Chapter 7
River Linking Project: A Solution or Problem to India's Water Woes?

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Abstract The public discourse on the National River Linking Project (NRLP) has been hopelessly lopsided—with the protagonists of the project unable to take on the antagonists on either their rhetoric or their analytics. This paper contributes to the discourse by presenting a balanced analytical point of view from a series of studies conducted by the International Water Management Institute and its partners. The studies have analyzed the drivers and assumptions used to justify the NRLP and have assessed hydrological, financial and social implications of the NRLP water transfers. These studies find that the underlying assumptions have either changed over time or have flaws and alternative options are not given the consideration these need and deserve. Given these and many other factors, the hydrological, financial and social benefits and cost, if implemented in its present form, are mixed. However, the paper also argues that the idea of NRLP may have come a decade or two soon; and that a slew of upcoming contingencies shall not only change the tenor of the debate around inter-basin water transfers but even make a compelling case for them, even if in a different form than the present proposal.

Keywords River linking project • NRLP • River basin • Water transfers • Storage • Irrigation • Groundwater

7.1 Introduction

For a long period, 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. Few grand proposals of linking rivers evoked the imagination and

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enthusiasm of water stressed Indians from time to time. At the forefront were, Sir Arthur Cotton's plan of linking rivers in southern India in the nineteenth century, Dr K. L. Rao's plan of linking Ganga and Cauvery in the 1970s, and Captain Dastur's plan of lateral Himalayan canal linking Ravi and Brahmaputra and an interconnected Garland Canal girdling peninsular in the later seventies. In addition, the latest is the grandiose scheme to link Himalayan rivers and river in peninsular India—those currently under discussion as National River Linking Project (NRLP). In the early 1990s, the National Water Development Agency (NWDA) was entrusted to start detailed planning for a mega-scheme of NRLP under the national perspective plan for water resources development (NWDA 2012a).

Implementing mega-schemes, which require pre-feasibility, feasibility, and environment impact studies, is a long drawn out process. Many proposals do not even go beyond the drawing board, as the planners themselves dismiss ideas as too grandiose. Nevertheless, in 2003, acting on public interest petitions, the Supreme Court of India has decided that the time had come for the nation to pull its act together on the waterfront, and enjoined the Government of India to complete all planning required to complete the NRLP by 2016. President Abdul Kalam too endorsed the idea and vigorously argued that the government should plunge headlong in its implementation without wasting time unduly in studies.

The ruling National Democratic Alliance government at that time—constituted a high-powered, multi-disciplinary task force to embark upon the NRLP project forthwith in deference to the Supreme Court's injunction. However, a groundswell of opposition to the project emerged from environmental groups and civil society organizations with a battery of arguments representing a variety of perspectives. Most of these did not even address the benefit-cost issues but questioned the basic model of water resources planning and management through large-scale dams and canal networks ('the disease of gigantism', as one antagonist referred to it) that the NRLP exemplified (Alagh et al. 2006). The interest in the project has waned since then, or at least placed in the back burner until the next major nation-wide drought.

The idea of linking Himalayan Rivers with peninsular and western ones has however proved hard to kill. Like phoenix, it rose from its ashes again in 2012, when the Supreme Court took note of it *suo moto*, and based largely on an economic analysis by the National Council for Applied Economic Research (NCAER 2008), again enjoined the government to implement the project so as to complete it by 2016! (Venkatesan 2012). The NCAER study showed NRLP's economic benefits will exceed its costs, but it is not clear whether the battery of assumptions would hold under intense scrutiny. Once again, the civil society started to express anxiety of the Supreme Court decision (Iyer 2012; Narain 2012). The responses of the Government of India to the second Supreme Court decision and on people's concerns are not clear yet.

Against this backdrop, this paper discusses major assumptions and implications of NRLP water transfers on Indian water, land and social scape. After this brief introduction, the next section, on *the NRLP project*, gives a brief technical overview of the project concept. Section 7.3 titled, *Justification of the NRLP*, discusses the economic and social justification of the project as advanced by the

NWDA. Section 7.4, *Analyses of Core Assumptions*, critique the core assumptions behind the large project. Section 7.5, *The Implication of NRLP Water Transfers*, assesses the implications of implementing such a large project. The final section discusses under what contingencies a project like NRLP would be required to address India's water woes and their implications on policy and research.

7.2 The NRLP Project

7.2.1 Himalayan and Peninsular Component

The NRLP intends to transfer 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 2012a). Conceptualized in two components, Himalayan and Peninsular (Fig. 7.1), the project will build 30 link canals and approximately 3,000 storages to connect 37 Himalayan and Peninsular rivers. The canals, which are planned to be 50–100 m wide and more than 6 m deep, will handle 178 billion cubic meters (BCM) of inter-basin water transfer/per year. The Himalayan and Peninsular components will transfer 33 and 141BCM of water respectively, through a combined network of close to 15,000 km long distributary canals.

