drinks the region dry." Iyer (2003) is acerbic in his comments on IRL projects: "Are rivers bundles of pipelines to be cut, turned around, welded and re-joined? This is technological hubris – arrogance – of the worst description, prometheanism of the crassest kind. The country needs to be saved from this madness."

Yet more recently the pendulum has begun to swing back towards investments in water infrastructure, and in some countries, most notably in China, which did not have to depend on external sources to secure the necessary financing, there have been many dams constructed in the recent past. The ICOLD World Register of dams shows that China has 4,434 dams (ICOLD 2000). Other sources estimate much higher figures for dam construction in China, as high as 22,000 large dams (WCD 2000). At WSSD in Johannesburg, recognition was given to hydropower as a renewable resource for power generation, and the World Bank water strategy (World Bank 2005) laid the groundwork for a re-engagement of the multi-lateral banks in large-scale water infrastructure. Most recently the Comprehensive Assessment of Food and Agriculture (CA 2006) determined that investments in large-scale infrastructure will be necessary in regions where there has historically been under-investment, such as sub-Saharan Africa and parts of Asia. That Assessment said, investment in large-scale irrigation, even as a component of multi-purpose developments is generally economically unattractive. Also, while certain parties may again be attracted to investing in water infrastructure, the modalities to ensure that the infrastructure developed is effective and sustainable remain highly contentious.

Social Costs

ILR is likely to cause the displacement of tribesmen and poor people on a massive scale; and India's past record in fair and just rehabilitation of 'Project-affected people' does not inspire confidence among ILR critics that the project will not ride roughshod over millions of displaced people. The construction of reservoirs and river-linking canals in the peninsular component alone expects to displace more than 583,000 people and submerge large areas of forest, agriculture and non-agricultural land. Two of the proposed reservoirs, Inchampalli at Inchampalli-Nagarjunasagar and the Polavaram at Godavari Polavaram –Krishna (Vijayawada) and the associated river-linking canals are estimated to displace more than 100 thousand people in each locality.

According to one estimate, the network of canals, extending to about 10,500 kms, alone would displace about 5.5 million tribesmen and farmers (Vombatkere 2003). To this number, we must add the people to be displaced by the various reservoirs planned. The plight of these people becomes even more serious because the government of India does not have a sound and clearly spelt out resettlement and rehabilitation policy (Bandyopadhyaya and Praveen 2003).

A major lesson to be drawn from the recent history of large-scale water resources projects in India and elsewhere is that despite government policies and procedures that include the necessary redress measures, displaced populations still suffer unduly. Although assurances are given to mitigate the social impacts of such projects, it has proven to be difficult to transfer such assurances to deeds. However, it must be said that this is not something insurmountable.

Although many often focus on the social impacts of displacement of persons under IBTs, these multi-purpose water transfers do bring significant social benefits too. Many water transfer projects require both skilled and unskilled labor, and the training provided for the local and sometimes for the regional or national workforce, is a major advantage for future endeavors. Often, large water development projects increase access to new infrastructure: roads, which otherwise takes hours to reach to a decent mode of transport; markets, which otherwise are not even reachable for several days; clean water supply- without which people, especially women and children, trek hours to find a potable water source. The large irrigation projects not only enhance the livelihood of the farming families in the command area, but also bring substantial multiplier effects to the region, and in some cases at the national level too (WCD 2000). The Bhakra Irrigation Project's regional multiplier is 1.7 of the direct benefits (Bhatia and Malik 2005). And the Indus Basin, where irrigation is an integral part of the crop production system, meets more than 80 % of the food production deficits of other basins in India. It is not a secret that irrigation was a major factor in transforming the major food deficits in India in the 1950s and 1960s to present day food surpluses.

