Interlinking of Rivers in India

Assessing the Justifications

The present form of the river interlinking proposal, made by the National Water Development Agency, has been hailed as a 'must' for the country by many politicians. This paper critically examines the assumptions behind and the main justifications extended for the project. The paper disagrees with the concept that river basins can be mechanically divided as 'surplus' or 'deficit' ones, and views the proposed interlinking as an extremely cost-ineffective measure for the expansion of a rather inefficient traditional irrigation process. Thus, in the event of the mega-project being taken up as it is, it will lead to sub-optimal use of the water resources of the country through a huge and unwise investment. The official justifications for the proposed interlinking of rivers are not found to be backed by any scientific reasoning.

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I
Water Resources of India

In spite of the surface of the earth being covered mostly by water, over the past few decades water scarcity has emerged as a global problem. All life forms and human economic activities are critically dependent on water, the movement of which is governed by the global hydrological cycle. Humans have moderated such movements of water and made available large quantities of this resource at times and places to suit the needs of societies and meet the demand of economies. In course of time, the level of such human interventions has grown to such an extent quantitatively that the need for a more informed approach to this vital natural endowment is being recognised and articulated all over the world [Falkenmark et al 1980; Wittfogel 1957].

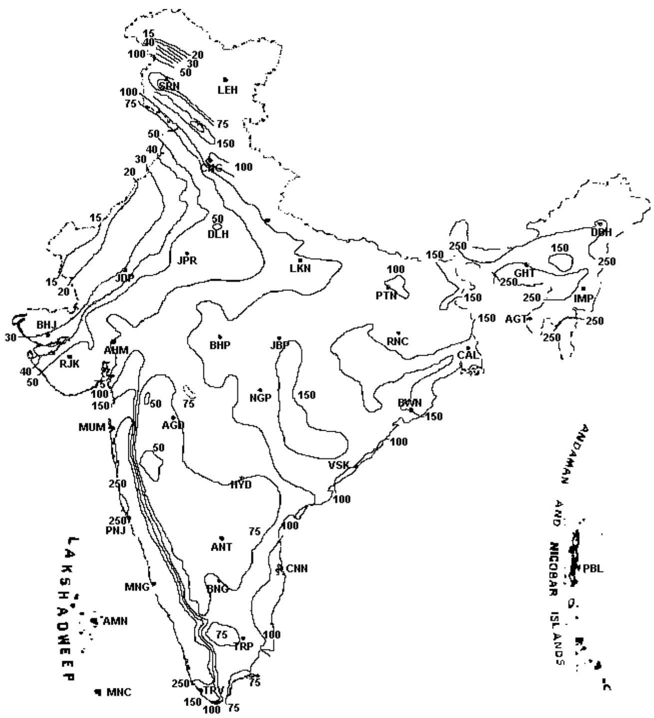
At the global scale, "freshwater lakes and rivers, which are the main sources for water consumed by the human societies, contain on an average about 90,000 bn cubic metres (BCM) of water, which is about 0.26 per cent of total global freshwater reserves" [Shiklomanov 1993]. The global withdrawal of freshwater has increased sevenfold between 1900 and 2000 [Gleick 2000]. If this trend continues, the world may see a more than sixfold increase in the number of people living in conditions of water stress, from 470 mn today to 3 billion in 2025 [Postel 1999]. With respect to its share of global water resources, India is regarded as a better endowed country, with a total annual precipitation of about 4,000 bcm. This is about 4 per cent of the total average annual runoff in the world's rivers [NCIWRDP 1999a]. As reported by the NCIWRDP (1999a), India has annual available water resources of 1,953 cu km. On the other hand, it is also true that, if the population of a country grows rapidly, there will naturally be a proportional reduction in the per capita availability of water. From this point of view, India is facing a regime of stress [Dyson 2001], as the per capita availability of water declined from around 5,177 cu m in 1951 to 1,869 cu m in 2001. Given the projected rise in India's population by 2025, the per capita availability may drop further to below 1,000 cu m. In terms of country-level indicators, such a situation would be considered as one of 'water scarcity'. This picture is not typical of India, but a rapid growth in population exacerbates the situation.