The Himalayan Component, with 16 river links, has two sub-components one linking Ganga, Brahmaputra and Mahanadi Basins (links 11–14 in Fig. 7.1), and the other comprising links between eastern Ganga tributaries and Chambal and Sabarmati river basins (links 1–10). Altogether, these transfers intend to mitigate floods in the eastern parts of the Ganga Basin, and provide the western parts of the basin with improved irrigation and water supplies. The Himalayan component needs several large dams in Bhutan and Nepal to store and transfer floodwaters from the tributaries of the Ganga and Brahmaputra rivers, and within India to transfer the surplus waters of the Mahanadi and Godavari rivers.

The peninsular component, with 14 major links has 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 will serve a substantial area as proposed under the NRLP, and much these beneficiary lands are in arid and semi-arid western and peninsular India.

The 'back-of-the-envelope calculations', the best available so far, suggest that the project will altogether cost about US$ 123 billion (or Indian Rs. 560,000 crore) at 2000 prices. This includes US$ 23 billion (In Rs. 106,000 crore) for the peninsular component, US$ 41 billion (Rs. 185,000 crore) for the Himalayan component and US$ 59 billion (In Rs. 269,000 crore) for the hydroelectric component. Given that India's Wholesale Price Index in 2012 is 120 % higher than in 2000, the project cost at current prices would be more like Rs. 1.19 trillion (US$ 216 billion).

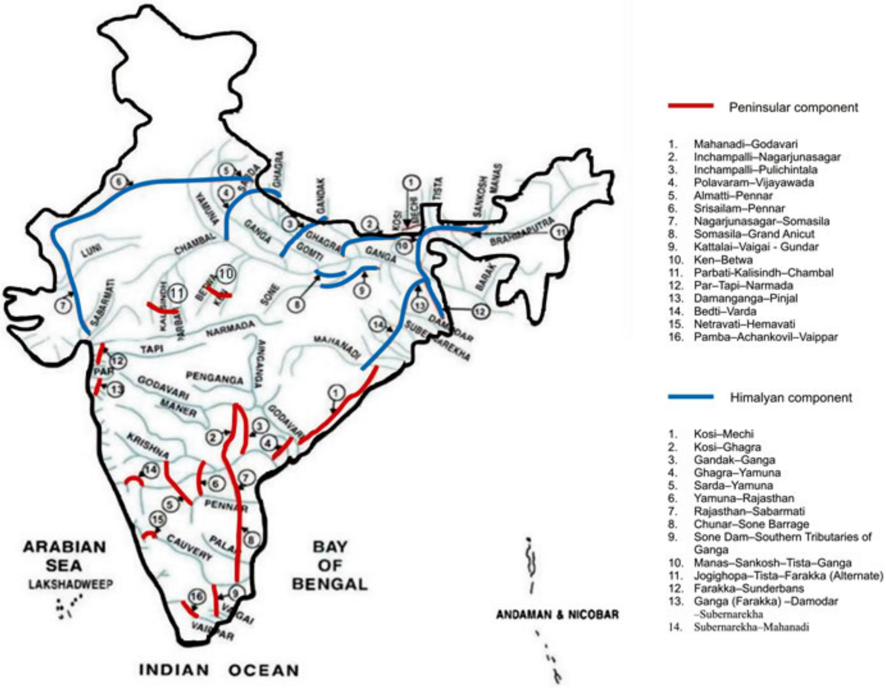

Fig. 7.1 Links of the Himalayan and peninsular components (*Source:* IWMI (2008))

NWDA claims the project will add 34 G watts (GW) of hydropower capacity, which includes 4 and 30 GW from the peninsular and Himalayan components respectively. Approximately 3,700 MW would be required to lift water across major watershed ridges by up to 116 m. It also adds 35 million hectares to India's irrigated areas, and generates an unknown volume of navigation and fishery benefits (NWDA 2012a). One worry with these numbers is their reliability. Water infrastructure plans in India are often exaggerate estimates of likely benefits and under-estimate costs, making them appear highly desirable. As projects unroll, the actual benefits turn out much smaller and costs much higher than shown in the planning documents.

7.2.2 Grandiosity of the NRLP

The NRLP is unique in its unrivalled grandiosity. If fully implemented, it could be the largest water infrastructure project ever undertaken in the world. The NRLP 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). The NRLP will also handle four times more water than the Three Gorges Dam; five times all the inter-basin water transfers completed in the U.S.A; and six times more than 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; Periyar- Vegai Link; and Telgu Ganga.

The cost of the NRLP could 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. The project will require a larger investment than the sum total of all irrigation investments made by the governments of colonial and free India since 1830. The actual cost could most likely be several times more than the present US$ 123 billion 'guest estimate', when it considers the cost of land acquisition and rehabilitation and resettlement.