Resources Mobilization

Rath (2003) called the ILR a 'pie in the sky' because he, like many others, is skeptical of the government's capacity to mobilize the kind of investable funds that ILR demands. Budgetary provisions made so far for water development are far from enough to complete ongoing projects. During recent years, under a special 'Accelerated Irrigation Benefits Scheme', the government has been setting aside funds for the so-called 'last mile' projects (projects which are nearly complete but have been languishing for years for the lack of relatively modest funds to complete minor residual work). Many incomplete projects dot the country, to the extent that the NCIWRD estimated that India needs Rs.70,000 crores during the Tenth Plan and Rs.110,000 crores during the Eleventh Plan just to complete these 'last mile' projects. Senior researchers like Iyer (2003) quip, "We have had great difficulty in completing even single projects successfully and we want to embark on thirty massive projects at the same time."

Domestic Politics

Domestic and regional geo-politics play a key role in the discussions on ILR. For one, for the Indian political class, ILR has provided a vehicle for grandstanding. As Iyer (2003) suggests, “Gigantism always casts an irresistible spell on our bureaucracy and technocracy as well as on our politicians.” What are now recognized as the Supreme Court’s unpremeditated casual remarks, were zealously adopted by senior NDA government leaders as the court’s order by the government ‘with uncharacteristic promptitude and enthusiasm’. The successor UPA government is procrastinating on the project; however, there is little doubt that political push at a sufficiently high level will be enough for the technocracy to brush aside all the debates and launch the country headlong into ILR implementation quite like Lin Piao, China’s Premier launched his country in the South-to-North water transfer project in 1995. Such a rushed scenario at best would result in developments that are less than economically, socially and environmentally optimum for India’s future, and, more than likely, would fail to deliver on the promised water-secure future.

But politics may also act as a barrier to ILR. Even within India, creating a strong political consensus around the project will require considerable effort. Neither political negotiations nor arm-twisting of the kind Mrs. Indira Gandhi used to settle water disputes among states promise such consensus; economics may help wrench open a window to cooperation. Bihar refused to let Ganga waters to be transferred, arguing that if her farmers are unable to use her water today, does not mean they will remain unable to do so forever. Her leader Lalu Prasad Yadav, however, did a volte-face when someone mentioned Bihar might get paid for the Ganga water she allows to be transferred.

Even more serious political issues arise when the dynamics in riparian countries—Nepal, Bangladesh, Bhutan—are considered. The realization of the Himalayan component is critically dependent on the agreement of neighboring countries Nepal and Bhutan to the proposed construction, especially of dams, in their respective territories. Bangladesh, as a downstream country, will be an affected party, and needs to be taken into consideration. Under the India-Bangladesh Treaty of December 1996 on the sharing of Ganga waters, India has undertaken to protect the flows arriving at Farakka, which is the sharing point. West Bengal has only reluctantly agreed to the large allocations of waters to Bangladesh under the Ganga Treaty and has been pressing the needs of Calcutta Port. On the other hand, Bangladesh may feel threatened that a diversion of waters from the Ganga to the southern rivers will not be consistent with the sharing arrangement under the Treaty.

Owing to this geo-political conundrum, the planning of the Himalayan component of IRL as well as discussions about it are shrouded in opacity. Even as a National Commission, the National Commission of Integrated Water Resources Development Project (NCIWRDP) could not have access to data related to the Himalayan component (NCIWRD, 1999:187). This opaque data environment obfuscates several critical issues. For instance, how can one estimate the minimum flows in Padma or Meghna or the Hooghly-Bhagirathi required for sustaining fishing livelihoods in southern Bangladesh and the state of West Bengal. Or as Bandyopadhyaya and Praveen (2003) ask: “What will be the impact of the diversion of the 10 % of the lean season flow from ‘surplus’ river basins on the groundwater resources and saline incursion in the downstream areas?”

Protagonists of ILR, like Verghese and Prabhu are the first to accept that ILR as a concept is a non-starter until India offers its co-riparian countries a deal they cannot refuse. Verghese (2003) suggests that the project can be a win-win opportunity for all neighbors. However, civil society players in Nepal and Bangladesh do not share Verghese’s positive view, at least not yet.

