7 IRRIGATION AND WATER RESOURCES

PART I IRRIGATION: ACHIEVEMENTS AND CHALLENGES

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What is Irrigation?

Irrigation is the artificial application of water for the cultivation of crops, trees, grasses and so on. For the urban Indian, the word 'irrigation' conjures up images of the first Prime Minister of India, Jawaharlal Nehru, and the Bhakra Nangal Dam (Temples of Modern India) and images of Medha Patkar, Aamir Khan, and the tribal oustees of the Narmada dam. These are diverse perspectives on the story of large irrigation infrastructure in India. In fact, in popular public perception, irrigation connotes 'large irrigation infrastructure' rather than provision of irrigation services.

For a typical Indian farmer, looking up to the skies to see whether the rain gods will favour him this time, irrigation means a wide range of interventions at the farm level, ranging from a couple of support watering(s) (or 'life saving' watering) during the kharif (monsoon) season from a small check dam/ pond/tank/dry well to assured year-round water supply from canals or tube wells to farmers cultivating three crops a year. The method of application has also evolved, from traditional gravity flow and farm flooding to micro-irrigation where water is applied close to the root zone of the plant.

Indian farmers gain access to irrigation from two sources—surface water (that is, water from surface flows or water storage reservoirs) and groundwater (that is, water extracted by pumps from the groundwater aquifers through wells, tube wells and so on). Surface irrigation is largely provided through large and small dams and canal networks, run-off from river lift irrigation schemes and small tanks and ponds. Canal networks are largely gravity-fed while lift irrigation schemes require electrical power. Groundwater irrigation is accessed by dug wells, bore wells, tube wells and is powered by electric pumps or diesel engines. To meet the growing needs of irrigation, the government and farmers have largely focused on a supply side approach rather than improve the efficiency of existing irrigation systems.

Irrigation Sector Terminology

The terms used by the Ministry of Water Resources (MoWR), Ministry of Rural Development (MoRD), and the Ministry of Agriculture (MoA), the three ministries within the government responsible for irrigation are as follows:

1. Major irrigation (cultivable command area above 10,000 ha).
2. Medium irrigation (cultivable command area between 2000 ha to 10,000 ha).
3. Minor irrigation (cultivable command area less than 2000 ha)
   a. Surface irrigation
   b. Groundwater irrigation

This classification belongs to an era when all 'irrigation' was largely surface irrigation, promoted and supported by the government. Hence, groundwater irrigation, which was in its infancy till the 1960s, is slotted into minor irrigation as each 'scheme' (or well/bore well) in its individual capacity irrigates 1 to 5 ha of land. Minor irrigation also includes a large number of small surface irrigation schemes such as village tanks, and ponds, including many which were constructed pre-independence and managed by the local community and have been now handed over to the panchayat administration.

Two other terms which are critical to our understanding of irrigation sector are 'watershed' and 'micro-irrigation'. 'Watershed' may be defined as an area from where rainwater is drained through a common outlet (lake/river/rivulet) and therefore, can range in size from a few states to a few ha. It is a hydrologic unit which is useful for natural resource planning and management. The watershed programme, funded by the Ministry of Rural Development (MoRD) and Ministry of Agriculture (MoA), focuses on a range of multi-disciplinary interventions (afforestation, soil and water conservation measures, water harvesting and so on) in a watershed which is demarcated so as to be as contiguous to the village boundary as possible. The watershed programme is a key programme of the MoRD and MoA to increase agriculture productivity in areas which are rainfed and cannot access any surface irrigation scheme (the watershed programme guidelines specifically prohibit work on villages which have more than 30 per cent area already under irrigation).

Micro-irrigation encompasses drip and sprinkler technologies. Traditionally, irrigation is provided to crops by flooding the entire farm, largely through gravity-based flow. To get 'more crop per drop' two major technologies of drip and sprinkler irrigation have been developed. In both these technologies, water is available in quantities and location more suitable to the plant growth and near the root zone. Use of these technologies improves the efficiency of irrigation. Application of micro-irrigation devices leads to 30–70 per cent water savings relative to flood irrigation.

Irrigation and Water Resources in India: Competition for Scarce Resources

The world over, the irrigation sector is the largest user of water—almost 80 per cent of the water in the world is taken up by irrigation (in India, the irrigation sector uses ~85 per cent of its available water resources). The average rainfall in India is 1170 mm and given the geographical area of 3.3 million km, gives India 4000 cu km of water. Almost 50 per cent of this water is lost to evaporation, percolation, sub-surface flows to oceans and only 1953 bcm is accounted for. Because of spatial and temporal variation in the availability of water, only 1086 bcm is utilizable* (Phansalker and Verma, 2005). An availability of 1700 cubic meters of water per capita annual water resource (AWR) is safe (Falkenmark et al. 1976). India's AWR was 2214 cum in 1996 but is estimated to go down to 1496 cum by 2025. Also, while the AWR is high now, the real availability of water is based on the developed water resource (DWR) which is only 25 per cent of the AWR (Gulati et al. 2005). Also, the national averages do not tell the whole story as water is a local issue and there are many regions in India where water availability per capita is below the safe level. The other main users of water, (urban and rural drinking water), industry and environment, show an increase in demand.

As urbanization increases in India, demand for water from the urban sector will increase. Already water conflicts are rising with irrigation water being diverted for urban drinking water supplies in times of scarcity. Farmers in Rajasthan have not allowed dam waters to be drained to the Bharatpur Sanctuary. With an increasing population and growing needs, the gap between the demand and availability will only widen with time. Hence, irrigation as a sector will be under increasing pressure from other sectors to share scarce water. The irrigation sector will be compelled to introduce reform towards better water management and minimization of wastage to be able to meet its growing demands from progressively less water availability per capita.

*Small variation from utilizable surface water given in Part II is due to different sources of data.

Status of Irrigation

In India, the irrigated area is 34 per cent of the net area sown. The gross irrigated area is 80 million ha which gets India the prize for the largest amount of irrigated agriculture in the world. The break-up is given in Table 7.1.1.

The so termed 'minor' irrigation is now the major source as groundwater provides 50 per cent of the gross area under irrigation (in fact recent data shows that in terms of net sown area, groundwater provides 60 per cent of the net irrigated

Table 7.1.1
Irrigated Area in India

	Utilization (in million ha)	Capacity (in mha)	Ultimate irrigation potential[1] (in mha)
Major & Medium	28.02	32.69	58.50
Minor:			
Groundwater	42.50	45.73	64.05
Surface	10.12	10.89	17.38
Total	52.62	56.62	–
Total	80.54	89.31	139.90

Source: Gulati et al. (2005).

[1]The Ultimate Irrigation Potential (UIP) is an estimate prepared by the Ministry of Water Resources of the overall potential for irrigation in the country.

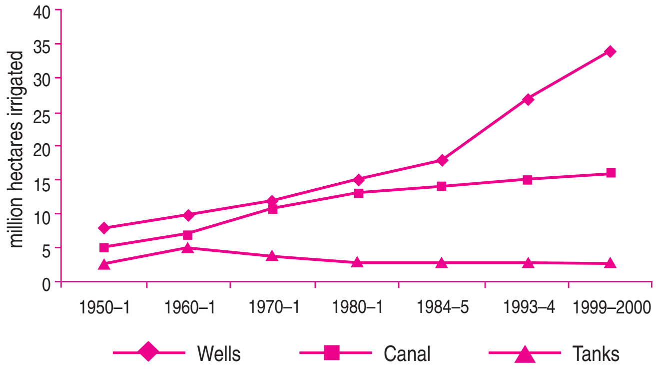

Fig. 7.1.1 The Evolution of Forms of Irrigation in India 1950–2000

Source: Bhatia (2005).

area (Shah and Deb, 2004). As can be seen, the potential created so far (till 1997) is only 64 per cent of the UIP. Thus, groundwater is a critical element in filling the need gap for the rural farmers, as it has provided irrigation in areas where the public irrigation systems have not reached or where the service delivery has been poor. In the last two decades, 84 per cent of the addition to net irrigated area has come from groundwater.

Major and Medium Irrigation

In terms of investment by the government, major and medium irrigation sector accounts for 57 per cent of investment in the irrigation sector which serves only 35 per cent of the total area irrigated (Gulati et al. 2005). The infrastructure is ageing; there is an increased siltation of large dams, time and cost over-runs, and tail-ender deprivation.

Ageing of the infrastructure

Almost 60 per cent of the total dams of the country are more than two decades old (Figure 7.1.2). Canal networks also need annual maintenance. Besides regular maintenance, many older structures need replenishment for which funds are a constraint.

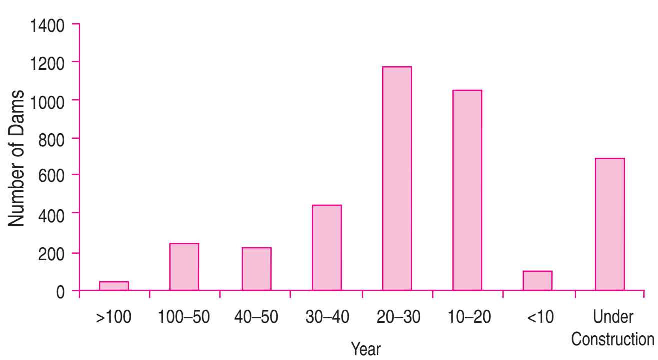

Fig. 7.1.2 Age of Major Water Infrastructure in India

Source: Tyagi (1987).

Increased Siltation of Large Dams

The Inter-Ministry Task Force on large reservoirs maintains that one third of their storage capacity has been affected by siltation, resulting in reduced area under irrigation and lowering the life of the dam. In most cases the rate of siltation is far in excess of the rate assumed during construction (Planning Commission, 2002).

Time and Cost Over-runs

Another issue related to most large dams is that they are not completed within the scheduled period or budget and spill over from one 5-year plan to another. When the Tenth Plan began, there were 410 on-going projects, some of them started in the Fifth Five-Year Plan. The spillover costs from previous projects to the Tenth Plan are Rs 17,700 crore which is more than the allocated amount (MoRD, 2006). These delays have not only led to escalated costs but also to delays in returns from the investment and lower the viability of these projects.

Tail-ender Deprivation

Farmers who have land at the end of the canal system are called tail-enders. They include farmers in the tail reach as well as those at the end of the upper and middle reaches of the canal system. It has been known that many get neither enough nor timely water. A national research study undertaken by the Development Support Centre shows that tail-ender deprivation is far more than assumed thus far. In Gujarat, in a major water deficient project Dharoi with 45,000 ha of command area, the tail-enders' problem was found in 37 per cent of the command area. Even in the areas with warabandi system in Punjab and Haryana, 70 per cent of the tail-end farmers got 54 per cent to 70 per cent less water than they were entitled to. A good example of how this is hidden from the existing monitoring system is the large Tungabhadra system in Karnataka where farmers in the last reach got 91 per cent less water than they were entitled to even though the project performance was claimed as 90 per cent (DSC, 2003). A major impact of this was the lower agricultural productivity of tail-end farmers, movement to low-value crops or practice of leaving land fallow.

The causes of tail-ender deprivation are excessive use by head-reach farmers, poor maintenance, less funds allotted to tail regions for maintenance, poor construction, and design fault.

Minor Irrigation

Minor irrigation currently covers 52.62 million ha of land. The third minor irrigation census carried out in 2000–1 covered

6.3 lakh villages in 586 districts. It showed 19.7 million ha of irrigation of which 18.5 million are groundwater schemes and 1.2 million are surface water irrigation. The 18.5 million groundwater schemes have created an irrigation potential of 62.4 million ha (3.37 ha per schemes) while the 1.2 million surface irrigation schemes have created an irrigation potential of 11.9 million ha (9.9 ha per scheme). The surface and groundwater schemes are very different in nature and we analyse concerns and potential later.

Surface Water Schemes in Minor Irrigation

The average command area of the surface water schemes is about 10 ha (Census, 2001). This adequately covers the range of schemes included in this category from small ponds with a command area of 2 to 5 ha to large flow irrigation systems with a capacity of 5200 ha and more. Administratively, in most states minor irrigation schemes are managed by the Panchayat irrigation department. Since there are a large number of schemes with low command area and are dispersed over many villages, existing panchayat irrigation staff for managing these schemes is much less. In most cases, village panchayats do not have the resources to maintain these schemes on their own leading to shrinkage in use of this potential to only 58 per cent i.e. 6.9 million ha only. The major structures under surface irrigation schemes are tanks and water harvesting structures which amount to 0.55 million structures out of the 1.2 million schemes. In drought prone areas where rainfall is uncertain, like Rajasthan, the tanks have fallen into disuse. Out of the 0.55 million tanks only 0.47 million tanks are in use. About 3 million ha potential irrigation is lost because of non-use or under-utilization of these tanks. The major issues concerning minor irrigation are:

1. lack of attention by the irrigation institutions;
2. siltation and non-availability of power;
3. though technically they belong to the panchayat, they are neither managed by them nor are the funds routed through them. Hence, the community ownership of many of these panchayats is very low;
4. Traditional institutions—community-based organizations (CBO)—which used to manage these tanks, do not exist now and new institutions at the village level to address the changing needs of the villagers have not yet evolved.

Groundwater Irrigation

Groundwater now contributes to 60 per cent of the area irrigated in India. India also has the highest annual groundwater extraction in the world. Since 1970, it has been contributing more to agricultural wealth than surface irrigation. The contribution of groundwater increased from Rs 22 billion in 1970 to 132 billion in 1993 while surface water increased from 77 billion to 115 billion (Shah and Deb, 2004). Tube wells are now the largest source of irrigation in the country and their share has increased from 1 per cent in 1960–1 to 37 per cent in 1999–2000 (MoRD, 2006). Since this sector has almost no dependence on the government, it is growing at a rapid rate and it is estimated that one million wells are added every year (Shah and Deb, 2004).

Being an individually managed source, ground water irrigation is also a more efficient form of irrigation, with crop yields per cubic meter of water being 1.2 to 3 times higher than surface irrigation. However, since this sector has grown through investment by individual farmers, with little state involvement compared to canal irrigation, government support for understanding this sector and improving its performance is negligible. The major issues for the future growth of groundwater irrigation are declining resource base, demand driven growth, and a lack of policy and regulatory framework.

DECLINING RESOURCE BASE

While on the average out of the 430 bcm available, only 160 bcm is withdrawn, this average hides the localized stress on the resource of large regions currently dependent on groundwater. The number of blocks which have more than 90 per cent groundwater development (GWD) is increasing. In Punjab, Haryana, and Rajasthan more than 40 per cent of the blocks are over-exploited and for the country as a whole, 14 per cent of the blocks are over-exploited. This is expected to increase to 60 per cent in the next 25 years (MoRD, 2006).