Although enjoined to complete by 2016, the way irrigation projects in India have proceeded during recent decades, general agreement is that this grandiose project may not fully complete even by 2050. Varghese (2003) suggests, realistically, that NRLP could be a 50–100 year project. Only nine of the 30 proposed links are independent and can be constructed and operated without the other links. In the first stage of the Project, which won government approval, a 230-km canal will transfer water from the Ken River to the Betwa River in the northern Madhya Pradesh. A dam and small hydroelectric plant in the Ken River will be located in the Panna Tiger Reserve. Work on the first component of this US$ 1.1 billion project is underway, and will alone take 8 years to complete (Bagla 2006).

7.3 Justification of the NRLP

7.3.1 Augmenting Utilizable Water Supply

The *raisons d'être* of the project is the accentuating water scarcity in western and peninsular India, low storage capacity and per capita utilizable water supply, high spatial and temporal variability of rainfall and the associated droughts and floods.

In India's 19 major river basins, only 55 % of the total renewable water resources (TRWR) are utilizable (GOI 1999). 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 TRWR. The Brahmaputra sub-basin alone drains 31 % of the TRWR, but due to geographical restrictions, only 4 % of the TRWR are potentially utilizable. In contrast, the Krishna, Cauvery and, Penner river basins and few other eastward flowing rivers cover 16 % of the land area, host 17 % of the population, but drain only 6 % of total water resources.

Due to this spatial variability of water supply, more than 200 million people have per capita utilizable water supply below 1,000 m^3/day, which, according to Falkenmark et al. (1989), indicates severe regional water scarcity. Due to over-development, some basins are physically water-scarce (Amarasinghe et al. 2005). One of the solutions suggested to deal with increasing water scarcity, is augmenting the utilizable water supply of water scarce basins by transferring waters from surplus basins.

Low reservoir storage capacity is another concern. At present, it is only 200 m^3 per person at present. These result in *economic* water scarcity, which, many fear, will impede economic growth. In comparison, other arid and semi-arid regions of the world have invested heavily in storage creation; Brazil, Australia and the U.S.A, have per capita storage capacity of 3,388, 4,717 and 5,961 m^3 respectively. Even China has increased its per capita storage capacity to 2,486 m^3. For this, and the fact that variability of rainfall is increasing due to climate change, many consider that it is imperative that India increases its storage for regulating the vast amount of runoff that otherwise cannot be beneficially utilized. The proposed NRLP water transfers will increase utilizable surface water resources by an estimated 25 % and improve water availability in water-scarce regions.

Flood and droughts inflict heavy damages. 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. Floods inflict an annual damage of well over US$ 220 million (Rs. 1,000 crores) (GOI 1999). In contrast, recurrent droughts affect 19 % of the country, 68 % of the cropped area and 12 % of the population (Nair and Radhakrishna 2005). Reservoir storages and the canal diversions in NRLP would, it is argued, reduce flood damages by 35 % (Sinha et al. 2005) and ease drought-proneness in semi-arid and arid parts. Also, NRLP will make 12 km^3 of water available for domestic and industrial sectors in these drought-prone districts. Many argue that diverting a portion of the surplus floodwater from the Himalayan Rivers into the drought-prone areas can only be a win-win proposition for the country.

7.3.2 Meeting Food Self Sufficiency

Self-sufficiency in food grains is a key plank of the NRLP justification. Lay circles consider that the report by the National Commission of Integrated Water Resources Development (GOI 1999) as the first cut justification of the NRLP's design-concept. Assuming the criticality of maintaining national food self-sufficiency and agricultural exports, the Commission projected a grain demand in the range of 425–494 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 (NWDA 2012b). The surface irrigation from NRLP alone is expected to add 25 million ha of irrigated land.

Improving rural employment is another justification for the NRLP. The rural population in India will peak at about 775 million by 2015 (UN 2004). The Commission projected that the rural population will decrease to about 610 million by 2050, but assumes that a large part of the rural population will remain agriculturally active in the future.

7.4 Analyses of Core Assumptions

7.4.1 Demographic Change

Changes in demography are critical to NRLP food and water demand projections. The NCIWRD projected the state-wise population growth by pro-rata distribution of national population projections from the 1991 population census. However, the new regional projections (Mahmood and Kundu 2009) incorporating age-size structure, HIV/AIDS and adjusted fertility and mortality estimates from the 2001 census, show vastly different emerging patterns. Although the total national population projections are not different, new projections show that many water scarce states, including Andhra Pradesh, Kerala, Karnataka, Punjab, and Tami Nadu will have appreciable decline in population trends before 2050. Haryana, Gujarat, Maharashtra, Orissa and the West Bengal too will experience a moderate decline, while Uttar Pradesh, Bihar, Jharkhand, Madhya Pradesh and Chhattisgarh will show an increase in population. Thus, unlike in the NLRP assumptions, the latter group of states—which are to cede water to southern and western states—is where pressure for farmlands and demand for irrigation will continue to be high.