Questioning Core Assumptions

It would be wrong to say that the arguments for and against ILR are evenly balanced. Even the available sketchy arguments based on superficial information and an analytic base raise serious questions about: a) what is ILR b) what precisely are the problems that ILR would help resolve c) is ILR the best available alternative for resolving those issues d) are the problems ILR is currently designed to resolve likely to stay that way when the project is commissioned 50 - 70 years hence?

Recent work by IWMI and partner researchers throws new light on these questions. Many of the factors that the NCIWRD projections were based on have already undergone significant changes, and could alter future water supply and demand projections. For instance, the justification for, as well as the cost-benefit calculus of the ILR in its broadest conception, critically hinges upon projections of population growth, urbanization patterns, and occupational diversification. And contrary to NCIWRD prognoses, recent data suggests that all of the said factors are displaying significant rates of change. In contrast to the NCIWRD projected state-wise population growth by pro-rata distribution of national population projections from the 1991 population census, the new regional population growth projections, incorporating age-size structure, HIV/AIDS and adjusted fertility and mortality estimates from the 2001 census, show vastly different emerging patterns (Mahmood et al 2006). According to these new estimates, India's population is projected to increase from 1,027 million in 2001 to 1,190 million by 2051 and stabilize thereafter. Although the total population is not drastically different to the NCIWRD projections, many states, especially those which are water-scarce, have significantly different growth patterns. Andhra Pradesh, Kerala, Karnataka, Punjab, and Tami Nadu are expected to face appreciably declining population trends before 2050. Haryana, Gujarat, Maharashtra, Orissa and the West Bengal too will experience a moderate decline, while Bihar, Jharkhand, Madya Pradesh, and Chattis Garh are expected to show an increase in population. These are the states where pressure on farmlands and demand for irrigation will continue to be high. This new regional demographic calculus needs to be incorporated into future water demand estimations, although even at this stage the differences between these estimates and those used in the overall conception of the NRL project underscore the need to revisit the basic idea of the scope and ultimate effectiveness of ILR.

NCIWRD's prognosis of food demand too has received considerable scrutiny from proponents and opponents of the ILR debate. The food grain demand projection (279 kg/person and 450 million MT/year total by 2050) of the Commission was a major driver for irrigation demand estimation. At this rate of food grain consumption, the total calorie intake per person is estimated to be at least 4,000 kcal/day (assuming that grains constitute 63 % of the total calorie supply). These estimates are way above the average calorie intake of even the most developed economies at present, and are clearly out of line with the changing consumption patterns. A recent study (Amarasinghe et al. 2006) incorporating a number of significant aspects from the changing consumption patterns over the past decade and their consequences for the future, projects India's total grain demand to increase from 209 million MT in 2000 to about 380 million MT by 2050. This projection includes 120 million MT of feed grain demand, which is a 10-fold increase from the present levels and a factor that was not considered in the earlier estimates. Even the results of this study, however, fall short of the NCIWRD's projection of total grain demand by 114 million MT.

It is argued by many that to heighten the need for expanding irrigation, the NCIWRD took an unduly bleak view of the potential to increase food grain yields. They assumed average grain yield to fall from 1.5 tonnes/ha in 1993 to 3.1 tonnes/ha in 2050 (2.3 and 1.0 tons/ha on irrigated and rain-fed yields respectively in 1993 to 4.0 and 1.5 tons/ha on these by 2050). Critics argue that 50 years is a long period and India can easily outdo the Commission’s unrealistically low projections of yield growth with far cheaper and simpler interventions than ILR. China and India had similar grain yields in the early 1960s, but China’s present yield is two and a half times more that that of India. Over the same period, the USA’s grain yield increased by almost 4 tonnes from 2.5 tonnes/ha in 1961. Can’t India’s average yield be increased to 4.0 tonnes/ha, China’s present level, even over a 50-year period? If yes, India will be self-sufficient in food without *any* additional land for grains.