DEMAND DRIVEN GROWTH

There are many regions of India with hard rock geology which have lower groundwater potential than the alluvial plains. Since groundwater extraction is primarily driven by the needs of the population and the density of farmer population and not the quality of resource, groundwater irrigation is scaling up even in such hard rock areas causing irreversible depletion of the resource base (Shah and Deb, 2004).

A POLICY VACUUM

Currently there is no policy framework governing the use of groundwater. In 1974, the central government had introduced the Groundwater Act which was not adopted by any state. In any case, most policy makers feel that regulating thousands of wells is operationally not possible. However, the first requirement for evolving effective policies is to shift from water resource development to water resource management as in many areas, development has already taken place and if not managed, will lead to collapse of the groundwater resource. Options which can be considered are a combination of legal measures with indirect regulation through power supply.

The Importance of Irrigation in the Indian Economy

Till the 1990s, Finance Ministers used to say that 'Every budget is a gamble on the monsoon'. For the more than 70 per cent of the Indian population, living in rural India and dependent on agriculture directly or indirectly, the monsoon controlled their purchasing power year after year. Even now, when agriculture contributes less than 20 per cent to the national economy, more than 600 million people are dependent on agriculture for their livelihood. Therefore, irrigation infrastructure, which has the potential to insure the farmer against the vagaries of the monsoon and increase his income from a small (and diminishing) land holding is the most critical infrastructure for rural India.

There have been several studies which have established immense benefits of irrigation. The increased food security of the country, increased agriculture incomes in irrigated areas, the success of the green revolution, are all linked to timely availability of water for crops not dependent on rainfall alone. In addition to the direct benefits there are indirect benefits emanating from forward and backward integration. Studies both at the village level and regional level have shown these indirect impacts. For every Rs 100 of direct benefits the Bhakra dam generated 90 rupees of indirect benefits for the regional economy and had an impact in areas even beyond the region (World Bank, 2005). Similarly, the impact of the green revolution in the North Arcot region of Tamil Nadu proved that each rupee spent on irrigation led to an additional value generation in the non-farm economy (IFPRI, 1985). About 50 per cent of the growth in the non-farm economy was due to agricultural demand for inputs and marketing services and the remaining 50 per cent was because farmers as consumers had higher purchasing power to buy more consumer and other goods (Chambers, 1988). In fact, the provision of irrigation improved the returns on social sector investment as well. Returns to five years of education were 32 per cent in irrigated districts and nil in un-irrigated districts (Pritchett, 2002). Chambers (1988) mentions that impact of irrigation on the livelihoods of the rural poor comes about through employment incomes, security against impoverishment, non-compulsive migration, and improvement in the quality of life.

In terms of food security in India, the 35 per cent irrigated area provides more than 60 per cent of the food production. Studies show that at the village level irrigation provides higher and more stable employment and the poor are the major beneficiaries. In fact, the contribution of irrigation to employment is greater than even high yielding varieties. Studies show that there is an increase in number of days work required per ha with irrigation compared with rainfed condition ranging from 60 per cent (Datiwada canal) to more than 150 per cent (Ferozpur, Punjab) (World Bank, 2005).

The increase in value and incomes which irrigation provides can also be judged by two other indicators: (a) increase in land prices after a rainfed area got access to irrigation and (b) the large private investments made by individual farmers in ground water irrigation.

Irrigation Multiplier

The Irrigation multiplier is estimated to be 4.5 (returns per ha per season) and 3.15 (returns per ha per year). In either case the farmers' share of the total marginal benefits of irrigation to the society is between 22 to 32 per cent. This means that the economy-wide benefits of irrigation are much higher than what a farmer gets in terms of increased crop output in a crop season or year. However, it should be noted that while there is strong correlation between increased irrigation and reduction in poverty in India, the ultimate impact of irrigation on reduction in poverty depends on other factors such as the structures of agriculture production, rural institution, the consumption feed back and labour mobility. In fact, there are states in India like Bihar, UP, and Tamil Nadu which have high irrigation and yet high rates of poverty (Bhattarai, 2004b). The marginal impact of irrigation on poverty has also declined over time. Responsiveness of poverty reduction which used to be 0.4 to 0.5 with respect to 1 per cent increase in irrigated area has reduced to 0.2 in 1999–2000 (World Bank, 2005).

Beneficiaries of Irrigation

A major concern regarding the irrigation systems, especially, that provided by large dams is that it benefits only large farmers. Data, however, show that 40 per cent of the beneficiaries of major irrigation systems are small and marginal farmers. Large farmers form only 12 per cent of the command area of the major irrigation schemes (Joshi, 1997). In addition the increased income of labourers who are not direct beneficiaries of the irrigation system is substantial. Besides, with the increased number of working days, the wage rate is also likely to increase when there is provision of irrigation. These are great benefits, especially, for the landless who have to migrate every year to urban areas to get employment during the non-monsoon period leading to fragmentation of families. Studies show that villages with intensive year-round irrigation attract landless population from the surrounding villages who then settle down permanently (Chambers, 1988). Distressed and seasonal migration has a negative effect on education as parents do not lead a stable life. Studies show that after irrigation when people stay in one village, they start sending their children to school.

Groundwater-based irrigation largely has the same benefits as surface irrigation. However, groundwater brings greater benefits for small and marginal farmers. But, there is a downside for small and marginal farmers who own dug wells at the village level. As large and well-resourced farmers can dig deeper and invest in bore wells their extraction from the bore wells renders many shallow dug wells nearby inoperative. This means that farmers who are getting irrigation from dug wells now do not reap the benefit in the longer run as their groundwater source is extracted by larger bore well farmers.

Gender Issues

While irrigation largely benefits the farming community, within a typical farming household men and women have different roles and responsibilities. While in groundwater irrigation, the entire decision-making is at the farm level since most farmers have private wells, in canal irrigation systems decision-making is through irrigation institutions. Membership to irrigation institutions is based on ownership of agricultural land and because hardly 3–5 per cent of rural women own land, women are largely absent in most irrigation cooperative societies. Studies show that 65 per cent of agricultural activity in most part of the country is done by women farmers (Douglas and Bavisker, 1997). Increased migration to cities in many areas by men has also led to an increase in women headed rural households wherein women bear almost total responsibility for the agriculture operations. Shilpa Vasavada, in her study of women irrigators of canal irrigation systems in South Gujarat, has shown that while women farmers contribute substantial labour in agricultural operations and in the maintenance of canal, their involvement in the decision making for access of canal instituitions is marginal (Vasavada, 2000). Therefore, institutions which exclude women from the decision-making-process do not really represent the ground reality and consequently, they do not run systems efficiently or equitably. This lack of participation from women farmers in irrigation institutions is not only detrimental to the efficiency of the system but also affects the workload on women farmers. Advaita Marathe's study points out that when women are involved in decision-making roles, there is better conflict management and timely recovery of dues (Marathe, 2003).

Therefore, policy action must target proactive involvement of women farmers in all decisions related to irrigation water management at the village level. Participatory Irrigation Management Act needs to incorporate clauses which ensure that women and men are both members of Water User's Associations even if they do not own the land.

Who Loses out to the Prevailing Irrigation Policy Imperatives?

While much has been written about the benefits of irrigation, there is a downside to both surface and groundwater irrigation methods. Over the years, the negative effects of irrigation (both surface and groundwater) are becoming apparent and irrigation projects are no longer perceived as 'temples of modern India'. The major problems caused by irrigation are submergence of land, displacement of people, and over-extraction of ground water.

Submergence of Land due to Surface Reservoirs

Submergence of land for reservoirs leads to displacement of people and also causes extensive environmental damage as stretches of forest and traditional eco-systems are also submerged. Fish population in rivers is also affected, negatively affecting the livelihoods of downstream villages. Estimates on the number of people displaced so far as a consequence of surface reservoir systems vary widely from 21 million to 40 million with 40–50 per cent of those displaced belonging to scheduled tribes (D'Mello, 2002). The fact that the country has no systematic rehabilitation and resettlement policy for this large group of people is a matter of serious concern.[2] Displacement leads to fragmentation of communities, loss of livelihoods, and a pitiable migratory existence in search of labour in urban and semi-urban areas. While the rehabilitation policy has changed from cash compensation to land-for-land, the government has still not developed a system to ensure that farmers, whose only livelihood skills are related to farming, are supported towards developing new livelihood skills after displacement. Rehabilitation, therefore, suffers from the following policy infirmities.

1. The definition of project-affected people is not adequate, with villagers displaced partially or those displaced by irrigation department housing colonies being treated differently from dam displacement.
2. Rehabilitation procedures are time-consuming, cumbersome, and have a history of instances of 'rent-seeking behaviour'.
3. The land allotted is scattered and not with similar livelihood options (tribals, for example, who were earlier near forests depended on forests for part of their incomes).
4. Cash compensation is given without proper advice or livelihood training with the result that money is spent without a new long-term livelihood option, leading to increase in the numbers of unskilled labour force.

Tribals and Displacement

A large number of people displaced are from tribal communities, because large dam sites submerge hilly areas where most tribals live. Tribal areas are among the poorest in the country[3]. It is estimated that till 1990, 8.5 million tribals have been displaced, out of which 64.23 per cent are yet to be rehabilitated (Fernandes, 1994).

[2]National Policy on Resettlement and Rehabilitation for Project Affected Families-2003 by the Ministry of Rural Development is not comprehensive enough to deal with resettlement and rehabilitation issues.

[3]About 30 of the poorest 69 districts in the country have a tribal population of more than 30 per cent (Debroy & Bhandari, 2003).

Scheduled tribes are the most deprived sections of the Indian society, even when compared to scheduled castes. With 8.4 per cent population, scheduled tribes have a poverty incidence of 49.2 per cent and form 15.7 per cent of the total poor. This compares unfavourably with scheduled castes, who form 21.3 per cent of the population and have incidence ratio of 42 per cent and 'other communities', who have poverty incidence ratio of only 28 per cent. While tribals are displaced so that the 'country' gets irrigation, the area under irrigation in tribal areas is much less (less than half!) than the national average. Tribal districts have only 14.98 per cent of irrigated area as percentage of net sown area as against 33.59 per cent for the country as a whole. Only 3.66 per cent of the irrigated area in tribal districts is served by major irrigation schemes compared to 9.9 per cent for the country (Phansalker and Verma, 2005b). Hence, there should be a comprehensive approach to addressing the issue of displacement. Otherwise large projects will never be feasible in this country. There is also a need to address the irrigation needs of tribals so that irrigation is not merely a 'curse' for the poorest in the country.

Groundwater Over-extraction Affecting Quality of Water

The unregulated growth of groundwater irrigation, while providing irrigation access to millions of small farmers, has led to mining of groundwater aquifers and affected the quality of groundwater. Since groundwater is a common source for domestic water supply in addition to irrigation, the drinking water quality of a large number of villages and urban settlements has been affected. Field-level studies show how excessive exploitation by a few farmers has rendered entire villages dependent on external sources for drinking water. Since women are traditionally responsible for fetching drinking water there has been increased drudgery for women in many such areas. This, in turn, causes health problems for all such drinking water users. The major water quality problems are:

1. Salinity in coastal areas: Over-extraction has led to intrusion of sea-water along the coast. Four coastal states, namely, Andhra Pradesh, Orissa, West Bengal, and Gujarat suffer from coastal salinity. Gujarat alone has set up a separate 'Salinity Ingress Prevention Circle' as part of its Irrigation Department to address this problem. The Gujarat government records show that 950 villages suffer from coastal salinity ingress.
2. Excessive fluoride causing fluorisis: Thirteen states in India have evidence of fluorisis and it is reported that about half a million people in India suffer largely due to excessive fluoride.
3. Nitrates: Excessive nitrate is a problem in twelve states, though in some cases it is not only caused by excessive groundwater withdrawal for irrigation but because of high mineral content in the aquifers as a natural condition.
4. Arsenic: This is found in West Bengal and is also caused by extraction of deeper aquifers.

Water-logging Affecting Quality of Land

The water-logging of areas because of excessive irrigation and, consequently, rendered saline and alkaline, is a major problem. The Ministry of Water Resources shows total area waterlogged, saline and alkaline, as 6 million ha. Considering the fact that surface irrigation projects have only irrigated 38 million ha so far, this is a considerable loss of cultivated area (Vaidyanathan, 1994 and MoRD, 2006). The other negative effects relate to increase in malaria and water-borne diseases because of increased waterbodies.

Financing of the Irrigation Sector

The country spent Rs 920 billion (at historical prices) till 1997 on the irrigation sector. Fifty-seven per cent of this expenditure has been for major and medium irrigation, 32 per cent for minor irrigation, 6 per cent for command area development and 5 per cent for flood control. It may be noted that the expenditure on minor irrigation only includes the State expenditure and it does not include the money spent by farmers themselves. Tushaar Shah estimates the total private investment in the groundwater irrigation to be Rs 480 billion (Shah and Deb, 2004).

Financing of Surface Irrigation

While in absolute terms, state investment in the irrigation sector has increased, and recently the government announced a range of schemes like the Accelerated Irrigation Development Programme (AIDP), the Bharat Nirman and so on, the irrigation sector's outlay, as a percentage of the total plan outlay, is now less than 10 per cent. The irrigation sector needs funds for maintenance and replacement of the existing canal irrigation infrastructure, developing new infrastructure in areas which have had no access to irrigation so far, and funding the power infrastructure which makes groundwater irrigation possible.

The international norm for replenishment and repair costs as a percentage of the value of the capital stock[4] is about 3 per cent which translates to Rs 60 billion for maintenance which is much more than the annual plan outlay. Hence, meeting this norm does not seem feasible and therefore, the quality of the infrastructure is bound to decline over time if not maintained properly.

The Irrigation Commission appointed by the Government of India in 1972 recommended that the maintenance cost should be covered by the water charges. However, in India

[4] In India the current value of the infrastructure of major, medium, and minor irrigation is about Rs 2000 billion.

this is not the case as water rates are decided on political considerations and have remained stagnant in most states for the last twenty years. In 1960s, the receipts could cover the O&M expenses, but since then the ratio of receipts/working expenses has steadily declined and is currently about 40 per cent. The O&M budget of the Government of India includes administration costs, extension and maintenance and repairs. With increased staff costs, a larger proportion of the O&M budget has gone towards administrative costs, leaving fewer funds for actual repairs and maintenance. Overall, only 27.5 per cent of the total O&M funds are available for repairs and maintenance (Gulati et al. 2005).

Therefore, a combination of low water rates, poor recoveries, and increased allocation of O&M expenses to administrative costs have led to a situation where there is hardly any money for maintenance and replenishment. Since O&M budgets are at the discretion of the state governments, in a scenario of increasing state deficits, it gets less priority. This scenario has meant that the quality of infrastructure has declined rapidly. Many states have accessed international funding to restore infrastructure rather than build new infrastructure.