Rural employment was a major driver of India's past irrigation development, the fact that NCIWRD has also emphasized. However, according Sharma and Bhaduri (2009), today's younger generation in Indian villages has different perception and priorities. 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 increased access to irrigation. This is more evident among rural youth who have 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. In addition, many rural centers will become small towns and towns to sprawling urban centers. Infrastructure facilities such as access to roads, electricity, and telecommunication are also increasing. Thus, migration from full time agriculture to non-farm rural and urban livelihood will increase; especially in economically more dynamic states where NRLP proposes to transfer Himalayan water.

7.4.2 Food Self Sufficiency

The NCIWRD has projected that India will have to produce 450 million MT (or 284 kg/person/year) of food grains by 2050, and an additional 45 million MT for feed, seed and waste. However, Amarasinghe et al. (2007) have shown significant changes in food consumption patterns over the recent decades. Because of these changes, India's total grain demand shall increase from 217 million MT in 2000 to about 380 million MT by 2050. This projection includes the feed grain demand of

120 million MT, which is a tenfold increase from the present levels, a factor that the NCIWRD study has significantly underestimated. Even then, the projections of Amarasinghe et al. study (2007) s fall short of the commission's projection by 115 million MT.

The Commission also assumed that self-sufficiency in food grains as a major driver of irrigation cropping patterns and water demand. The self-sufficiency assumption was based on three concerns: (1) India has a large population and food grain is the staple food, so, no major deficits are acceptable; (2) Agriculture is the main driver of economic growth and contributes to a large share of the GDP; and (3) India's foreign exchange reserves are too low to permit large scale imports of food grains. However, all three reasons are no longer valid in a rapidly growing India: food consumption patterns are fast changing, agriculture sector contribution to GDP is rapidly decreasing; foreign exchange reserve is increasing; and imports and exports, even in the agriculture sector, are growing (Malik 2009). The only concern that demands a significant level of self-sufficiency is that large grain imports from a country of India's size could potentially impact world prices and hurt the very consumer that imports are expected to help feed.

7.4.3 Yield Growth

Many argue that the Commission took an unduly bleak view of the potential to increase food grain yields. The Commission assumed average grain yield to increase from 1.5 tonnes/ha in 1993 to 3.1 tonnes/ha by 2050. However, if India can double the land and water productivities (1.67 tonnes/ha and 0.48 kg/m^3 of consumptive water use in 2000) in 50 years, it can not only be self-sufficient but also will not require any additional irrigated land or withdrawals for food grains (Amarasinghe et al. 2010).

The moot question is: will India be unable to increase its average grain yield to 4.0 tonnes/ha, which is the present level of China, even over a 50-year period? Research suggests that a significant potential exists for larger yield growth. There is significant variation in yield even within a same irrigation system or in the same region growing similar crops (Kumar et al. 2009) or in regions of similar consumptive water use (Amarasinghe et al. 2010). Increasing the reliability of irrigation and increasing the application of inputs can significantly increase grain yields in irrigation areas. Sharma et al. (2010) showed that even small doses of supplemental irrigation during critical periods of crop growth can double the productivity in the rainfed areas.

7.4.4 Future of Irrigation

The NCIWRD's prognosis for how India's future of irrigation shapes up is the most contentious. The composition of surface water and groundwater area in 1993 was 55 % and 45 % of the gross irrigated area. The Commission assumed surface irrigation would be the dominant form of irrigation by 2050, and the composition of net irrigated area will reverse by 2050. However, the developments in recent decades show a completely opposite trend (Fig. 7.2). There has been no appreciable increase in surface irrigated area in India, although, due largely to private small-scale investments, the groundwater irrigated area has recorded a rapid growth.

Today, net groundwater irrigated area is 39 million ha, which constitutes 63 % of the net irrigated area, and contributes to 64 % of the gross irrigated area. It is therefore, largely due to this increase in groundwater irrigation that India has achieved in 2000 the projected gross irrigated area of 79 million ha for the year 2010. But, the sustainability of these trends depends on how far groundwater irrigation can grow without any surface irrigation growth?

Many contend that increase in groundwater irrigation is not possible without surface irrigation recharge. But a substantial part of groundwater irrigated area growth in the last decade took place in districts outside the command areas (Shah et al. 2003) and showed no significant spatial dependence on surface irrigation growth (Bhaduri et al. 2009). The analysis by Amarasinghe et al. (2008) shows that if the 10 million ha of net surface irrigated area from the projects under construction and another 25–35 million ha of net groundwater irrigated area are 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 exaggerated projections of, and the self-sufficiency targets of grains. With this increase, groundwater irrigation by 2050 will cover more than 70 % of the gross irrigated area. Such a change will significantly reduce the total surface irrigation demand due to differ-