NCIWRD’s prognosis for how India’s future of irrigation shapes up is also a contentious issue. According to the Commission, surface water supply would be the dominant form of irrigation by 2050. The Commission projects that surface and groundwater irrigated area will change from 1993’s levels of 55% and 45% of the gross irrigated area to 45% and 55%, respectively, by 2050. However, the developments over the last two decades show a completely opposite trend. There was no appreciable increase in surface irrigated area, although due largely to private small-scale investments, the groundwater irrigated area recorded a rapid growth. Today, groundwater contributes to 33 million ha which constitutes 63 % of the net irrigated area and 64 % of the gross irrigated area. It is therefore, largely due to this increase in groundwater irrigation that the gross irrigated area projection of 79 million ha for the year 2010 has been already achieved by the year 2000. But the consistency of these numbers depends on how far groundwater irrigation can grow without any surface irrigation growth?

Many contend that groundwater irrigation cannot be increased without surface irrigation recharge. But a substantial part of growth in groundwater irrigated areas in the last decade took place in districts outside the command areas (Shah et al. 2003) and showed no significant spatial dependence on surface irrigated area growth (Bhaduri et al. 2006). Our analysis shows that if the 10 million ha of net surface irrigated area from the projects under construction and another 25 to 35 million ha of net groundwater irrigated area is added to the present level of irrigation, the gross irrigated area will increase to about 130 to 140 million ha. This is the area required for achieving the Commission’s projections of, and perhaps the bloated, self-sufficiency targets of grains. With this increase, groundwater (GW) irrigation by 2050 will cover more than 70 % of the gross irrigated area. Such a change will significantly reduce the total irrigation demand due to differences of efficiencies between surface irrigation (60%) and GW irrigation (77%). But, can the commission’s optimistic assumptions on irrigation efficiency increase be realized by 2050?

The commission assumed a significant increase in irrigation efficiencies—from 35%-40% to 60% for surface irrigation and from 65%-70% to 75% for groundwater irrigation across all the river basins. The little information we have today on the variation of irrigation efficiency across river basins is not adequate to predict future directions. However, they show that groundwater irrigation efficiency is already close to or even higher than the commission’s projections (Kumar et al. 2006). But the surface irrigation efficiency has shown virtually no increase over the last decade. With water-scarce river basins approaching high degrees of closure, there are no flows to the sea on many days of the year. In these, efficiencies of surface irrigation are low, but they have high basin efficiency due to reuse of the return flows of irrigation Thus increasing irrigation efficiency in one location, and then using the saved water for new locations or for other purposes, would certainly affect some other water users elsewhere. We need to know more on the interactions of efficiencies at the system and basin levels before making firm statements on the potential improvement of efficiency in the surface systems. Or, at least we need conservative assumptions on the potential increases based on the information currently available.

To what extent will the younger generation of today take to agriculture as their primary occupation in the future? NCIWRD assumed that many rural people would stay in agriculture and the access to irrigation is necessary for adequate livelihoods for them. However, according to recent research on the agriculture demography of India (Amrita et al. 2006), today's younger generation perceived it differently. There is a high likelihood that today's young rural farmers will move out of agriculture, or at least keep it as a secondary income activity, regardless of the increased access to irrigation. This is more evident in the group who has different skills and better education. The tendency of moving out of agriculture is higher where the distance to travel to town or urban centers is less. Certainly, future generations of India will be more educated, and will be acquainted with better skills. And many rural centers are being transformed to small towns and towns to sprawling urban centers. Infrastructure facilities such as access to roads, electricity, and telecommunication are also increasing. Thus, the migration from permanent rural agriculture to other primary income generating activities will increase. So we also need a better understanding of the emerging trends of the agriculture demography and the resulting land use patterns to project the future agriculture water demand.