Funding New Infrastructure

The capital cost of canal irrigation has gone up steadily over the years. Some economists put the capital cost of irrigation potential created during the Eighth Plan at Rs 1.9 lakh per ha (Gulati et al. 2005). The CWC on the other hand, using a simplistic formula of dividing the cumulative costs by the cumulative potential, arrives at a figure of Rs 68,000 per ha. As per the Planning Commission (2002), the cost of creating additional potential from major and medium projects is Rs 1.43 lakh per ha at the end of the Ninth Five-Year Plan (MoRD, 2006).

The gap between potential created and actual irrigation potential of surface irrigation schemes (major, medium) is about 25.2 million ha. Assuming Rs 1.42 lakh per ha, the funds required are a staggering Rs 350,000 crore, making the task look improbable with only government funding.

Alternate Financing Options

The future for financing the new irrigation sector looks bleak unless other options are explored. Several states (Karnataka, Gujarat, and Maharashtra) have explored the option of raising funds from the market to finance irrigation infrastructure. However, as Phansalkar points out in his study, these efforts have slim chances of success unless there is a comprehensive reengineering of the irrigation institutions, their performance incentives and accountability (Phansalkar, 2004).

Participatory Irrigation Management pilot studies show that cost-recovery does improve and farmers do take up canal repairs on their own, at much lower unit costs than the irrigation department, if they have management responsibility for the canal irrigation system. In groundwater irrigation and small water harvesting structures, where individual or groups of farmers feel that they can exercise greater control over the management and use of the resource, there is substantial 'private' investment. Applying the same principle, if the irrigation institutions allow a greater role to farmers and political populism does not propagate free water assets, farmers will invest in the major and medium irrigation sector, as they do in groundwater and minor irrigation schemes.

Irrigation–Power Nexus

Groundwater now covers 70 per cent of the total irrigated area in the country and 70 per cent of the irrigated households. Almost 1 million wells are added every year. A large number of wells are funded by farmers or entrepreneurs. However, as the contrast between the costs of canal irrigation (where the government pays for the entire infrastructure of delivering water to the field and charges a low water rate which amounts to 3 per cent of the cost of cultivation) and groundwater irrigation (almost 10 time more) increased, there was a demand for subsidizing the electricity used for groundwater extraction. As irrigated areas increasingly moved to groundwater irrigation, the 'free or subsidized electricity' developed great value as a populist tool, with the result that many states declared free power for farmers. The Planning Commission says that 30 per cent of the sales of the State Electricity Board go to the agriculture sector which provides only 3 per cent of the revenue. However, others differ—World Bank estimates that farm subsidies amount to 10 per cent of the total supply cost or about Rs 240 billion a year. This is about 2.5 times the annual expenditure of canal irrigation. In seven states, the electricity subsidy to agriculture is more than 40 per cent of the gross fiscal deficit (2000–01) (World Bank, 2005).

The irrigation power nexus has also led to large amount of water wastage:

1. Since power is subsidized, and for a long time there was a fixed annual tariff[5] based on the horsepower of the motor, there was no incentive for the farmer to save water. Irrigation is a low priority sector and often receives electricity at night. Farmers generally leave the motors switched on and sleep while the waters flood their fields and drain away.
2. Increased subsidies make groundwater extraction cheap, hence, there is no incentive to make irrigation more efficient (explaining the poor growth of the micro-irrigation sector) Cheap irrigation provides an incentive for a high level of

[5]The fixed tariff was tried to make it cheap for farmers to pump out water in waterlogged areas and also because the cost of collecting metered rates was greater than the value of the bill in many areas.

groundwater extraction, making the source unsustainable. The greater the depth of extraction (in the north Gujarat region, bore wells have reached 1000 feet depth!) the greater the pumping costs and the higher the level of energy subsidy. This has become a vicious cycle and abrupt subsidy reduction is not feasible, especially as the power supply is unreliable and irregular and farmers would not agree to pay for what is renowned to be poor service (Box 7.1.1).

Recent Initiatives by the Government

The Accelerated Irrigation Development Programme (AIDP) has provided central loan assistance to states since 1997. The rate of creation of irrigation potential per year has increased to 0.92 Mha during the period 1997–2005 from the earlier 0.51 Mha during the period 1951–97. This scheme has supported 173 major and medium, 4169 minor, and 21

Box 7.1.1

Water and Energy Use in Groundwater Irrigated Agriculture: Case Study of the BESCOM Doddaballapur Substation Feeder Line DF 12 and DF 13 Service Area

Background

The objective of the Water and Energy Nexus (WENEXA) Project is to identify measures for reducing adverse impacts of inadequate power pricing and distribution on use of water in the agricultural, municipal, and industrial sectors. The Project is a four-year initiative financed by the United States Agency for International Development/India (USAID/India), implemented under contract by PA Government Services, Inc. Under the auspices of the USAID and the Ministry of Power, GoI, the WENEXA Project selected Doddaballapur Taluk of Bangalore Rural District, Karnataka, for a site-base activity in groundwater irrigated agriculture. The area is defined as the Bangalore Energy Supply Company (BESCOM), Doddaballapur Subdivision, Feeder Lines DF 12 and 13 service area.

The Doddaballapur Subdivision 11 kV Feeder lines, DF 12 and DF 13, originate from the 66/11 kV D-Cross Substation. They serve 26 revenue villages and fall within the jurisdictions of five Gram Panchayats: Melekote, Heggedehalli, Rajagatta, Konagatta and Tubagere. The area is located in the upper catchments of the Arkavathy River of the Kundanvathy watershed, although little of the stream flows provide irrigation water to the farms in this region. Between 1971 and 2004, the average groundwater depth declined from 64.5m to 184m. The Department of Mines and Geology recently classified this area as an overexploited groundwater region.

The area includes 3500 households and a population of approximately 17,000 people. Almost all households rely on agriculture as a source of livelihood. The reported annual average income here is Rs 29,000.[6] Six hundred and fifty-three borewell farms fall within the DF 12 and DF 13 service area, where forty crops are cultivated on a net sown area of 2500 acres. 50 per cent of the area is rainfed and the rest irrigated.[7] Groundwater is the primary source of irrigation water[8] with an estimated total annual water use of 5.8 million cum. Two crops, mulberry and grapes, account for 66 per cent of the total use.

Subsidized power is a key issue for the electric distribution company struggling to meet demand for electricity to pump water in this highly subsidized loss sector. Improvements in energy efficiency could reduce utility losses, but upgrading the distribution system to provide consistent, high-quality electric service is a necessary pre-condition. However, distribution investments have not yet been made and voltage fluctuations of this area commonly lead to pumpset motor burnout.

Electricity tariffs for irrigation pumpsets in Karnataka are flat HP-linked, supplied to farmers at zero-marginal cost, and do not cover the cost of supply. Furthermore, the bill payment rate in this area is quite low. Thus, energy efficiency is rarely a factor in pumpset purchases. Three-phase power is typically supplied for only eight hours a day. Use of converters to run three-phase pumpsets on single-phase power for longer hours is not uncommon. Poor quality of service and highly subsidized power tariffs lead farmers of this area to pump when power is available rather than applying water according to crop water needs. As a result, over-watering takes place. In some cases, twice the amount of water than is necessary is used to optimize crop yields.[9]

Farmers naturally behave in an economically rational manner in response to the realities created by well-meaning but dysfunctional policies. Since electricity is cheap, they use large amounts of it. And since poor quality power ruins high efficiency pumps, they use rugged, low cost but very inefficient pumps. The perverse result is a system that induces the wasteful consumption of two precious resources: water and energy.

[6]Institute for Youth and Development. WENEXA Secondary Data Collection for Doddaballapur Subdivision Feeder Lines DF 12 and DF 13. 2005.

[7]Institute for Youth and Development. WENEXA Water and Energy User Survey for Doddaballapur Subdivision Feeder Lines DF 12 and DF 13. 2006. www.waterandenergynexus.com

[8]Although tank-fed irrigation constituted 15 per cent of the irrigation water use in past years, with the onset of a multi-year drought, tank-fed irrigation is rarely practised.

[9]University of Agricultural Sciences, Bangalore. WENEXA Technical Report No. 7. Detailed Project Report: Irrigation Efficiency in Groundwater Irrigated Agricultural for the BESCOM Doddaballapur Subdivision Feeder Line DF 12 and 13 Service Area. 2006. www.waterandenergynexus.com

Investments in Energy and Irrigation Water Use Efficiency

The WENEXA Project conducted studies to identify investments for improving energy and water use efficiency. A GIS-based pumpset inventory identified 950 irrigation pumpsets connected to the feeder lines, of which only 663 are operational. Borewell failure is the primary reason for the non-operation of the remaining 287 pumpsets. Because groundwater depths here average 150 m, all of the pumpsets in use are submersible. The average pumpset capacity is 9 HP, and ranges from 3–15 HP. The average pumpset operates for 2000 hours per year.

An energy audit of a 10 per cent sample of the functioning pumpsets showed that 91 per cent operate with efficiency of less than 30 per cent. A network survey determined the voltage profile on both feeder lines which was found to be, in most areas, inadequate to support the quality of power needed for the operation of pumpsets meeting Bureau of Indian Standards (BIS) specifications. A groundwater availability map was developed to predict borewell failure risks.

Replacing inefficient pumpsets with efficient pumpsets has the potential for reducing electricity consumption along the two feeders by an estimated 45 per cent. Based on the data, it was determined that the current annual power consumption of irrigation pumpsets connected to DF 12 and DF 13 is estimated at 9.7 million kilowatt hours (kWh). With replacement of 601 pumpsets operating at less than 30 per cent efficiency[10] the annual power consumption is estimated at 5.3 million kWh, resulting in an annual energy savings of 4.9 million kWh. The monetized value of the savings based on the raw purchase price of Rs 2.5/kWh is Rs 110 lakh. The investment cost for replacement of approximately 601 pumpsets at Rs 40,000 per pump is approximately Rs 286 lakh, assuming a 10-year pumpset life expectancy and a 10 per cent interest rate. The payback period based on energy saving benefits that accrue to the power sector is roughly 2.6 years.[11] The payback period for pumpset replacement based on savings to farmers on pumpset repair and maintenance resulting from necessary power system upgrades, is estimated at 14 years—not a bankable investment for farmers in this highly subsidized sector.

Shifting from flood to drip irrigation has the potential for reducing total annual groundwater use by 42 per cent and for further reducing annual power consumption by an additional 20 per cent. The findings indicate that drip technologies are suitable for 53 per cent of the total net sown area currently under flood irrigation. This investment would result in an estimated annual water savings of approximately 2.2 million cubic metres of water and 2.0 million kWh of electricity per year. The estimated amortized cost of drip irrigation is Rs 150 lakh, assuming a 10 per cent interest rate. The annual on-farm gains due to yield increases are estimated at Rs 250 lakh per year. The value of the energy savings based on the raw tariff of Rs 2.5 is Rs 50 lakh annually. The payback period for the drip investment is 0.6 years for mulberry, 1.2 years for grapes, and 0.6 years for other horticultural crops.[12] Shifting from rainfed irrigation to drip irrigation should be discouraged to ensure that benefits resulting from a shift from flood to drip irrigation are not lost through a net expansion in irrigated area.

The findings above indicate that an overall investment of Rs 43.6 million for energy efficient pumping systems and drip irrigation technologies within the DF 12 and DF 13 service area could result in annual benefits of approximately Rs 410 lakh per year. Rs 250 lakh in benefits would accrue to farmers as increased farm incomes, and Rs 160 lakh could accrue to the power sector as loss reduction resulting from energy savings. This is in addition to an un-quantified benefit due to water savings of 2.2 million cubic meters per year that could improve village water supplies and ensure water availability for future use.

Pumpset Replacement Pilot Study

The WENEXA Project conducted a controlled pilot to pre-test various aspects of investments in energy efficient pumpsets and drip irrigation systems. The pilot was designed to explore the following parameters:

The impact of installation of energy efficient pumpsets in the absence of improved network voltage;

1. Responsiveness of farmers to energy efficient pumps;
2. Potential reduction in energy consumption;
3. Responsiveness of farmers to drip irrigation technologies; and,
4. Potential reduction in water consumption.

Fifteen farm households from the DF 12 and DF 13 service area agreed to participate in the WENEXA pilot programme where a new energy efficient pumpset was installed in exchange for each farm shifting at least one acre of flood irrigated area into drip irrigation. All of the original fifteen pumps were oversized pumps and only three met BIS specifications. The average age of the pumpsets was two years. Pump motors were generally repaired at least once a year because of severe fluctuations in voltage. All fifteen farms used flood irrigation and planned to shift grapes, mulberry, and sapota into drip irrigation.

[10]Pumpset retrofication was considered as an option. However, because of the depth to groundwater in this area, this option is at least as expensive as pumpset replacement. Furthermore, there is no way to control rates of discharge which could exacerbate the groundwater overexploitation.

[11]International Institute for Energy Conservation (IIEC). WENEXA Technical Report No. 4. Detailed Project Report for Pumpset Efficiency for the BESCOM Doddaballapur Subdivision Feeder Line DF 12 and DF 13 Service Area. 2005. *www.waterandenergynexus.com*

[12]University of Agricultural Sciences, Bangalore. WENEXA Technical Report No. 7. Detailed Project Report: Irrigation Efficiency in Groundwater Irrigated Agricultural for the BESCOM Doddaballapur Subdivision Feeder Line DF 12 and 13 Service Area 2006. *www.waterandenergynexus.com*

With pumpset replacement, the average pumpset capacity was reduced by 2 HP, the average number of pumpset stages was increased from 18 to 21, and the average depth where pumps were seated in the wells declined from 156.3m to 152.1m—all factors contributing to improved energy efficiency. Power consumption and water discharge measurements were taken prior to de-installation of the old pumpsets, at installation of the new pumpsets, and six-months after operation of the new pumpsets. The combined total power demand of the old pumps was measured at 71,782 watts. The combined total power demand of the 15 replacement pumps at installation was measured at 51,559 watts, and was measured at 55,334 watts after six-months of operation. Water discharge rates of the new pumpsets remained essentially unchanged from that of the old pumpsets. Within six months after installation, two of the new pumpsets were returned for repair as a result of frequent voltage fluctuations. Within nine-months of installation six farms were reporting pump burnout.[13]

The use of energy efficient, right-sized pumpsets, in conjunction with drip irrigation systems resulted in an overall 70 per cent reduction in energy consumption and a 60 per cent reduction in water consumption, as compared to that of the inefficient, oversized pumpsets used with flood irrigation. These estimates were calculated using measurements of pumpset consumption and water discharge discussed above, and self-reporting data from farmers on the number of pumping hours per week with the old and new pumps. Findings indicate that on average, annual energy consumption using inefficient pumpsets with flood irrigation practice is 16,500 kWh/pump/year, with an average of 3446 pumping hours/pump/year. Energy efficient pumpsets used with drip irrigation systems consume on average 4740 kWh/pump/year with an average of 1269 pumping hours/pump/year. The annual overall water consumption for all fifteen farms using flood irrigation was estimated at 332,782 cubic metres per year. Water consumption using drip irrigation is estimated at 130,439 cubic metres per year.