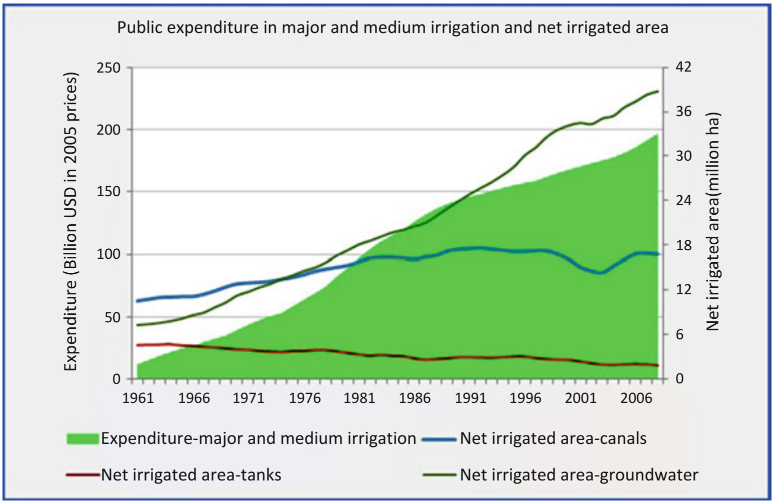

Fig. 7.2 Trends of public expenditure in major and medium irrigation and net irrigated area from different sources in India (*Sources:* Public expenditure data are from the Central Water Commission, Ministry of Water resources, Government of India (accessible via http://cwc.gov.in/main/webpages/statistics.html)). Net irrigated areas under different sources are from the Ministry of Agriculture, Government of India (accessible via the http://dacnet.nic.in/eands/)

ences of efficiencies between surface irrigation (60 %) and GW irrigation (75 %). But, can these optimistic assumptions on irrigation efficiency increase be realized by 2050? Can Managed Aquifer Recharge (MAR) in a decentralized format enable India to use its aquifers as large-scale storages in place of surface storages? These are critical questions for India's water future.

7.4.5 Irrigation Efficiency

The Commission assumed a significant increase in irrigation efficiencies—from 35–40 % now to 60 % in the future 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. 2009). But the surface irrigation efficiency has shown virtually no increase over the recent decades.

It is also clear that many water saving technologies, especially micro-irrigation systems, can significantly increase water use efficiency. Narayanamoorthy (2009) showed that the efficiencies of sprinkler and drip irrigation systems range from 75 % to 90 %. And, more than 70 million ha of land can potentially benefit from micro-irrigation. Many of these technologies are more easily adopted by groundwater irrigators than canal irrigators. This too may work in favor of larger contribution from groundwater to India's food self-sufficiency.

Many water-scarce river basins approaching high degrees of closure as there are no flows to the sea on many days of the year. In these basins, projected application 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 we can make 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.

7.4.6 Rain-fed Agriculture

Did the Commission's report overlook the potential of rain-fed agriculture? Surprisingly, the Commission projected only a modest growth in rain fed yields from 1.0 tonnes/ha in 1993 to 1.5 tonnes/ha by 2050. At present, rain-fed area accounts for 56 % of the grain crop but contributes only 39 % of the total production. But, by doubling the rain-fed yield to about 2.0 tonnes/ha 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 can meet a substantial part of the future food demand.

Sharma et al. (2010) find that frequent occurrence of mid-season and terminal droughts were the main causes for low yield or crop failure in rain-fed cropped lands. Small 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. This requires collecting only 18–20 km^3/year of water through rainwater harvesting using small-scale structures, and will have little or no effect on downstream users.

7.4.7 Eco-system Water Needs

The Commission's water allocation to eco-system services is only 10 km^3–less than 1 % of the mean annual runoff of all river basins. Even the Commission has admitted that this is not an adequate provision. IWMI research shows that in many basins, maintaining a healthy river ecosystem requires much more minimum environmental flows (EF) (Smakhtin and Anputhas 2006).

Level of minimum EF needed depends on the natural hydrological variability of the river and the maintenance requirements under various environmental management classes (Smakhtin et al. 2007). The former is an endogenous driver of the water system and the latter is exogenous. Environmental management classes, which depend on qualitative importance assigned by people, could range from pristine (natural) condition to slightly to moderately to critically modified conditions, and the minimum EF could accordingly vary from 70 % to 15 % of the mean annual runoff.

At present, many of the water surplus river basins considered in the NRLP fall in moderately modified category (Amarasinghe et al. 2008). If eco-systems' water needs get high priority, then effective water supply that is available for potentially utilizable supply for other uses would diminish. In fact, many argue that environmental water demand should also 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 proportion of the utilizable water resources are required for the eco-system water needs.

7.5 Implications of NRLP Water Transfers

7.5.1 Hydrological Feasibility

Surplus water in river basins and hydrological feasibility of large water transfers is a topic that is much in discussion; it is a highly contentious topic, too. Many contest the very notion that there can be water surpluses in river basins. One such extreme view, held by Bandyopadhyaya and Praveen (2003), is that "…from a holistic perspective, one does not see any 'surplus' water, because every drop performs some ecological service all the time. ….there is no 'free surplus' water in a basin that can be taken away without a price." Shiva (2003), likewise, considers NRLP to be an act of violence against nature. Iyer (2003) is acerbic in his comments on NRLP 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."