Did the commission's report overlook the potential of rain-fed agriculture? They projected only a modest growth from 1.0 tons/ha in 1993 to 1.5 tons/ha by 2050. At present, rain-fed area accounted for 56 % of the grain crop but contributed to only 39 % of the total production. If the rain-fed yield can be doubled over the next 50 years, the grain production on the existing rain-fed lands can alone be increased by 81 million metric tonnes. This kind of increase in grain production will meet a substantial part of the future food demand. IWMI research shows that supplemental irrigation, especially during the water-stress period of the reproductive stage of crop growth, can benefit a substantial part of the rain-fed area (Sharma et al. 2006). And this requires collecting only 18-20 km^3/year of water through rainwater harvesting using small-scale structures. They argue, that water harvesting of this magnitude would have no effect on the downstream users.

The commission's eco-system water demand estimate is an anathema to environmentalists and a concern to many others too. And, perhaps, they have every reason to be critical. Even the commission has admitted that the eco-system water demand estimate— 20 km^3 - 1 %— median of the mean annual runoff of all river basins is not an adequate figure. Preliminary research by IWMI on environmental water demand shows that in many basins, depending on their hydrological variability, a healthy river ecosystem may be maintained even with 10-20 % of the environmental flow allocations from the average annual runoff (Smahktin et al. 2006). Many argue that environmental water demand should include the needs of wetlands, for cleaning the polluted rivers, for fisheries' needs in the down streams etc. All these, and the resulting ecosystem water needs will have a significant impact on inter-basin water transfers, as the ultimate decision of the surplus or the level of closure of river basins is decided on what part of the utilizable water resources are required for the eco-system water needs.

Concluding Remarks

If the fate of ILR were decided on the shape of the present national debate around it, the dice are heavily loaded against it. However, this intensely polarized ongoing Indian debate about ILR is a product of a plurality of prevailing conditions and past experiences. A classic example is the turn the debate takes over different years: in a year of widespread monsoon failure and hydrological drought, when concerns of water scarcity dominate media attention and public debate, demand for state intervention through grandiose schemes like the ILR gathers momentum. In contrast, in years of nation-wide good monsoon—such as 2005 and 2006—water infrastructure issues fade from public spaces.

It is possible to argue that the present proposal for ILR has come a decade too soon. Many factors may change, which are likely to create conditions favorable for a comprehensive solution of the kind the ILR’s proponents promise, although it is likely to be quite different in nature to the ILR that is presently conceived. In particular, the following seven contingencies may be important in determining how the country will plan its water infrastructure investments over the coming decade or two:

Economic Growth

Many bold infrastructure investment proposals appear financially unfeasible in a low-income economy with limited capacity to generate investible resources. It is no accident that over 90 % of the IBT projects that Snaddon, Davis and Wishart (1999) review are from the US, Australia, New Zealand, Europe or other rich economies. Mao proposed China’s South-to-North water transfer project in the early 1950s; however, it was the government of only a much richer China in the mid-1990s that began putting their money on an idea that Mao had mooted. The ILR proposal of investing US$120 billion sounds outrageously bold for an Indian economy of US$700 billion; however, if the Indian economy keeps growing at 8-9 %/year, the proposal may not appear outlandish in a decade or so, especially if its proponents can produce a convincing justification for it;

Improved Public Systems

Implicit in much civil society opposition to ILR is the abysmal track record of water bureaucracies to deliver on their promises. Even though India has a very low storage per capita, it is ironic that most of its dams seldom fill up to the full, canals never reach designed command areas; public irrigation systems cost many times more per hectare to build than they ought to; and hydroelectric plants seldom perform at par. This chronic underperformance median —caused in part by poor capacity and in part by lack of accountability mechanisms—has created a confidence crisis in public systems. However, with creeping improvement in other infrastructure sectors—notably, roads, railways and power—new institutional models for infrastructure creation and management are likely to restore the country’s confidence in its capacity to create and manage large infrastructure projects.