All of the participating farm households express a high level of satisfaction with the drip irrigation systems, two-thirds report satisfaction with the replacement pumpsets, and all express dissatisfaction with the network voltage and hours of supply. Some report use of single phase converters as a coping strategy to address inadequate power supply.[14]

Summary and Conclusions

The WENEXA Project proposes investments in energy efficient pumpsets and drip irrigation systems that have the potential for reducing power consumption of the Doddaballapur Subdivision Feeder Lines DF 12 and 13 service area by as much as 65 per cent, and reducing water use by 42 per cent. The pumpset replacement pilot confirms these findings and empirically demonstrates that shifting to energy efficient pumping systems in conjunction with use of drip irrigation systems can reduce energy use by 70 per cent and water use by 60 per cent. The proposed investments are highly-bankable. The payback period to the energy sector for the pumpset replacement investment is 2.5 years based on the value of energy savings. The payback period among farm households that invest in drip irrigation is 1.2 years or less, based on increased incomes due to improved crop yields.

With six of the fifteen newly installed energy efficient pumpsets burning out within a nine-month period, it is clear that without simultaneous investments in network system upgrades, voltage fluctuations will reduce pumpset life expectancy well below the ten years that the analysis assumes. This would increase the payback period for pumpset investments and affect project bankability. Therefore, investments in network system improvements that provide adequate quality of power are a necessary condition for water and energy demand side management programmes for groundwater irrigated agriculture.

Extension, Renovation and Modernization (ERM) projects till 2005.

As a response to the gap between the existing irrigation and ultimate irrigation potential the government has proposed a time bound plan for rural infrastructure for the year 2005–9 under Bharat Nirman.[15] The Ministry of Water Resources in collaboration with state governments is responsible for the creation of additional 10 million ha of irrigation capacity by the year 2009 through major, medium and minor irrigation projects complemented by groundwater development.

Of these 10 million ha, 4.2 million ha is through completion of major and medium irrigation projects and 2 million is through enhanced utilization of completed projects. So more than 60 per cent of additional potential is gained through improved efficiency of on-going and completed works. New projects would, therefore, account for only 3.8 million ha out of which 2.8 million comprise groundwater irrigation. The groundwater irrigation will largely be concentrated in the eastern regions of the country. In addition to the Bharat Nirman the Ministry of Water Resources has also launched a national project for Repair, Renovation and Restoration of waterbodies directly linked to agriculture.[16] This scheme, started in 2004–5, a pilot scheme in sixteen districts of the country, will now be expanded to other districts.

[13] Institute for Youth and Development. WENEXA Quarterly Report. June 2006.

[14] PA Government Services, Inc. WENEXA Technical Report No. 8. Case Study on Pumpset and Irrigation Efficiency in Groundwater Irrigated Agriculture—BESCOM's Doddaballapur Subdivision Feeder Line DF 12 and DF 13 Service Area. 2006. 2006. www.waterandenergynexus.com

[15] *http://www.bharatnirman.gov.in/*

[16] *http://wrmin.nic.in/*

In addition, there are many projects funded by the World Bank, Asian Development Bank, European Commission, Overseas Economic Cooperation, Japanese, French, Dutch, Canadian and German assistance in many states like Andhra Pradesh, Madhya Pradesh, Orissa, Rajasthan, Haryana, Tamil Nadu, Kerala, and Maharashtra. These schemes largely focus on increasing efficiency and utilization of existing projects through repairs and replacements of existing irrigation schemes, rather than creating new irrigation potential.

Surface irrigation: Is More Money the Answer?

Need for Institutional Reform

The poor performance of the irrigation system and poor quality of infrastructure is assumed to be the result of inadequate funding. It is assumed that because rates are low, there are inadequate funds for Operations and Maintenance (O&M) which cause poor quality of services leading to farmer dissatisfaction and consequently, poor recoveries. This vicious cycle is not broken in most states[17] and, therefore, the irrigation infrastructure and services are of a poor quality. Therefore, there is an assumption that increasing water rates would be the single step leading to improvement in the irrigation system performance. But the problem is more complex than that. Irrigation sector performance is largely linked to the quality of services provided by the irrigation institutions,[18] and since there is no incentive to improve performance (or disincentive against poor performance) irrigation departments are not affected by the increased water rate. Therefore, merely increased water rates would not substantially change the performance.

The decision on water rates is not merely based on the O&M costs but is largely a political decision. There are only a few states which have increased their water rates, and in some states like Punjab, the rates were revised downwards after the change in government. However, there are many reform-oriented state governments like Andhra Pradesh, Maharashtra, and Gujarat which have increased their water rates annually to reach the stage wherein they can cover their costs.

There is also no structured link between water recovery and O&M costs. In most states, water rate recovery is done by the Revenue Department and goes straight to the treasury, while O&M costs are part of the budget allocation. Since each system is not treated as a cost centre, the irrigation staff has little incentive to improve water rate recovery and farmers also consider the water rate as a tax rather than a user charge which is linked to the maintenance of their system.

[17]Water rates for surface irrigation systems are decided by the state government.

[18]Most states have an Irrigation or Water Resource Department.

The irrigation departments have little accountability to the farmers they serve. Farmers have little say over the works carried out on their irrigation system and cannot influence the quality of the work and therefore, the system performance. Because of these weak institutional linkages, merely increasing water rates will do little to improve O&M rates. Increased O&M rates do not necessarily mean a proportionate improvement in quality of work and system performance. Besides, since O&M budgets are largely spent on staff costs in the irrigation institutions, it would be difficult for the farmers to understand why they should pay more even if water rate recovery was linked to the O&M costs budgeted by the irrigation institutions.

All this has led to lack of funds for repairs and maintenance, leading to a decline in the quality of infrastructure and poor irrigation service to the farmer. Therefore, the story of the surface irrigation sector has largely been 'Build-Neglect-Rebuild' and pouring more funds will improve things only partially. Figure 7.1.3 describes the political economy analysis of the irrigation system and recommends that only a comprehensive reform process will help to improve the performance of the irrigation sector.

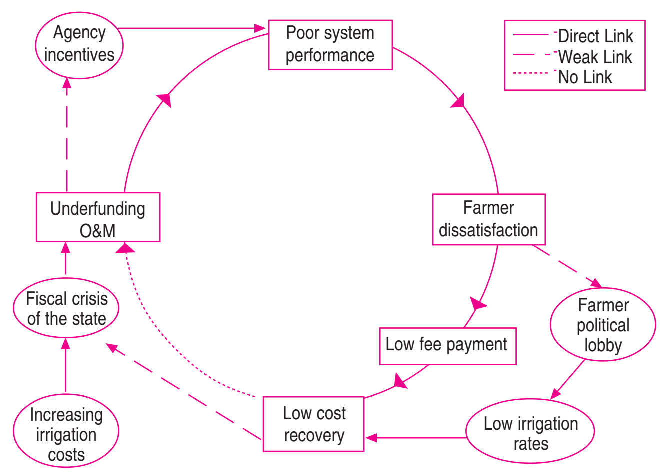

Fig. 7.1.3 Political Economy of Irrigation System

Source: Gulati et al. (2005).

Reforms Agenda

Participatory Irrigation Management(PIM)

Participatory Irrigation Management (PIM) or Irrigation Management Transfer (IMT) is an approach of surface irrigation management wherein the management of the canal system is gradually handed over to the farmers in the command area. This approach is based on the belief that farmers have most to gain from improved irrigation services and hence, if they govern the irrigation systems, then the irrigation institutions would be more accountable.

Water user associations are promoted and facilitated to take over the management of canal systems. Notable success has been achieved in many places (Joshi, 1997). However, many researchers feel that despite being tried out for so long, the results are not substantial. In India, Andhra Pradesh was the first state to pass a PIM Act, i.e. an Act by which all irrigation systems were to shift to a PIM approach. Rajasthan and Madhya Pradesh are among the other states which have also passed an Act, while Gujarat and Maharashtra are two states where the Irrigation Departments and NGOs have demonstrated successful pilot projects and scaled up PIM through a number of government resolutions.

What PIM does is to try and empower the users to take decisions on the management of their system. Since this requires the irrigation bureaucracy to hand over some of these powers to the farmers (of whom earlier they were patrons), progress has been painstakingly slow and, more the result of rare initiatives of individual officers or a few Water Users Associations (WUAs) than a policy shift across the board. However, wherever there is political will behind this paradigm shift, as was the case in Andhra Pradesh, results have been apparent. PIM is as much a process of empowerment of farmers and letting go of 'state power' as a means of irrigation management, and therefore, suffers from all the delays of 'empowering' processes. While PIM alone may not be the 'magic pill' which works fast, in the absence of a comprehensive reform of the irrigation institutions, it is a small step towards 'liberalizing' the irrigation sector from the irrigation bureaucracy. For PIM to work, it has to be a part of the overall reform which includes water entitlements and accountable irrigation service agencies.

Just like other sectors the irrigation sector also suffers from the lack of an independent regulatory authority. In surface irrigation systems, the government is the service agency and the regulator. This leaves the farmers with limited options to demand better services. Unfortunately, there is a vicious cycle here; since services are subsidized, farmer users do not demand better services and since the services are poor, there is resistance when user charges are raised and subsidy reduced. Maharashtra has recently taken a bold step in resolving this by setting up the Maharashtra Water Regulatory Authority (Rastogi, 2006).

The Irrigation reforms, because they involve decisions on substantial resources, will have to be led by the political leadership. In states like Andhra Pradesh and Madhya Pradesh, the then Chief Ministers led the reform agenda. A similar political will is required at the national and state level if the irrigation sector has to be improved.

Community-based Watershed Programme

Irrigation has been the engine of economic growth in most rural areas and hence, ground water irrigation, largely financed by farmers, has been growing at a rapid rate in the country. India has the highest annual extraction, 150 million cubic metres, in the world. However, the surface irrigation (major and medium) and groundwater irrigation have left out many regions of the country where there is no irrigation. Two-third of the unutilized irrigation potential is in the eastern part of the country—Jharkhand, Orissa, Chhattisgarh, Eastern UP, and West Bengal—which also happen to be the 'poorest' regions of the country. With declining growth of agriculture and food grain production which is not keeping pace with population growth rate, enhancing agricultural productivity in these areas is of critical importance.

Increased agriculture productivity requires increase in water and land productivity. While the irrigation sector provides water, the watershed programme focuses largely on land productivity and soil erosion. Increasingly, it also leads to development of small irrigation infrastructure. The watershed approach originates from the earlier efforts to reduce soil erosion and increase land productivity undertaken by the Ministry of Agriculture. In the early 1980s, experiences of community involvement for treating watersheds showed success (Sukhomajri in Haryana, Ralegaon Sidhi in Maharashtra) and an Integrated Watershed Development approach was taken up under the Ministry of Agriculture and Ministry of Rural Development. Besides this, many NGOs had piloted successful models of community-based watershed development in the country. The major advantages of the watershed approach are reducing soil erosion, in-situ moisture conservation, generation of biomass, and increased groundwater recharge as well as low costs of irrigation.

For the irrigation sector, the watershed programme provides three major advantages:

1. It reduces siltation of the large dams by soil conservation in the upper catchments. For surface storage dams, siltation is a key problem as it reduces the storage capacity and hence, life of the dam (MoRD, 2006). The Inter Ministry Task Force on large reservoirs has pointed out that large reservoirs have lost over 33 per cent of their storage capacity due to siltation. This reduces the area under irrigation over time. The life of many large dams has decreased as actual siltation rates are much more than estimated. Hirakud Dam has siltation 2.5 times the rate assumed, reducing the expected life by half (Planning Commission, 2002).
2. Watershed treatment helps in recharging the local aquifers and makes investments in groundwater irrigation by farmers more viable.

3. Watershed treatment provides a low cost decentralized option to rainfed remote villagers that are not part of any irrigation schemes and do not have access to power and capital to scale up groundwater irrigation. A large number of small water harvesting structures (check dams, gabions, farm ponds, village tanks) are constructed or rehabilitated under the watershed programmes which provide much needed 'life-support' irrigation to kharif crops.

The International Crop Research Institute for Semi-Arid Tropics (ICRISAT) analysis of 311 watershed programmes finds that soil loss reduced by 0.82 tonnes/ha/year, irrigated area increased by 34 per cent, cropping intensity increased by 64 per cent, there was additional employment of 182 person days/ha/year, and the benefit to cost ratio was 2.14 (MoRD, 2006). There are individual studies which show that water levels have risen by 10 per cent in Andhra Pradesh. Watershed programme is also an effective drought coping intervention, as the study done by Development Support Centre shows that villages which have had watershed treatment have more food and water security during drought years than villages without watershed treatment (MoRD, 2006).

Reforms in the Watershed Sector

Learning from the success of community-based watershed projects, the MoRD launched the 'common guidelines', bringing together five different programmes of the Ministry of Rural Development, namely, Drought Prone Area Programme, Desert Development Programme, Integrated Wasteland Development Programme, Jawahar Rozgar Yojana, and Employment Assurance Scheme in 1994. These common guidelines were unique in many ways with assured funding for four-five years directly at the village level, involvement of NGOs, and a high emphasis on capacity building of the community. These guidelines have been modified in 2003 and issued as 'Guidelines of Hariyali' with a greater involvement of village panchayats. Recently, the Government of India appointed a Technical Committee on Watershed Programmes and its latest report provides new directions to the watershed programme. This report, titled 'From Hariyali to Neeranchal,' argues the case for a greater investment and scaling up of the watershed programme and a comprehensive instituitional reform to enable the government to operationalize the participatory guidelines (MoRD, 2006).

Financing the Watersheds

In terms of costs, while there is community contribution in terms of labour and supervision (in most projects the users themselves are involved in the implementation of the programme), the government investment till date has been Rs 4000 per ha. Till date the area covered under watershed programme (under Ministry of Rural Development, Ministry of Agriculture, externally aided projects and so on) has been 45.58 million ha at a cost of Rs 17,037.42 crore. However, the recent report of the Technical Committee on Watershed Programmes in India feels that the unit cost is inadequate and recommends an investment of Rs 12,000 per ha so that there is substantial increase in the water harvested and the area irrigated (MoRD, 2006). The Committee recommends an outlay of Rs 150,000 crore to treat 125 million ha at a unit cost of Rs 12,000 per ha. Since the annual outlay is hardly Rs 2300 crore, it is suggested that by diverting funds from the National Rural Employment Guarantee Scheme, where focus and coverage area is the same as that for watershed programme planning, the current programme outlay can be doubled to Rs 5000 crore and the watershed work on 125 million ha can be accomplished by 2020.