But others argue differently. For them, some large Indian River basins have vast non-utilizable water resources, even after meeting all human and eco-system service's needs. The total renewable water resource of the Brahmaputra basin is about 584 km^3, which is about a quarter of India's total water resources. But, only about a quarter of that is potentially utilizable within the basin. Mohile and Anand (2009) showed significant non-utilizable water resources also available in Mahanadi and Godavari basins. Rapidly expanding population and increasing demand in other basins can beneficially use a part of these non-utilizable water resources, without noticeable impact on the eco-systems.

Although major donor basins have significant surpluses, Smakhtin et al. (2007) showed that the use of annual data in feasibility reports shows up more water perceived to be available than actual for transfers at some transfer sites. This study concluded that when intra-annual variability of flow is accounted, any transfers of water at the transfer sites within the Krishna river basin would affect the environmental water requirement in the Krishna delta or vice versa. Hydrological modeling of the Godavari (Polawaram)-Krishna (Vijayawada) link (Fig. 7.1) also confirms the above finding that water transfers would affect the downstream users of the Godavari basin (Bharati et al. 2008).

Most recently, the Comprehensive Assessment of Food and Agriculture (CA 2007) by IWMI and partners determined that investments in large-scale infrastructure is necessary in regions where there has historically been under-investment, such as sub-Saharan Africa and parts of Asia. That Assessment however also said that investment in large-scale irrigation, even as a component of multi-purpose projects, is generally economically unattractive. But, Kumar and Saha (2008), based on data of India's large and medium dams, shows that increasing the storage capacity through large/medium dams is important for rapid economic growth in India.

These concerns and others hint at the need to be more circumspect about large-scale water transfers worldwide. However, more recently the pendulum has begun to swing back towards investments in water infrastructure. 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. According to the ICOLD World Register, China has 4,434 large dams (ICOLD 2000), but the actual number can be as high as 22,000 according to other sources (WCD 2000). The WSSD in Johannesburg recognized hydropower as a renewable resource for power generation. And, the new World Bank water strategy (World Bank 2004) laid the groundwork for a re-engagement of the multi-lateral banks in large-scale water infrastructure. All in all, the pendulum of global opinion has gradually moved again in favor of large dams, notwithstanding all the concerns that have arisen during recent decades. This change in the worldview may influence Indian thinking about NRLP. Despite renewed attention to 'giganticism' in water infrastructure planning, the modalities to ensure that the infrastructure developed is effective and sustainable will still remain highly contentious

7.5.2 Environmental Impacts

Environmentalists are worried about the ecological impacts of the NRLP water transfers of such a massive scale. In May 2003, the Government of India's own Ministry of Environment and Forests raised 23 environmental concerns about the NRLP. Independent researchers too worry on many counts, including seismic hazard, especially in the Himalayan component (Bandyopadhyaya and Praveen 2003). Many worry also about the transfer of river pollution that accompanies inter-basin water transfers. The potential loss of forests and biodiversity, of course, are recurring themes.

When completed, some 3,000 plus storages reservoirs of NRLP, will substantially change the river flow patterns and impact sediment loads to down-stream deltas. Such reduction in sediments could shrink river delta, affecting production and mangrove ecosystems. Large numbers of reservoirs already constructed in the Krishna basin have contributed to the shrinking of the river delta (Gamage and Smakhtin 2008). Further construction under NRLP, on the one hand could only exacerbate the shrinking of delta, and on the other hand may reduce the environmental flows, which-if protected—could partially arrest the shrinking delta.

The NRLP water transfers could also have both positive and negative externalities in terms of groundwater recharge and water logging. The proposed irrigation transfers in the Godavari (Polawaram)-Krishna(Vijayawada) link could raise the groundwater water level by 2 m and improve the groundwater profile of the over-exploited blocks of the Krishna basin. Simultaneously, intensive surface irrigation could increase the risk of water logging in about 16 % of the command area (Sharma et al. 2008). Without precautionary planning, as in many other large irrigation schemes in the past (Sharma et al. 2010), disbenefits of water logging could easily offset the benefits of groundwater recharge.

7.5.3 Irrigation Benefits

The NRLP envisages many benefits: generation of hydropower, supply of much needed drinking water to several million people, and industrial water supplies to drought-prone and water-scarce cities in the west and south, mitigation of floods in the east and droughts in the west and the south, and facilitation of inland navigation. However, increased irrigation is by far the largest benefit envisaged from the project. It adds 25 million ha through surface irrigation and 10 million ha through groundwater irrigation to water-scarce western and peninsular regions. This in turn shall generate more employment and boost crop output and farm incomes. It shall also provide multiplier benefits through backward linkages such as farm equipment and input supplies and forward linkages such as agro-processing industries.

Among the many scathing criticisms that this key plank of the project has come under, 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 (Rs. 2,015/acre @ 1 US$ = 45 In Rs) in the peninsular component and US$ 334/ha in the Himalayan component. For irrigating hybrid *jawar* (sorghum) in peninsular India, the required annual capital recovery cost alone will be US$ 221/ha. Similarly, the annual capital recovery cost at 7 % interest over 50 years amounts to US$ 0.30 per watt of hydropower. At the same interest rate charged during the construction period, the three components will cost US$ 252 billion (In Rs. 1,147,873 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 (In Rs. 100,000 crore) per year.