Rehabilitation

By the same token, the question of managing displacement and rehabilitation of project-affected people in water infrastructure projects will increasingly get benchmarked against road, SEZ and other high-stake infrastructure projects where economic costs of delays or inaction are far higher than irrigation projects. Unless the country puts into place a more humane and widely acceptable rehabilitation policy, infrastructure projects in economically more dynamic sectors are likely to run into road blocks. Much better rehabilitation packages recently offered by some private sector players, such as Reliance and Tata, is an indication of movement in this direction.

Economic Water Scarcity

What responses India forges to respond to water scarcity will depend critically on the revenue model that it can implement to make water infrastructure viable in economic terms. The litmus test for scarcity of anything is its increased price. Ironically, growing water scarcity in India's countryside and towns is still producing only weak and fragmented price signals, especially for the water services delivered by public systems. This raises big questions about how a huge infrastructure investment that a project like ILR implies, would be financed and sustained. Financing its construction and O & M wholly through taxes would be hard to sell, especially if the revenue generation model cannot even take care of maintenance and repair, as has been the case with much public irrigation infrastructure. Arguably, the ability as well as willingness to pay for better water service is linked to disposable incomes in domestic uses and water productivity in irrigation. With economic growth, as the 'median voter' with higher disposable income demands better water services and is willing to pay for them, large-scale investments in water infrastructure will become more viable in financial terms. Economic water scarcity—in terms of willingness to pay for scarce water—will also affect the political dynamics of water sharing. So far, water-scarce states are increasing their share in national water resources using adjudication or central government's authority. However, as water-scarce states get richer, they will be willing to pay water-rich poor states for water imports just as Gauteng paid Lesotho and Singapore paid Malaysia.

Agricultural Diversification

In purely economic terms, public investments in irrigation can hardly be justified in today's India. At the aggregate level, the difference in gross value of output on an irrigated and unirrigated hectare is just about US$100-120/year while it costs US$3,500-4,000 to bring an additional hectare under public irrigation. This is because most command areas are used to grow food grains, while high-value crops are grown outside the command areas. In California, Spain, and Victoria in Australia, irrigation supports a gross value of farm output in the amount of US$5,000-9,000/ha, as irrigated land is generally used for high-value export crops. Movement in this direction—of using reliable irrigation for growing high-value crops for urban markets and exports—is gathering momentum in many parts of India. Farmers using irrigation for value-added farming, demand a better and more reliable irrigation service, and are willing to pay for it. Should such a trend gather momentum, farmers in water-scarce western and southern India will make a stronger economic and political demand for ILR type interventions.

Rising Energy Costs

Irrigation expansion in India—South Asia in general—during the recent decades has come not from public investments in surface irrigation projects but from private investments in small lift irrigation systems, using mostly ground but also surface water sources. These offer the advantage of flexible, reliable, on-time irrigation that most surface sources are unable to provide. However, this mode of irrigation development is highly energy intensive; and as energy prices—electricity and diesel—rise relative to farm product prices, one should expect a growing preference from farmers either for superior irrigation from surface water sources or supply of surface water for groundwater recharge. Rising relative energy prices may have a dramatic impact on rural India's support for an investment proposal such as the ILR.

Urbanization

Most Indian towns and cities depend largely on groundwater for running their water supply systems. Experience around the world shows that as a village grows into a town and thence into a city, its area extent grows at a much slower pace than its population. And when the population density of a settlement rises, its groundwater fails to keep pace with water demand regardless of water harvesting and recharge. Beyond a stage, a city invariably has to source its water from a distant reservoir. This is becoming increasingly evident in India, but more so in China whose urban water supply trends present a leading indicator to India. Indeed, growing cities and hydropower generation provide a much stronger socioeconomic justification for IBTs than the need for producing more food. Urbanization will thus make IBTs economically viable and politically compelling, although the shape of these IBTs may be different from the proposal currently under discussion. There seems little India will be able to do to avoid either IBTs or water infrastructure investment scales comparable to—or even exceeding—the present proposal.

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