The Rain Water Harvesting Movement

The success of the decentralized water harvesting structures in the watershed programme has led to increased focus on water harvesting in all the states. While Gujarat state has a high profile 'Sardar Patel Jal Sanchay Yojana', Madhya Pradesh has a 'Jalabhishek Yojana' and Rajasthan has a 'Jalbiradari' scheme. In all these states (water scarce regions) the Chief Ministers personally spearhead the programmes. There is a huge publicity campaign and mass awareness campaign approaches (padayatra and so on) are used as a means of communication. All the political leaders in these states give priority to these programmes, and the 'schemes' are part of the election manifestos and self-promotions campaigns of all political parties. What appeals to the political leaders is the relatively low cost, widespread appeal, the speed of implementation (relative to the huge time and cost-over-runs of the major and medium irrigation schemes) and the fact that community participation is relatively easy and visible. These small water harvesting structures are largely win-win, that is, with no problems of land acquisition, submergence and so on. Being small and technically simple, village communities also feel confident about implementing such schemes with little external support (Box 7.1.2).

In many other states (such as Andhra Pradesh, Karnataka, and Uttaranachal) there is a special, high profile water harvesting movement which has been launched and prioritized by the incumbent Chief Minister. If there is one 'rural irrigation' programme which has caught the imagination of the current political leaders, it is this approach of a large number of small water harvesting structures (as opposed to a few large dams of the 1960s). For modern India, a large number of small check dams is definitely a better option of delivering results

Box 7.1.2

Check Dam Programme of Gujarat

Gujarat has one of the largest community based check-dam programmes in the country. After the drought of 1999, young men of Khopala, a village in water scarce Saurashtra, grew tired of the poor agriculture productivity due to water shortage and decided to try and solve their problem themselves instead of waiting for a government scheme. They collected money from within the village and from those who had migrated to urban areas (many of whom were diamond merchants in Surat). With community labour and native intelligence, they constructed 200 check dams, small and large, in a six month period before the monsoons. The water harvested during monsoon transformed the village economy, increasing the area under irrigation and improving the availability of drinking water.

Other nearby villages emulated the example, and village and local leaders spread the message of self-reliance and water harvesting through water-walks (jal yatra) in nearby blocks and districts. NGOs working in the region sent thousands of villagers for an exposure visit and the message spread quickly. Religious leaders, regional media also took up the campaign. Soon this became a mass movement which attracted thousands of villagers to the simple idea of becoming self-reliant by harvesting water.

The Government in tandem with the mood of the masses developed an easy-to-access scheme called the Sardar Patel Participatory Water Conservation Scheme. In this scheme, the government funded 60 per cent of the cost while the community contributed 40 per cent through labour, material, and cash (it was changed to 80:20 scheme in 2005). In a display of rare political will, the irrigation department was restructured to support this scheme which had very simple design parameters for the dams which could be replicated by the community. Application procedure was simplified and approvals given with basic technical guidance. In Gujarat, since January 2000 which is when the Sardar Patel Participatory Water Conservation programme was launched, about 30,000 check dams have been built up to 2003 (conversation with senior staff reveals that till 2006, almost one lakh check dams would have been constructed). The average cost is about Rs 5 lakh and storage varies between 0.15 Mm^3 to 0.35 Mm^3.

within a five year term rather than the slow-moving, expensive and controversial 'temples' of the 1960s!

Though it is difficult to get a consolidated idea of the amounts invested by various states, Gujarat alone has invested Rs 2 thousand crore in the 'Sardar Patel Participatory Check Dam Scheme' and the 'Sujalam Sufalam' schemes over the last five years.

Micro-irrigation

Much of the debate and discussion in the irrigation sector has been on increasing the supply of water to agriculture and this has led to bringing of more area under surface and groundwater irrigation. However, little attention has been paid to improving the efficiency of irrigation, i.e., ensuring that there is 'more crop per drop' of water. Agriculture data still measure productivity in kilos per ha even though in many areas the scarce resource is water, not land. It is in this context that micro-irrigation emerges as a potential answer to the problem of increasing irrigated area with limited water resources available.

As noted earlier, micro-irrigation comprises two technologies—drip and sprinkler irrigation. Both of them save conveyance losses and improve water application efficiency by applying water near the root-zone of the plant. Drip systems convey water in small quantities through drippers/micro-tubes while sprinklers are pressurized systems where a fountain or spray of water is released by the sprinkler connected by pipes, resulting in foliar irrigation.

Benefits of Micro-irrigation

1. The increase in yield for different crops ranges from 27 per cent to 88 per cent and water saving ranges from 36 per cent to 68 per cent vis-à-vis conventional flow irrigation systems (Phansalker and Verma, 2005).
2. It enables farmers to grow crops which would not be possible under conventional systems since it can irrigate adequately with lower water quantities (Box 7.1.2).
3. It saves costs of hired labour and other inputs like fertilizer.
4. It reduces the energy needs for pumping, thus reducing energy per ha of irrigation because of its reduced water needs. However, overall energy needs of the agriculture sector may not get reduced because most farmers use the increased water efficiency to bring more area under irrigation.

Conventional drip systems, which have been subsidized by the government, use 'drippers' and have pressurized flow. Their cost ranges from Rs 40,000 to Rs 60,000 per ha and the government subsidy (given to the drip company) ranges from 30 per cent to 80 per cent.These systems have been subsidized over the last two decades. Because of the high costs and complex subsidy procedures, most farmers, especially the poor, have not been able to access this technology even though they, with their insecure water sources, stand to gain most from these. Hence an NGO, the International Development Enterprise India (IDEI) has developed a low-cost drip irrigation technology which costs much less than the conventional drip,

Table 7.1.2
Yields and Water Use for Selected Crops under Conventional and Drip Irrigation Systems in India

	Yield (Quintal/Ha)			Water Supplied (cm)		
Crop	Conventional	Drip	Increase	Conventional	Drip	Saving
Banana	575.00	875.00	52%	176.00	97.00	45%
Grapes	264.00	325.00	23%	53.20	27.80	48%
Sugarcane	1280.00	1700.00	33%	215.00	94.00	65%
Tomato	320.00	480.00	50%	30.00	18.40	39%
Watermelon	240.00	450.00	88%	33.00	21.00	36%
Cotton	23.30	29.50	27%	89.53	42.00	53%
Chillies	42.33	60.88	44%	109.71	41.77	62%
Papaya	13.40	23.48	75%	228.00	73.30	68%

Source: Verma, 2004.

Box 7.1.2
Transformation of Tippehalli

In Tippehalli of Sangola block in Solapur district, from where the current phase of dramatic growth of low cost micro-irrigation has begun, farmers had long given up cultivation of their own lands. The village is located at a relatively higher altitude on hard basalt. Their wells have water that lasts barely 30 minutes of pumping for some eight months of the year, soils are gravel and thin. Farmers had given up cultivation and had taken to migration for cane cutting as their principal source of livelihood. With the advent of micro-irrigation and pomegranate cultivation, the village has seen the end of misery, forced migration and hunger. The crop can manage with little water during prolonged summer months and the low cost drips help farmers stretch their limited water sources to save their plantations.

Source: Raina (2004).

Box 7.1.3
When do Subsidies lead to Market Creation?

We have mentioned earlier that sprinklers have followed a somewhat different trajectory compared to drip irrigation though only in a few pockets of the country. Narsinghpur has seen a huge spread of sprinklers. Here the landscape is undulating, soils are alluvial and dominant crops grown are leguminous pulse crops which cannot stand excessive flooding or waterlogging. Undulating farms make gravity flow difficult while sprinklers have proved to be a boon. It should be noted that this ground situation enhancing suitability of sprinklers in Narsinghpur district enabled the subsidy, initially offered on sprinklers, to kindle a huge interest in farmers and that led to expansion of volume of sales of sprinklers. Thus, even after the subsidy amounts were reduced, the market took off on its own. The rise in volumes meant competition grew and product prices dipped bringing the technology within reach of a large number of farmers. Even some poor tribal farmers adopted the technology.

Source: Rahul (2004).

is a divisible technology (the conventional drip has the major disadvantage of being available in large units, which are expensive, unsuitable for small farmers and cannot be adopted on an incremental basis by farmers who first want to try out a new technology and then scale up). IDEI has three models which it has been promoting in the market for the last five to seven years, largely through a non-subsidized approach using the market-based system of incentives and awareness.

With all these efforts by the government and social innovators like IDEI, there are still only 3 lakh users of drip in the country (covering about 250,000 ha of land) and the area under sprinklers is also only 700,000 ha. Considering that there are almost 20 million well owners, the potential of micro-irrigation is huge. The potential for drip ranges from 10 million ha to 16 million ha (Phansalkar, 2004). Overall, drip systems cover 1.5 per cent of potential. The potential for sprinkler irrigation is about the same.

Scaling up of Micro-irrigation

If the micro-irrigation devices achieve their potential of about 20 to 30 million ha, and even if water savings are on an average of 30 per cent, then an area of almost 6 million ha can come under irrigation with almost no additional irrigation infrastructure. Considering the huge subsidies required, both under surface irrigation and groundwater irrigation for bringing an additional ha under irrigation, investing in micro-irrigation is probably the most economical and environment friendly option. If scaled up, this may prove to be the technological breakthrough to address growing irrigation needs in a period of scarce resources. But there are many reasons why drip is not expanding despite its many benefits. It is obvious that unless the government, financial institutions and NGOs devote quality human and financial resources, scaling up may not occur (Phansalkar, 2004).

Way Forward

The major challenge for the irrigation sector is to provide irrigation to rainfed areas, improve the quality of irrigation to existing irrigated areas, and achieve both of these objectives without incurring the large human, financial, and environmental costs of the past.

The displacement costs to rural livelihoods, especially tribal livelihoods, because of large surface irrigation infrastructure have been huge and before new projects are initiated, the country needs mechanisms to redress the sufferings of those affected by the large irrigation projects. These projects have high costs, both in terms of capital investments as well as repairs and replacements, and existing budgetary outlays do not match the needs. Operational costs are largely subsidized, and the irrigation institutions are in a poor condition with few linkages between water rates, recoveries, and system performance. Therefore, major and medium surface irrigation systems have become increasingly unviable as capital, operational, and management costs rise with low contribution from users.

To look at the brighter side, many state governments have increased their water rates, increased the role of farmers in surface irrigation management through PIM and stopped recruitment to the irrigation departments. Groundwater irrigation has proved the largest source of irrigation in the last two decades. Since the capital cost is mainly funded by the farmers themselves, its rate of growth and spread has been determined by demand for water rather than availability of water resources or government funds. However, the operational costs of pumping out water have been subsidized through power subsidies, and these are substantial. The source is being over-exploited and many aquifers may not last unless there is focus on management and regulation of use by the irrigation sector. Watershed development, which enhances agricultural productivity in rainfed regions through soil and water conservation, has done much to alleviate the problems in non-irrigated regions. Watershed treatment recharges the groundwater and reduces siltation of large dams.

It is not possible to meet the challenge without substantial reforms in the irrigation institutions. The lessons of the last thirty years show that farmers increasingly want to manage the irrigation services they avail of. The high private investment in groundwater irrigation and substantial community contribution in small water harvesting structures indicate the farmers' willingness to invest in reliable, self-managed irrigation. If they can get timely and reliable irrigation water and if there is transparency in the allocation and use of funds, they do not mind investing their money and time in managing and maintaining the irrigation systems. The irrigation institutions and policy-makers also need to reduce their obsession with the supply side approach and give attention to improving irrigation efficiency.

Irrigation departments in many states are over-staffed and despite the increased role of 'minor' irrigation, have a larger share of staff for major and medium irrigation projects. Irrigation itself requires an understanding of agriculture, sociology, agriculture economics, and agriculture engineering. Most irrigation departments are overwhelmingly staffed by civil engineers whose core competence is in constructing large dams and canals. Therefore, there is a need for a major shift in the existing staffing profile of water resource development departments so that their skill sets are relevant to the changing needs. Institutional reforms are a must and the revised guidelines[19] for the AIDP make 'reforms' a pre-condition for funding irrigation projects. The time is ripe for most institutional reforms, such that

1. Irrigation institutions reflect changing approaches and technologies.
2. Institutions focus not only on increasing the amount of water available but improving the irrigation efficiency of the farmer so 'there is more crop per drop'.
3. Irrigation institutions are so structured and incentives evolved such that there is a link between water rate, water recovery, and irrigation system performance. Only when this is done can irrigation systems recover their operational costs.

[19] *http://wrmin.nic.in/investement/aidp_guidelines.pdf*

4. The irrigation department, reduces its role in existing irrigation substantially and hands over powers to farmers' associations or any other alternative institutions (farmers, entrepreneur and so on) which can take over the role of water distribution and management (after making sure that the physical system is in a shape which needs management and not extensive repairs!).
5. Groundwater irrigation and other 'minor' irrigation get the attention they deserve and water management rather than development becomes the focus.
6. Tribal and other non-irrigated areas are served with irrigation technologies appropriate to their context.

No single approach to irrigation—surface irrigation, groundwater, or watershed—can be applied to the diverse socio-geographical regions of the country. The government and all other agencies will have to evolve the best fit of technology and in the institutional arrangements for the different regions of India. This is the key learning of all these years, and therefore, to a large extent, the debate of choosing one approach to the exclusion of the others is irrelevant. In India, there are many areas where reforms and innovations have been tried out successfully; Participatory Irrigation Management in Andhra Pradesh, the participatory check dam scheme in Gujarat, the work done by NGOs in drought-prone and tribal areas in promoting water-harvesting, low-cost irrigation, and watershed treatment as well as low-cost, easy-to-use micro-irrigation devices, all offer lessons which can be scaled up.

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PART II INTER-BASIN WATER TRANSFER

N.K. Bhandari and N.S.R.K. Reddy

Introduction

The water resources projects are the closest to the hearts of rural people. They are usually located/proposed in the gorge portions of river systems which are normally remote rural areas inhabited by tribal and other backward classes. These projects transform regions, ushering in socio-economic development for the people. Interlinking of river projects is no different in this regard. Rather, it can be visualized as conventional water resources project, extended in scope for development/benefit of not only the surplus in-basin but also neighbouring water-short basins. Even today, the success of India's agriculture is mostly dependent on rainfall, the prediction of timing and intensity of which has become an onerous task. Much of the rainfall pours in a few intense spells only during the four monsoon months from June to September. Even this is not evenly distributed across the country. The basic philosophy of the inter-basin water transfer is thus to correct the natural imbalances in the availability of water in different seasons and across different regions of the country. In this part, the National Perspective Plan for Water Resources Development being pursued by the GoI is discussed in the context of its likely impact on India's rural development.