There are other concerns about such large scale investment, given the past trends of irrigation investments and benefits. The most notable trends are:

- India has invested more than US$ 24 billion (In Rs. 100,000 crore) since 1990 in major and medium irrigation, yet it has hardly increase the net surface irrigated area (Fig. 7.2). Tank irrigated area has been decreasing relentlessly
- Among southern states Tamil Nadu and Andhra Pradesh, two of the major water recipients of NRLP, have spent more than US$ 5 billion (In Rs. 22,500 crore) in major and medium irrigation since 1970, but lost more than 500,000 ha of net canal irrigated area over the same period (Amarasinghe et al. 2009);
- On the western front, Gujarat has already spent more than US$ 6 billion in the Sardar-Sarovar Project, although the planned cost of construction was only US$ 1.5 billion (In Rs. 6,840 crore). In spite of the cost over-run, only 0.1 of the 1.8 million ha of proposed area is irrigated (Talati and Shah 2009).

Ex-ante benefit: cost analyses of two link canals—Godawari (Polavaram)-Krishna (Vijayawada) and Ken-Bethwa—show similar trends. Major parts of the command areas in both links are already irrigated by groundwater or pre-existing schemes. In the Godavari-Krishna link, groundwater already irrigates 90 % of the en-route canal command. In the Ken-Bethwa link, rainfall is sufficient for the Kharif season crop cultivation, for which a substantial part of the water transfers under the link is planned. These studies show that when the canal links are considered individually, direct and indirect benefits per every cubic meter of water consumed or delivered are rather low even under most optimistic scenarios of cropping patterns (Bhaduri et al. 2009; Amarasinghe et al. 2008).

However, many of the NRLP links, such as those in the peninsular component, are inter-dependent. Water transfers to a river basin from up-stream links are a substitute for water transfers out from the basin from downstream links. These form a large project with many small components. Inocencio and McCornick (2008) have shown that large projects with many smaller schemes, with diversified cropping patterns, show better economic performance. Viewed from this perspective, similar are water transfers and irrigation benefits from the major links from Mahanadi to Godavari to Krishna to Pennar and Cauvery in the peninsular component (Amarasinghe and Srinivasulu 2009). Although irrigation benefits of some of the individual links are not financially attractive, the links taken together as a project may prove financially attractive under a diversified cropping pattern.

Of course, the above benefits are only direct and indirect financial benefits from irrigation. But, water infrastructure projects have other direct and indirect costs, including the cost of displacement of people—resettlement and rehabilitation, and the environmental impacts. The data on many of these aspects are scanty at best, and it is difficult to assess financial implications to complete a social cost and benefit of all links at present.

7.5.4 Social Costs

It is likely that NRLP shall displace *adivasi's* and poor people on a massive scale. Estimates are sketchy, but the construction of reservoirs and canals in the peninsular component alone is expected to displace more than 583,000 people, and submerge large areas of forest, agriculture and non-agricultural land. One estimate suggests that the network of canals alone would displace about 5.5 million tribesmen and farmers (Vombatkere 2003).

Many critics of large water projects often focus only on negative impacts, multi-purpose water transfers potentially can and do bring significant social benefits. Recent history of large-scale water resources projects in India and elsewhere, however, shows that despite government policies and procedures that include the necessary redress measures, displaced populations still suffer enormously. Such suffering can be moderated or reduced but only though planned and sensitive resettlement and rehabilitation programs which India has generally failed to establish so far. Samad et al. (2009) shows that enhanced livelihood opportunities in relocation sites can create longer-term benefits to compensate short-term losses.

In fact, 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 et al. 2007). 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.

7.5.5 Resources Mobilization

Many critics are skeptical of the government's capacity to mobilize the kind of investable funds that NRLP 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 at the turn of the century that India needed US$ 15.5 billion (Rs. 70,000 crores) during the Tenth Plan and US$ 24.4 billion (Rs. 110,000 crores) during the Eleventh Plan just to complete these 'last mile' projects. It is this fact that made senior researchers like Iyer (2003) to quip, "We have had great difficulty in completing even single projects successfully and we want to embark on 30 massive projects at the same time!"

These concerns relate to the small versus large storage debate. It is clear that freshwater storage at present is inadequate to address tomorrow's water needs. The situation will be more acute with the pending climate change impacts. There is evidence that increasing storage only through a combination of large reservoirs, small pond and tanks, soil moisture, groundwater aquifer and wet lands can bring the most socio-economic benefits while reducing the environmental cost (Keller et al. 2000; McCartney and Smakhtin 2010).