Water Resource Scenario

In terms of the total annual precipitation per unit of land surface, India stands well above the global average. However, the figures of gross annual precipitation over the country as a whole provide an unrealistic picture of the actual situation with respect to availability of water in the country. The domination of the south-west monsoon in the making of the climate of south Asia results in a wide spatial variation in the levels of precipitation from the east to the west (see the figure) and an acute temporal variation through the concentration of heavy precipitation during the 2½ months of monsoon, spread over July, August and September. The variability is exemplified by a comparison of the number of rainy days in parts of Rajasthan along the north-western boundary, where it is just five, and in some areas in north-east, where it rains for about 150 days [NCIWRDP 1999a:12]. Similarly, the average annual precipitation ranges from a low of about 200 mm in some locations in the western regions of India to a high of about 11,000 mm in the north-east.

It is thus quite clear, that the averaged-out national picture of precipitation cannot provide any realistic picture of the actual problems of water resource development and management. Due to the spatial and temporal inequities in precipitation, rivers in most parts of the country show a skewed hydrograph. The rain-rich regions experience regular annual inundations during the monsoon, while many rivers in the lower rainfall areas dry up soon after the monsoon is over. There is an increasing tendency to describe such obvious hydrological unevenness of rivers as

Figure: Spatial Variation in Precipitation Pattern



Source: http://www.imd.ernet.in/section/climate/annual-rainfall.htm

disasters. Whenever a river overflows its banks, statements accusing 'too much rainfall' or 'release of excessive water from the upstream' have become common. They are, however, not backed up by any open data. In areas with lower precipitation, growing water scarcity resulting from unsustainable utilisation practices and vanishing conservation measures, are frequently blamed on 'droughts'. How much of the growing scarcity is the result of human interventions in the water systems and how much is due to meteorological drought has not been openly analysed [Bandyopadhyay 1989].

As humans increasingly started to intervene in the flow of rivers [Deursen 2000], the gradual success of these interventions resulted in the upscaling of their operational dimensions that finally led to the emergence of large dams as instruments for river basin development [Bandyopadhyay et al 2002]. Like in all ancient civilisations, this scale of interventions in rivers and lakes has grown from very small to quite large over the last few centuries. In the colonial era, and more so in the post-colonial period, large-scale supply-side augmentation has been prescribed by engineers as the only way of meeting the growing water requirements of developing countries. As a result, policy-makers in India have been adhering to the idea of solving the water problem by harnessing the huge monsoon run-off in the main rivers in the eastern and north-eastern parts regions, primarily with the help of large structural interventions.

India's success in maintaining a high growth rate in food production further strengthened such ideas. The proposal for the interlinking of rivers offering a combination of storage dams and transfer canals, is an expression of that concept. It has been offered as a long-term supply-side solution to water shortages, especially in the drier western and southern parts of the country [IWRS 1996].

II
Proposal for Interlinking of Rivers

For the promotion of inland navigation, in the 19th century Arthur Cotton had proposed the linking of some rivers. For a different purpose, the idea was later revived in 1972 by K L Rao. It was to transfer water for irrigation in south India, where demand was quickly outstripping availability. The result was the idea of the 'Ganga-Cauvery Link Canal' as proposed by Rao [NCIWRDP 1999a:179-80]. In 1977, Captain Dastur, an aircraft pilot, proposed 'an impressionistic' plan for the construction of a pair of canals. Better known as 'the garland canal' scheme, it envisaged the construction of a 4,200 km long Himalayan canal and 9,300 km long southern garland canal and the connection between the two systems through two pipelines passing by Delhi and Patna.