Need for Inter-Basin Water Transfer

India receives on an average about 4000 billion cubic metres (bcm) of precipitation every year. More than half of this quantity is lost to the atmosphere or through deep percolation and only about 1869 bcm flow in the rivers as surface flow. This is estimated to be the water resources potential of the country. Approximately 690 bcm of surface water and 432 bcm of groundwater are available for use per year through conventional water resources development strategies. Nearly 60 per cent of the potential lies in the Ganga–Brahmaputra–Meghna system in the North. Another 11 per cent in the high rainfall region of the Western Ghats flows through the small west-bound rivers draining into the Arabian Sea. Apart from sundry sources, this leaves barely 19 per cent from all the other rivers put together including mighty rivers like Mahanadi, Godavari, Krishna, and Cauvery which flow east through peninsular India towards the Bay of Bengal. These large variations in water availability are the basis for the flood–drought–flood syndrome afflicting India with some areas suffering from flood damages, while some others battle acute long-run water shortage situations. Planners have long considered the merits of water transfer mechanisms draining water from surplus areas to areas of shortfall to redress the imbalance to an extent.

The population of the country in AD 2050 will be around 1593 million for middle variant growth, as projected by United Nations (2004 Revision) and corresponding foodgrain requirement will be about 450 million tonnes. Development of irrigation coupled with high yielding varieties of crops and increased use of fertilizers may possibly be the only strategy available to achieve the required level of production. Availability of water for irrigation is thus critical to self-sufficiency in food. In-basin water resources development alone cannot increase the irrigated area beyond certain limits. The ultimate irrigation potential that can be achieved from in-basin development is estimated to be around 140 million hectares. But, for achieving the food production level of about 450–500 million tonnes, it is imperative that an irrigation potential of at least 130 million hectares for food crops alone and 160 million hectares for all crops is created. One of the major strategies for achieving such a massive increase in irrigation potential could be inter-basin transfer of water.

Many large towns and mega cities, particularly those situated in water deficit river basins, are already facing shortages in domestic and industrial water supply. In 1901, the urban population was about 26 million which was less than 11 per cent of the total population. By 2001, the urban population increased to 285 millions (28 per cent of the total population) with 35 urban agglomerations/cities having a population of more than one million. It has been projected that by the year 2050, urban population in India of 820 million would constitute nearly 50 per cent of the total population. As the economic condition of the people improves, the per capita water demand will also grow. Meeting the water requirement of large cities will be a challenging task. Traditional local sources of water supply will no longer be sufficient to meet the water needs of large cities. In many large cities like Mumbai, Delhi, Hyderabad, and Chennai water demands are already being met through inter-basin transfer of water. For meeting the domestic water requirements for the ever-increasing population in the urban areas, long distance inter-basin transfers on large scales may have to be resorted to in the future.

Apart from large cities and towns, rural areas are also facing problems with regard to domestic water supply, particularly during years of less than normal rainfall. During such years, the groundwater recharge is reduced, and the traditional groundwater source for meeting domestic water requirements are also exhausted well before the onset of the next monsoon resulting in acute shortage of water, even for drinking purposes. A lasting solution to meet the water requirements of such chronically watershort rural areas, towns and cities lying in water deficit river basins, is perhaps long distance inter-basin transfer of water.

An important advantage of inter-basin water transfer technology may lie in its applicability to the power sector. The demand for power is growing at the rate of 9 per cent annually. The projected demand by the year AD 2050 would be 8.3 million MW. Bulk of this power is expected to be sourced from coal-based thermal plants and the peaking power from hydel sources. The peaking power requirement from hydel sources will be around 3.3 million MW against just 84,000 MW estimated hydro power potential of the country. It may, therefore, be essential to develop the large power potential available in Nepal and Bhutan as part of the Himalayan rivers development component of the river linking project.

Different water demand scenarios up to the year AD 2050 as enumerated by Central Water Commission have been presented in Table 7.2.1. There will be a gap between the water availability and requirement by AD 2050 which cannot possibly be met through conventional in-basin development because of likely environmental, social, legal, or techno-economic constraints. Therefore, in order to bridge the gap, interbasin water transfer is being viewed as a viable alternative which would also take care of water-short areas including drought-prone areas. The overall water resources situation in India is summarized in Table 7.2.2.

Table 7.2.1
Sector-wise Demand Scenarios of Water in India

Sector	Water Demand (bcm) in the year 2010	2025	2050
1. Irrigation	688	910	1072
2. Drinking (including livestock)	56	73	102
3. Industrial	12	23	63
4. Energy	5	15	130
5. Others (Forestry, Pisciculture, Tourism, Navigation and so on)	52	72	80
Total	813	1093	1447

National Perspective Plan

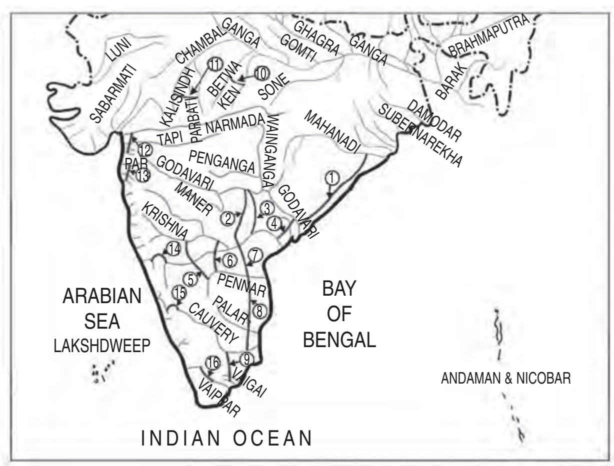
With a national objective of Water Resources Development in view, the then Ministry of Irrigation (now Water Resources) formulated a National Perspective Plan (NPP) in August 1980. The National Perspective Plan comprises two components, namely (i) Peninsular Rivers Development and (ii) Himalayan Rivers Development.

Table 7.2.2
Water Resources Scenario in India

1. Average annual precipitation	4000 bcm (3000 bcm during June–Sep)
2. Average runoff in all the rivers	1869 bcm
3. Utilizable surface water	1122 bcm
(i) By conventional means	690 bcm
(ii) Replenishable groundwater	432 bcm
4. Present utilization	605 bcm
5. Future demand by	
AD 2025	1093 bcm
AD 2050	1447 bcm
6. Possible additional water utilization through Inter Basin Water Transfer Scheme of GOI	170–200 bcm

Source: MoWR (2003).

Peninsular Component



1. Mahanadi (manibhadra)–Godavari (Dowlaiswaram)*
2. Godavari (Inchampalli)–Krishna (Nagarjunasagar)*
3. Godavari (Inchampalli)–Krishna (Pulichintala)*
4. Godavari (Polavaram)–Krishna (Vijayawada)*
5. Krishna (Almatti)–Pennar*
6. Krishna (Srisailam)–Pennar*
7. Krishna (Nagarjunasagar)–Pennar (Somasila)*
8. Pennar (Somasila)–Palar–Cauvery (Grand Anicut)*
9. Cauvery (Kattalai)–Vaigai–Gundar*
10. Ken–Betwa*
11. Parbati–Kalisindh–Chambal*
12. Par–Tapi–Narmada*
13. Damanganga–Pinjal*
14. Bedti–Varda
15. Netravati–Hemavati
16. Pamba–Achankovil–Vaippar*

* FR Completed

Fig. 7.2.1 Proposed Inter Basin Water Transfer Links

Source: *http://www.nwda.gov.in*

Peninsular Rivers Component

The scheme is divided into four major parts:

1. Interlinking of Mahanadi–Godavari–Krishna–Pennar–Cauvery rivers and building storages at potential sites in these basins.

This involves interlinking of the major river systems where surpluses from the Mahanadi and the Godavari are intended to be transferred to Krishna, Pennar, and Cauvery rivers to cater to the needs of the deficit areas in the south.

2. Interlinking of west-flowing rivers, north of Bombay and south of Tapi

This scheme envisages construction of as much optimal storage as possible on these streams and interlinking these storage facilities to make available appreciable quantum of water for transfer to areas where additional water is needed. The scheme also provides for taking water supply canal to the metropolitan areas of Mumbai.

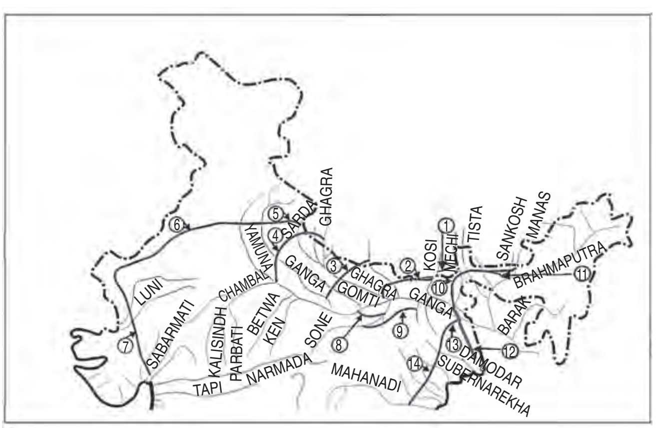
3. Interlinking of Ken–Chambal

The scheme provides for a water grid for Madhya Pradesh, Rajasthan, and Uttar Pradesh and an interlinking canal backed by as many storage facilities as possible.

4. Diversion of other west flowing rivers

The high rainfall on the western side of the Western Ghats runs down into numerous streams which discharge into the Arabian Sea. The construction of an interlinking canal system backed by adequate storages could be planned to meet all requirements of Kerala as also for transfer of some water towards the east to drought affected areas.

Himalayan Component



1. Kosi–Mechi
2. Kosi–Ghagra
3. Gandak–Ganga
4. Ghagra–Yamuna*
5. Sarda–Yamuna*
6. Yamuna–Rajasthan
7. Rajasthan–Sabarmati
8. Chunar–Sone Barrage
9. Sone Dam–Southern Tributaries of Ganga
10. Manas–Sankosh–Tista–Ganga
11. Jogighopa–Tista–Farakka (Alternate) to MSTG
12. Farakka–Sunderbans
13. Ganga (Farakka)–Damodar–Subernarekha
14. Subernarekha–Mahanadi

* FR Completed

Fig. 7.2.2 Proposed Inter Basin Water Transfer Links

Source: *http://www.nwda.gov.in*

The Peninsular rivers development is expected to provide additional irrigation of about 13 million hectare and generate about 4 million kW of hydropower.

Himalayan Rivers Component

The Himalayan Rivers Component envisages construction of storages on the principal tributaries of the Ganga and the Brahmaputra in India and Nepal, along with interlinking canal systems to transfer surplus flows of the eastern tributaries of the Ganga to the West, apart from linking main Brahmaputra and its tributaries with the Ganga and Ganga with Mahanadi.

This component will provide additional irrigation of about 22 million ha and generation of about 30 million kW of hydropower, besides providing incidental flood control on account of the storages proposed in the Ganga–Brahmaputra basin. It will also provide the necessary discharge for the augmentation of flows at Farakka required interalia to flush Kolkata Port and the inland navigation facilities across the country.

Benefits

The National Perspective Plan in totality is planned to give additional benefits of 25 million ha of irrigation from surface waters, 10 million ha by increased use of ground waters, to raise the ultimate irrigation potential from 140 million ha (expected through conventional means of development) to 175 million ha and generation of 34 million kW of power, apart from the benefits of flood control, navigation, water supply, fisheries, salinity and pollution control and so on.

National Water Development Agency

The National Perspective Plan was discussed with state governments and the initiative taken by the Central Government for optimal development of water resources in the country was welcomed. A National Water Development Agency (NWDA) was set up in 1982 under the Ministry of Water Resources as an Autonomous Society to study the feasibility of the Peninsular Component of National Perspective Plan. Subsequently, as the studies progressed, in 1990–1, NWDA was entrusted with the studies of Himalayan Component as well. Over the years, NWDA has carried out extensive desktop studies that are required in sequence to establish the feasibility of the Interlinking of Rivers (ILR) programme viz. water balance studies of basins/sub-basins and at diversion points, toposheet and storage capacity studies of reservoirs, toposheet and pre-feasibility studies of links and finally came out with thirty proposals (16 Peninsular presented in Figure 7.2.1 and 14 Himalayan presented in Figure 7.2.2) for proceeding to establish their feasibility on ground. The feasibility reports of fourteen Peninsular links out of the sixteen identified have been completed so far. All these studies are available on NWDA's website, *www.nwda.gov.in*. The feasibility studies of the Himalayan links are currently underway on Indian territory.

Benefits of Interlinking of Rivers Programme: Rural Perspective

It is expected that the ILR programme will have a major impact on rural India in general, and agriculture-dependent households in particular. As the programme is still at a conceptual stage, these aspects are elucidated only at macro level considering mainly its quantifiable benefits in the form of increased irrigation, improved drinking and industrial water supply, and enhanced electricity generation. The overall effect of the project can be expected to be much wider and more diverse, when all the tangible and intangible benefits are duly assessed through micro level studies and realized.

The Interlinking of Rivers Programme will have both short and long-term impact on the economy. The short-term impact of the link canal will be in the form of increased employment opportunities and the growth of the services sector. Sectors supplying crucial inputs to the construction sector, such as cement, iron, and steel will also grow. In the medium to long term, a major impact will be in terms of increased and assured irrigation, power generation, domestic and industrial water supply and associated development.

Irrigation

The National Perspective Plan will provide irrigation benefits of 35 m ha in rural areas. The envisaged annual irrigation by the ILR project will be nearly 35–40 per cent of current irrigated area in the country and one can visualize the agro-economic and socio-economic benefits that could be derived. Rainfed and water stressed lands can be assured irrigation and increased yields. About 2.5 m ha of drought-prone lands spread across several states are expected to be benefited from ILR Project.

According to a study carried out by National Council of Applied Economic Research (NCAER), the expected foodgrain production in the year 2018–19 will be about 394 million tonnes subject to the implementation of ILR programme (Table 7.2.3). The foodgrain productivity growth is not expected to vary far from the levels attained by conventional irrigation methods that is, 2.46 per cent after 2018–9 (post-implementation of ILR programme). The country's foodgrain production can be expected to reach about 500 million tonnes by AD 2050. This will be sufficient to meet the foodgrain requirement of the country's population and India will be able to maintain its self-sufficiency with respect to food.