7.5.6 Trans-boundary Conflicts

There are trans-boundary issues of over-riding significance—within India and outside—when it comes to the actual implementation of NRLP. 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 riparian country, will be an affected party, and its concerns need to be factored into the NRLP calculus. 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. Mamata Banerjee, West Bengal's Chief Minister recently refused to share Teesta waters with Bangladesh in an open show of defiance to Government of India's attempt to forge cooperation with Bengladesh. Inability of India to secure compliance from its own state governments weakens the scope for trans-boundary international cooperation even on a win-win formula.

Water transfers between Brahmaputra and Ganga basins and from Ganga to other rivers may require modification of existing agreements or new treaties. Bhaduri and Barbier (2008) showed that India and Bangladesh could modify existing agreements to augment water supply, which in turn may benefit both countries. However, this depends on the scale of political altruism India can muster to allocate water to the downstream user or create some kind of insurance mechanisms to safeguard rights of the downstream riparian. If India decides unilaterally to transfer water to peninsular basins, or the States decide to use more than their share, Bangladesh could incur huge environmental losses.

Existing international agreements elsewhere provide many lessons relevant to the NRLP (Gichuki and McCornick 2008). Initial agreements of water transfers are no longer functional in many inter-basin transfers, including those in the Aral Sea basin among Central Asian Republics, in Tagus and Ebro basins in Spain. Many of the conflicts arose later due to unforeseen circumstance at the planning stage. Often, initial planning did not undertake a holistic analysis of t water supply and existing uses, and future demand in different countries or basins.

Water transfers in the peninsular component too would hinge on inter-state politics, economics and agreements. Bihar may refuse to transfer Ganga water, as Lalu Prasad Yadav, a senior political leader of the State, argued that if her farmers are unable to use her water today, it does not mean they will remain unable to do so forever. But, such rejections could change if the recipient states compensate Bihar for the Ganga waters that it allowed to transfer.

7.6 Conclusion

Despite the Supreme Court order, if the fate of NRLP were to depend upon the shape of the national debate around it, the dice are heavily loaded against it. This is partly due to intensely polarized ongoing debate based on plurality of prevailing conditions and experiences. The analyses of this paper have mixed conclusions. The project is so large that it is difficult to conduct a holistic analysis leading to a social cost and benefits. The main reason for this is due to little information and data the available in the public domain. The NCAER (2008) study has evaluated the macro-economic benefits of the NRLP project, but lacked the environmental and socio-economic cost.

It is possible that the present proposal for NRLP has come a decade or two too soon. Many drivers and assumptions, which were conducive to the condition in the 1990s, have changed since the proposal conception, and may change further before the project undergoes feasibility analyses. Some of the changes are likely to create conditions favorable for a comprehensive solution of the kind of NRLP, although it is likely to be quite different in nature to the presently conceived form. 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:

1. Just as a cash-strapped China cold-stored Mao's proposal for transfers from South to North until the mid-1990s, a US$ 2 trillion Indian economy around 2015 may take more enthusiastically to the idea of massive water infrastructure investment that amounts to more than what was invested under the current US$ 2 trillion Indian economy;
2. Economy-wide demand for the improved performance of public systems in infrastructure creation and management—in road, railways, power, etc.,—will also restore public confidence in the water bureaucracies' capacity to deliver on their promises, and ease the prevailing opposition to 'sterile gigantisms';
3. Similar economy-wide pressures to improve the rehabilitation of people affected by projects on roads, Special Economic Zones and such other dynamic infrastructure areas will raise the bar for resettlement and rehabilitation work in water infrastructure projects, alleviating the other major concerns of civil society about large water projects;
4. Increasing disposable incomes will prompt the 'median voter' to demand better water services and pay for them, transforming extant water scarcity into 'economic' water scarcity; this will improve the financial viability and sustainability of water infrastructure; it will also mean water conflicts will be resolved through price negotiations rather than through political bargaining or administrative processes;
5. Similar pressures in agricultural water demand will arise due to intensive diversification of Indian agriculture that generates higher output-value per m^3 of water; diversification will create *economic* demand for more reliable, on-demand irrigation service for which the farmers will be willing to pay substantially more than what they pay for canal irrigation today;
6. Rising energy costs will make pump irrigation increasingly unattractive and increase demand for surface water either for direct application to crops or for groundwater recharge in western and peninsular India; rising costs of fossil fuel will also make hydropower dams more attractive; and
7. Finally, rapid growth in urban agglomerations will seriously strain their groundwater-dependent water supply systems and that in turn will make inter-basin water transfers for urban water needs economically viable and politically compelling.

India may or may not implement NRLP as proposed. However, there seems no avoiding massive water infrastructure investments on a scale similar or even exceeding the NRLP. Medium- to long-term water sector planning needs to take account of the aforementioned seven contingencies. Throughout Indian history, irrigation projects on a grand scale have been constructed more as political statements by ambitious rulers rather than as economic enterprises justified by cold calculus of benefits and costs. If and when projects like NRLP is back on the drawing board and for them to be a grand socio-economic statement, their techno-economics will need to be based on the reality of India's agricultural future rather than its past.

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