A network of thousands of kilometres of link canals will provide life lines for rural development. Besides food

Table 7.2.3
Foodgrain Production as per NCAER study (million tonnes)

Year	Baseline		With ILR programme	
	Expected Production	% increase	Expected Production	% increase
2006–7	228.66		228.66	
2007–8	234.72	2.65	234.72	2.65
2008–9	240.9	2.63	242.98	3.52
2009–10	247.13	2.59	254	4.54
2010–11	253.43	2.55	263.78	3.85
2011–12	259.77	2.50	273.51	3.69
2012–13	266.17	2.46	289.81	5.96
2013–14	272.62	2.42	323.59	11.66
2014–15	279.12	2.38	360.54	11.42
2015–16	285.68	2.35	376.21	4.35
2016–17	292.29	2.31	381.47	1.40
2017–18	298.95	2.28	387.49	1.58
2018–19	305.66	2.24	393.88	1.65
Average Growth (2006–7 to 2018–19)	2.46		4.53	
Average Growth (2008–9 to 2018–19	2.43		4.87	

production, the fertility of the lands may improve with irrigation development using surface water as well as recharged groundwater. Thus, the possibility of waterlogging which affects land productivity would be eliminated.

Rural Water Supply

The water supply situation is grim in rural areas. Womenfolk have to walk for miles in search of drinking water, which is often of poor quality. Link canals are so planned as to provide water to both urban centres and rural areas in the command with special emphasis on rural drinking water provisioning. Right of access to clean water is linked with fundamental right to life which the ILR aims to provide to common man both in the cities as well as in the villages. In the inter-basin water transfer schemes, domestic and industrial water supply will account for nearly 12 bcm. About 101 districts and Greater Mumbai, NCR of Delhi, Chennai, Kanpur, Lucknow, and other cities will benefit from the project. The intake structures, treatment plants, supply, and service lines will come up as part of infrastructure development in rural areas for assured potable water supply (Box 7.2.1).

Rural Electrification

Rural India suffers from power nonavailability, unreliability, as well as quality issues. The total hydel power potential of

Box 7.2.1

Drinking Water from Sardar Sarovar Project

The Government of Gujarat has developed a drinking water supply scheme based on Sardar Sarovar Project and it is the largest engineering intervention in India's rural water supply sector. The pipeline scheme, which is to cover 8215 villages when completed, will cost Rs 8096 crore at 2001 price level. Rural water supply was first started in Gujarat with Saurashtra in 2001, while in Kachchh it started in March 2003. The primary survey shows that 6 per cent of the villages of Gujarat (498 villages) included in the plan have already started receiving water, of which 180 receive water regularly.

The Sardar Sarovar Narmada Nigam Limited (SSNNL) is the 'bulk supplier' of Narmada water for drinking water supply. It supplies water to Mahi Right Bank Canal (MRBC) Authority, Gujarat Water Infrastructure Limited (GWIL) and directly to industries and municipal authorities. MRBC authority also supplies water to municipal bodies and industries. GWIL is the 'bulk carrier' of drinking water. GWIL and Gujarat Water Supply and Sewerage Board (GWSSB) purchase bulk water from SSNNL. GWSSB is responsible for implementation of the group distribution projects which connect to the bulk water pipeline projects for supplying water up to the village level distribution systems. It is the 'distributor' of the drinking water supply. It looks after O&M of main pipelines with pumping stations including filtration plants simultaneously with the execution of bulk water pipelines. It is also responsible for the O&M of the head works and distribution networks.

Pani Panchayats are being created at village level for O&M of village level facilities with technical assistance from GWSSB. The lowest level GWSSB functionary (line man/woman) is made a member of Pani Panchayat to share the O&M responsibility. These Pani Panchayats have to generate funds to meet part of the O&M cost. Apart from that, creating awareness about the installation of water meters to measure and control water use and water loss is one of the supportive roles envisaged to enhance water use efficiency at the village level. This is a very important role that Pani Panchayats have to play. In addition to that, they have to undertake many other functions such as creating awareness about health and hygiene among the villagers; keeping water structures, their distribution network, and their surroundings clean; adopting waste water management practices; taking up environmental sanitation programmes, and so on. *Talati cum Mantri*, a village level revenue officer cum secretary of Gram Panchayat will be the secretary of Pani Panchayat. The secretary will have to work under the administration of Taluka Development Officer of the state government.

Water and Sanitation Management Organisation (WASMO) is envisaged as a catalyst organization for implementation and maintenance of village level drinking water distribution with active participation of village communities. NGOs are being involved to facilitate the process of creating Pani Panchayats at the village level under the guidance of WASMO. Ultimately, Pani Panchayats are responsible for supplying drinking water to individual households in project villages. Pani Panchayats also have to collect the water charges from beneficiary households and have to pay their share of water charges to GWSSB on volumetric basis.

NGOs are also educating rural people on revenue generation at village level to compensate a part of the O&M cost. Despite all these efforts villages are reluctant to adopt volumetric water supply. Water allocation norms are well defined. Though the pricing policy is still evolving, there are clear indications that the water will be charged on volumetric basis and the rates will be far above the rates prevailing in rural drinking water supply schemes. The proposed new rates almost double the existing rate in cities. Given the fact that the economic cost of supplying water to these water starved regions is prohibitive, efforts to recover the cost, so as to make such projects financially viable, are inevitable.

The capital expenditure for piped water supply is of the order of Rs 2.88 per thousand litre. Generally, urban water supply project costs Rs.1.5–2.0 per thousand litre. Operational Expenditure (O & M Costs) are generally Rs 5 to 6 per thousand litre and in the present case, it is about Rs.8.6 per thousand litre. The rural water supply projects are costlier than urban water supply projects because rural population is more dispersed.

As water has started reaching villages, people in coastal villages of Saurashtra region have started growing trees using Narmada waters with immense positive outcomes. These examples indicate that Narmada water supply has really become a lifeline for the people of Gujarat.

Source: Talati et al. (2004).

the interlinking system will be 34,000 MW. Obviously, this will help in the electrification of nearby villages. The hydropower establishment in rural areas like power stations, sub-stations, supply, and distribution lines will be developed for power distribution through grids. Further, power transmission losses will also be minimized when rural areas receive power from proximate power stations.

Rural Industries

Adequate provision has been made towards meeting the projected requirements of industries in the region from link canals. Many agro-based and other industries may come up due to reliable supplies of water from link canals and increased agricultural activities in the region. Further, the ILR programme involves huge construction activity, which would include construction of dams/reservoirs, canals, control structures, road/rail bridges, and cross-drainage structures. This will have an impact on the industries supplying inputs for construction. There will also be an increase in employment and thus on demand for goods and services. The growth of the other sectors will depend on the strength of the backward linkages (sectors supplying inputs to construction sector) and forward linkages (sectors which are using output of construction sector as input) of the construction sector with the rest of the economy. This would certainly have a triggering/multiplier effect on the economy (Box 7.2.2).

Rural Employment

The interlinking of rivers is a mega project involving construction activity for years. The local population is likely to get employment as skilled and unskilled labour in these activities. Further, avenues of employment will be there for the poor people due to the increased agricultural activities and ancillary industries in the regions. This may help in socio economic upliftment of the project hinterland to a greater extent. More people will also be involved on a long term basis in the operation and maintenance of the link projects. Direct employment in the construction sector will grow by 22.74 per cent. Sectors such as coal tar products, cement and electricity, gas and water supply will experience higher growth of employment than the construction sector (NCAER, 2004). Total employment in economy would increase by nearly 4 per cent. Agricultural labourers are generally under-employed and they too have an opportunity to engage themselves in production activities during the lean season.

Rural Tourism

There are innumerable examples in India, like Krishnarajasagar, Nagarjunasagar and so on where a dam/reservoir has become a recreation spot promoting tourism, water sports and the like in the region. The Interlinking of Rivers Project has the potential to promote tourism on a large scale at its dam/reservoir sites, along canals and their confluence points which will yield revenue for the country. As a corollary, this will also lead to a spurt of guest houses, hotels, restaurants, and entertainment

Box 7.2.2

Bhakra Dam

The Bhakra Dam is a majestic monument across River Sutlej. Its construction was taken up first after independence, for the welfare of the people of Northern India. The construction of this project was started in the year 1948 and completed in 1963. The water stored at Bhakra has a tremendous potential of generating hydroelectric power. There are two power houses, namely, Left Bank Power Plant and Right Bank Power Plant. When Bhakra power houses were commissioned in 1969, total installed capacity in the entire country was 14,102 MW and the hydro capacity was 6,135 MW. To this, one single project, Bhakra, added 1050 MW (only dam for power houses) thus adding 7.5 per cent to the total capacity and 17 per cent to peak power capacity. The present installed capacity of the Bhakra-Nangal system, including the Beas-Sutlej link is a mammoth 2267 MW. Hydro-electricity by itself is sufficient justification of the project. Further, before Bhakra, the flood plains of Sutlej used to be 3 to 4 km wide. After Bhakra, the actual flood control offered by the dam, even though not planned, resulted in people occupying the flood plains up to a km or so.

The project is a vital component in Beas–Sutlej link in combination with Indira Gandhi Nahar Project which is an outstanding example of how the large inter-basin transfers brought about all round socio-economic growth with overall enhancement in the ecology and environment of the region. Under the Indus Water Treaty, the water of three eastern rivers viz. Sutlej, Beas, and Ravi were allocated to India. As the land to be benefitted in India lies mostly to the east and south of these rivers, the rivers had to be interlinked and the water conveyed through canal systems for serving vast tracts of land. The main storage on Sutlej is at Bhakra, while that on Beas is at Pong. Bhakra system provides irrigation to 26.3 lakh ha. of new area besides stabilization of existing irrigation of 9 lakh ha. A diversion dam, Pondoh, 140 km upstream of Pong on the Beas, enables diversion of water from the Beas to the Bhakra reservoir and generates 165 MW of power. Another dam on the Ravi namely, Ranjit Sagar dam will provide additional water to the Beas and will generate power. Subsequently, it was decided to link the Indira Gandhi Nahar Project with the river systems to provide 9.36 bcm of water to Rajasthan Canal for irrigating the areas of Thar Desert.

Transfer of surplus waters of Ravi, Beas and Sutlej to Rajasthan right up to Jaisalmer and Barmer through Indira Gandhi Nahar Pariyojana has eliminated drought conditions, provided power benefits, transformed desert waste land into an agriculturally productive area by bringing irrigation and vegetation to about 2 million hectare area. Contribution in agricultural production due to implementation of the project is worth Rs 1,750 crores annually. The Indian military at the western boundary receive water from this canal. The project has changed the living standard and socio-economic conditions of the people in the area beyond imagination.

Source: IWRS (2005).

parks in the region. A list of proposed dams in the ILR Project is given in Table A7.2.1 and Table A7.2.2.

Rural Services Sector

Once the project is in place, the services sector will flourish to meet the needs and demands of the people in the region. Establishment of health centres, schools, colleges, markets, community centres will take place. Rural health care, education, and family welfare are bound to improve.

Rural Forestry

The ILR programme involves construction of about thirty-three major dams. The programme, therefore, proposes afforestation as per GoI norms in lieu of the forest land that may get submerged under these dams/reservoirs. But, contrary to the opinion by many, all these dams are not exclusively proposed for the ILR programme. A number of these dams are already proposed by States and are likely to come up, even without the component of ILR. Only a few dams, not very huge, are specifically proposed where absolutely necessary and where there is no scope of integration of existing/proposed projects in the scheme. Nevertheless, in the long term, the rural forestry will improve on account of proposed afforestation in double the likely submerged forest area. Also, plantations proposed along the sides of the link canals would be both, aesthetic as well as valuable for rural forestry.

Rural Economy

With assured water supply for irrigation, domestic, and industrial use coupled with hydro power availability as well as access to basic amenities, services, employment avenues, and infrastructural facilities, the rural economy is certain to grow. The household per capita income in rural areas is expected to grow faster than urban areas to reduce rural poverty rapidly. Overall infrastructural development can be expected to escalate rural land and property prices boosting the economy further. The local administration can generate additional revenue by way of property and land registration, mandi tax and so on. The Comparative Growth Scenario of the country's economy with and without ILR programme as per the study of NCAER is presented in Table 7.2.4.

An attempt has been made to quantify and aggregate the various aspects of the Interlinking of Rivers Project based on very rough calculations using the information compiled based on pre-feasibility/feasibility studies of various link proposals carried out by NWDA which are given in Table 7.2.5.

The above table just gives an idea of the extent to which the ILR project can impact the rural economy and transform the rural livelihoods upon implementation. The list of link-

Table 7.2.4
Comparative Growth Scenario
(Average Growth during 2006–7 to 2018–19, percentage)

Variables	Baseline Scenario	With ILR Programme
Real GDP from Agriculture	2.27	3.92
Real GDP from Mining and Manufacturing	9.35	9.86
Real GDP from Electricity, Gas, and Water Supply	9.09	9.27
Real GDP from Construction	8.64	9.67
Real GDP from Transport, Storage, and Communication	11.04	11.19
Real GDP from Services	12.52	12.69
Real GDP at Factor Cost	10.13	10.50
Fiscal Deficit of Central Government	3.53	3.95
WPI of Foodgrains	4.94	4.61
WPI of Non-foodgrains	5.08	4.68
WPI of Agricultural Commodities	5.05	4.66
WPI Manufactured Products	3.86	3.66
WPI all Commodities	4.67	4.47
CPI (Agricultural Labourers)	4.17	3.89
CPI (Industrial Workers)	5.10	4.82
Production of Foodgrains	2.46	4.53
Production of Non-foodgrains	1.98	4.17

Source: NCAER (2004).

Table 7.2.5
Various aspects/parameters of ILR project

Sl. No.	Item	Size/Quantity
1.	No. of Dams to be constructed	33
2.	Length of the link canals (lined)	9,629 km
3.	Length of distribution network up to minors (lined)	12,468 km
4.	Size of link canals	Width varying from 3 m to 155 m and depth varying from 1.5 m to 10 m
5.	Lining involved	737 million square meters
6.	No. of canal structures	4,291
7.	Cement required	56 million tonnes
8.	Steel required	2 million tonnes
9.	Drinking water supply	101 districts and Greater Mumbai, NCR of Delhi, Chennai, Kanpur, Lucknow, and other cities
10.	Employment generation	58 lakh man years

Source: Pre-feasibility and feasibility studies of NHDA.

wise districts which benefit from the project is presented in Tables A7.2.3 and A7.2.4.

Roadblocks in ILR

The benefits enumerated above can only be reaped if the ILR project is implemented in time and managed in an appropriate manner. The implementation of ILR programme is not going to be a cakewalk. The many hurdles on the way include: arriving at consensus, addressing environmental concerns, sourcing funds and so on.

Consensus on ILR proposals

Ensuring consensus on ILR among the states is a complicated challenge. States have their own priorities in planning internal water resources which are not likely to be in unison with that of other states. The conflicting interests of the basin states, target states, and en route states are not easy to resolve. Therefore, relentless efforts are required on the part of the GoI to convince the states and get them to agree with the proposals. A group headed by the Chairman, Central Water Commission (CWC) and consisting of other officers of the CWC and the Secretaries of the Irrigation/Water Resources Department from concerned states was constituted by GoI in June, 2002 to discuss with the states the issues of arriving at a consensus regarding sharing of surplus waters and the preparation of a detailed project report by NWDA. Intensive efforts are being made by the government through deliberations in various meetings to ensure a consensus among the concerned states on the basis of feasibility studies of ILR proposals. As a result of such efforts, a Memorandum of Understanding was signed recently among the Centre, Madhya Pradesh, and Uttar Pradesh for the preparation of the DPR of the Ken–Betwa Link. The preparation of the DPR of this link has been taken up by NWDA and the quantification of various tangible and intangible benefits will be attempted at the DPR stage. To arrive at similar agreements in respect of the remaining links will be the main challenge, towards which consistent efforts have to be made.

Environmental Concerns

The ILR proposals have to address environmental concerns and clearly delineate remedial measures to mitigate damage to the ecology and biodiversity of the project areas, if any. Major concerns listed by the Ministry of Environment & Forests to be addressed during implementation of the Interlinking of Rivers proposals are:

1. Protection of forest cover.
2. Protection of reserve forests and wild life sanctuaries.
3. De-reservation of National Parks/Sanctuaries.
4. Loss of biodiversity, particularly for threatened species, endemic species of both animals and plants.
5. Adverse impact on migratory path of birds and corridor loss for animals due to change of habitat.
6. Resettlement and rehabilitation of lakhs of people and its adverse socio-economic impact.
7. Adverse impact on river hydrology and eco-system.
8. Loss of vegetation due to siltation of dams.
9. Impact on aquatic aspects, particularly fisheries.
10. Contamination due to agro-chemicals and organics.
11. Transfer of bad quality of water from one basin to another.
12. Measures to counter irrigation induced salinity, water logging.
13. Groundwater pollution due to seepage from canal systems.
14. Harnessing surface water alone is detrimental to conjunctive use.

Minimizing the adverse impact on the environment has to be meticulously planned and EIAs drawn up. In this direction, GoI constituted a committee of environmentalists, social scientists, and other experts on Interlinking of Rivers with a view to making the process of proceeding on Interlinking of Rivers consultative under the chairmanship of Secretary (WR) and environmental concerns to be resolved have been included in the Terms of Reference (ToR) for DPRs.

Financial Constraints

Interlinking of rivers is going to be a task of gigantic proportions both in terms of size as well as in terms of investment. However, if the investments are spread over a number of years, annual investment may not be substantially higher than the present state funding targeted at the water resources sector or other poverty alleviation programmes. The cost of the Interlinking of Rivers Programme is tentatively estimated to be about Rs 560,000 crore at 2002 price level. NCAER, in its study, has estimated that the cost of the ILR project would be about Rs 444,000 crore which is 21–22 per cent lower than the present rough estimate. The exact requirement on realistic basis will be available only after the preparation of the DPRs of all the links. Funding can be partly through public, public–private, and private inputs (TFILR, 2004).

In addition to the above, a plethora of points for debate in regard to the ILR Programme: (i) Should water be made available to non-basin States? (ii) What should the role of the Union government be? (iii) Should the Tribunals decide on the ultimate requirements of the basin and identify balance surplus waters? (iv) Should normal criteria of economic analysis be applied for ILR? (v) Is better water management a substitute to water transfers? (vi) Do we need Constitutional amendments to enable the ILR programme? and (vii) Should food self-sufficiency be a national goal? These points need to be debated on various fora and the modalities decided upon by the planners in the interest of the country (IWRS 1996).

Monitoring of the ILR Programme

The Supreme Court of India, in the Writ Petition No.512 of 2002 regarding networking of rivers, directed the Union Government to file an affidavit. The government has informed the Court that the MoWR has prepared a National Perspective Plan for inter linking of rivers of the country for transferring water from water surplus basins to water deficit basins. It was also stated in the Affidavit that a High Level Task Force can be formed to go into the modalities for bringing out the consensus among the states. As per the Perspective Plan for implementation of inter-basin water transfer proposals prepared by the National Water Development Agency submitted by the State of Tamil Nadu along with its affidavit to the Supreme Court, the completion of the Peninsular links will be achieved by 2035 and Himalayan links by 2043. On this, the Supreme Court has observed in the said petition, 'We do expect that the programme when drawn up would try and ensure that the link projects are completed within a reasonable time of not more than ten years. We say so because recently the National Highways Projects have been undertaken and the same is nearing completion and the inter-linking of the rivers is complementary to the said project and the water ways which are constructed will be of immense benefit to the country as a whole.'

The Supreme Court regularly monitors the progress of implementation of ILR projects. The Affidavits indicating progress of ILR are submitted by the government on a regular basis. The Court in its recent order has directed that the ILR website should contain an interactive contact so that those intending to give suggestions can use it to reach the concerned authorities. Further, the Court has directed that the authorities should expedite the completion of the DPR of Ken-Betwa link.

While the macro level monitoring of the ILR Programme is regularly being done by the Supreme Court, the detailed micro level monitoring is being carried out by the Steering Committee headed by Secretary (WR) and Monitoring Committee headed by Chairman, CWC.

Conclusions

To accelerate the country's GDP rate of growth to 8–10 per cent, it is essential that agricultural sector productivity be raised. Making use of water which runs off during monsoons is one of the ways to assure supply of water in a timely and equitable manner.

The ILR project has the potential to catalyze socio-economic transformation of rural masses and alleviation of poverty. It is focused on providing water for drinking, irrigation, and agro-based industries which will benefit rural people. Of course there are some important issues such as submergence, environmental concerns, and displacement which need to be addressed amicably.

There are a number of successful examples of water resources projects such as Bhakra (Box 7.2.2), Rajasthan canal, and the Sardar Sarovar project which have been instrumental to the overall well-being of the hinterland. ILR project is expected to emulate these projects in transforming the water resources development scenario in the country, both spatially and temporally.

Development of local water resources through watershed management must be carried out in tandem with interlinking of rivers to gain the true benefits of existing water resources. Watershed management measures are site specific and cannot be applied universally. Particularly, when the normal rainfall itself is quite low in the region the scope of watershed development in semi-arid and arid regions is not very significant. This strategy alone may not be able to solve the massive water availability problems which the Interlinking of Rivers Project is attempting to do. Integrated Water Resources Development plans must take into account all the options in meeting the prevailing as well as projected demand for water in the country. Also, it must be appreciated that conservation of water for its prudent use round-the-year will pay rich dividends.

ANNEXE
PROPOSED DAMS IN INTERLINKING OF RIVERS PROJECT

Table A7.2.1
Peninsular Rivers Development Component

S.No.	Name of Link	Proposed Dams
1.	Mahanadi (Manibhadra)–Godavari (Dowlaiswaram)	Manibhadra
2.	Godavari (Inchampalli)–Krishna (Nagarjunasagar)	Inchampalli
3.	Godavari (Inchampalli)–Krishna (Pulichintala)	Pulichintala
4.	Godavari (Polavaram)–Krishna (Vijayawada)	Polavaram
5.	Ken–Betwa	Daudhan
6.	Parbati–Kalisindh—Chambal	Patanpur, Mohanpura, Kundaliya
7.	Par–Tapi–Narmada	Jheri, Mohankavchali, Paikhed, Chasmandva, Chikkar, Dabdar, Kelwan
8.	Damanganga–Pinjal	Bhugad, Khargihill, Pinjal
9.	Bedti–Varda	Pattanadhahalla, Shalamalahalla
10.	Netravati–Hemavati	Yattin hole, Keri hole, Hongadhallad hole
11.	Pamba–Achankovil–Vaippar	Punnamedu, Achankovil Kal Ar, Achankovil

Table A.7.2.2
Proposed Dams in Inter-linking of Rivers Project:
Himalayan Rivers Development Component

S.No.	Name of Link	Proposed dams
1.	Kosi–Mechi and Kosi–Ghagra	Kosi
2.	Gandak–Ganga	Gandak
3.	Ghagra–Yamuna	Chisapani
4.	Sarda–Yamuna	Poornagiri
5.	Sone Dam–Southern Tributaries of Ganga	Kadwan
6.	Brahmaputra–Ganga (Manas–Sankosh–Tista–Ganga)	Manas, Sankosh

Table A7.2.3
States/Districts Benefitted by various Link Proposals of NWDA under Peninsular Rivers Development Component

S.No.	Name of Link	States/Districts Benefited
1.	Mahanadi (Manibhadra)–Godavari (Dowlaiswaram)	Orissa: Cuttack, Khurda,Nayagarh, Puri, Gajapati and Ganjam Andhra Pradesh: Srlkakulam,Vizianagaram and Visakhapatnam
2.	Godavari (Inchampalli)–Krishna (Pulichintala)	Andhra Pradesh: Warangal, West Godavari and Khammam
3.	Godavari (Inchampalli)–Krishna (Nagarjunasagar)	Andhra Pradesh: Warangal, Khammam and Nalgonda
4.	Godavari (Polavaram)–Krishna (Vijayawada)	Andhra Pradesh: Krishna and West Godavari
5.	Krishna (Almatti)–Pennar	Karnataka: Raichur*and Bellary* Andhra Pradesh: Ananthpur*
6.	Krishna (Srisailam)–Pennar	Andhra Pradesh: No en route irrigation proposed
7.	Krishna (Nagarjunasagar)–Pennar (Somasila)	Andhra Pradesh: Prakasam* and Nellore
8.	Pennar (Somasila)–Cauvery (Grand Anicut)	Andhra Pradesh: Nellore and Chittoor* Tamil Nadu: Tiruvallur,Kanchipuram, Cuddalore, Vellore, Villupuram and Tiruvannamalai Pondicherry: Pondicherry

(contd)

Table A7.2.3 (continued)

S.No.	Name of Link	States/Districts Benefited
9.	Cauvery (Kattalai)–Vaigai–Gundar	Tamil Nadu: Truchirapalli, Pudukkotai, Sivaganga, Ramanadhapuram*, Virudhnagar, Karur and Thoothukudi
10.	Ken–Betwa	Madhya Pradesh: Chhatarpur, Panna, Tikamgargh, Rajasthan and Vidisha. Uttar Pradesh: Hamirpur and Jhansi.
11.	Parbati–Kalisindh–Chambal Alternative-I	Madhya Pradesh: Rajgarh, Guna, Shajapur* Mandsaur, Ujjain,* Ratlam and Dhar*. Rajasthan: Jhalawar.
	Alternative-II	Madhya Pradesh: Rajgarh, Guna, Shajapur* Mandsaur, Ujjain,* Ratlam and Dhar*. Rajasthan: Jhalawar, Kota and Chittaurgarh
12.	Par–Tapi–Narmada	Gujarat: Valsad, Dang, Surat, Bharuch*, Vadodara, Kutch and Saurashtra*.
13.	Damanganga–Pinjal	Maharashtra: Water supply to Mumbai City.
14.	Bedti–Varda	Karnataka: Raichur*
15.	Netravati–Hemavati	Karnataka:Tumkur* Hassan* and Mandya
16.	Pamba–Achankovil–Vaippar	Tamil Nadu: Chidambaranar, Tirunelveli* Kamarajar

Table A.7.2.4
States/Districts benefittig by various Link Proposals of NWDA under Himalayan Rivers Development Component

S.No.	Name of Link	States/Districts Benefited
1.	Brahmaputra–Ganga (MSTG)	Assam: Goalpara, Dhubri, Kokrajhar and Barpeta West Bengal: Cooch Behar and Jalpaiguri Bihar: Purnea and Katihar
2.	Kosi–Ghagra	Bihar: West Champaran (Bettiah), East Champaran (Motihari), Saharsa (including Supaul and Madhepura new distt.), Madhubani, Darbhanga, Samastipur, Bengusarai, Khagaria, Bhagalpur, Katihar, Munger*, Sitamarhi, Muzaffarpur, Vaishali, Patna, Chapra, Siwan and Gopalganj Uttar Pradesh: Gorakhpur, Ballia and Deoria
3.	Gandak–Ganga	Uttar Pradesh: Sultanpur, Faizabad, Jaunpur, Azamgarh, Ghazipur, Ballia, Pratapgarh, Raibareli, Baharaich, Gonda Gorakhpur, Basti, Barabanki, Lucknow, Allahabad*, Varanasi* and Sitapur
4.	Ghagra–Yamuna	Uttar Pradesh: Pilibhit, Bareilly, Kheri, Shahjahanpur, Sitapur, Hardoi, Lucknow, Unnao, Etah, Mainpuri, Farrukhabad, Kanpur, Fatherpur, Allahabad*, Budaun, Etawah and Raibareli
5.	Sarda–Yamuna	Uttar Pradesh: Bareilly, Rampur, Muradabad, Budaun and Bijnor. Uttranchal: Udhamsingh Nagar NCR of Delhi: Domestic and Industrial Water Supply
6.	Yamuna–Rajasthan	Haryana: Bhiwani* Rajasthan: Ganga Nagar, Bikaner*, Jodhpur* and Jaisalmer*
7.	Rajasthan–Sabarmati	Rajasthan: Jaisalmer*, Barmer* and Jalore* Gujarat: Banaskantha*, Mehsana* and Gandhinagar
8.	Chunar–Sone Barrage	Bihar: Rohtas*, Bhojpur* and Buxer Uttar Pradesh: Mirzapur* Varanasi*, Gazipur and Ballia
9.	Sone Dam–Southern Tributaries of Ganga	Bihar: Patna, Saran, Nalanda, Gaya*, Jehanabad, Vaishali, Munger*, Begusarai, Bhagalpur, Nawada*, Jamui and Aurangabad* Jharkhand: Palamu*

(contd)

Table A7.2.4 (continued)

Sl.No.	Name of Link	States/Districts Benefited
10.	Ganga–Damodar–Subernarekha	West Bengal: Murshidabad, Birbhum, Nadia, Hoogly, Howrah, Burdwan, Bankura* and Midnapur* Jharkhand: Pakur and Dumka Orissa: Balasore and Mayurbhanj
11.	Subernarekha–Mahanadi	West Bengal: Midnapur* Orissa: Balasore and Mayurbhanj
12.	Kosi–Mechi	Bihar: Purnea and Saharsa
13.	Farakka–Sunderbans	West Bengal: Murshidabad, Nadia and 24 Paraganas
14.	Brahmaputra–Ganga (JTF) (Alt. to MSTG)	Assam: Goalpara, Dhubri and Kokrajhar West Bengal: Jalpaiguri and Cooch Behar Bihar: Katihar and Purnea

Note: * Drought Prone Districts.
Source: Pre-feasibility and feasibility reports of NHDA.

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