On the basis of studies undertaken by the Central Water Commission (CWC) and other expert bodies, these two proposals were not found to be worthy of serious consideration. However, in August 1980, the ministry of water resources framed a national perspective for water development, and the National Water Development Agency (NWDA) was established in 1982 to carry out studies in the context of the national perspective. The perspective has two main components: Himalayan river development and peninsular river development.

Under this perspective, the NWDA took up the task of developing a proposal for interbasin transfer of water that would be more comprehensive than previous ones. The proposals of NWDA for long-distance interbasin transfers have not been openly articulated so far with any technical details. In fact, it is reportedly still at the stage of an idea, and not a project. The NWDA was to survey and investigate 'possible storage sites and interconnecting links' in order to establish the feasibility of proposals forming part of the national perspective. According to the report of the NCIWRDP, the interlinking proposal aims to provide large-scale human-induced connectivity for water flows in almost all parts of India, through a total of 31 links on both the Himalayan and peninsular components. None of the pre-feasibility or feasibility studies are available in the public domain for an independent professional assessment of the technical and economic justifications for these links. However, the project has been described by many politicians as a win-win situation for the mitigation of floods and droughts. The issue gained sudden and renewed currency in political, legislative and civil domains when the Supreme Court, in connection with a public interest litigation, passed an order on October 31, 2002 for the government to complete all links of rivers within 12 years.

Justifications Advanced

The idea of interlinking rivers is described, from the president down to local-level leaders in regions with lower rainfall, as the perfect win-win solution that will address the twin problems of water scarcity in the western and southern parts of the country and the problem of floods in the eastern and north-eastern regions. The claims and statements of politicians, cannot, however, substitute comprehensive scientific and technical assessment so that one can know whether, if the proposed interlinking project is completed, the right quality and quantity of water would be stored and delivered at the right time in the right places. Further, all this is to be achieved in the most cost-effective manner, without creating any social deprivations like inadequate rehabilitation of the involuntarily displaced. In view of the fact that 'our past record in resettlement is deplorable', as noted by the former chairman of the task force for interlinking of rivers [Prabhu 2004], nothing less than an open professional assessment of the technical proposals based on the latest interdisciplinary systems knowledge would be appropriate.

Unfortunately, beyond a few lines drawn on the map, no scientific and technical information of the proposal is available in the public domain, so that an open and independent professional assessment can be undertaken. As a result, the justifications that are being presented to promote the project have remained mere exercises in guessing by the professional world as well as the common people. This absence of open professional assessment of the technical details of the proposals has important implications. For example, in contrast with the official prescription for interlinking of rivers, there is a strong opinion that India's water crisis is caused by the mismanagement of water resources, and the solutions do not lie merely in supply-side augmentations. Iyer (2000), a former secretary of water resources, corroborates this fact, with the view that:

> There has been no serious attempt to work out a series of area-specific answers by way of local conservation and augmentation to the maximum extent possible. The severe drought of the summer of year 2000 in India was not an indication of water 'insecurity' nor did it point to the need for big projects or long-distance water transfers…The drought conditions were a result of bad water management in the past and the answer lay in better resource management in the future.

Even if the publicised claims of the gains to be made from the interlinking project are not available in the public domain, it will be necessary to examine the scientific credibility of certain concepts that are leading to these justifications. It is important to ensure that such a costly project is not based on an outdated and questionable knowledge base. In particular, there is a great need to take into full cognisance, the move towards a new and interdisciplinary paradigm for looking at water resources the world over. Thus, the proposed interlinking of rivers needs to be assessed in the light of the emerging paradigm changes in the subject of water management.

Changing Paradigm of Water Management

The urgent need for a change in our vision of water has, over the past few years, found frequent expressions in the scientific literature on water and its management. The caution that the 'business as usual' way of looking at this crucial natural resource would lead to severe stress, and probably conflicts, has been registered even at the highest international professional platforms [WMO 1992:27; Cosgrove and Rijsberman 2000:xxi]. Similar concerns have been expressed in diverse contexts by many leading water professionals over the past several years [Biswas 1976; Falkenmark et al 2000; Gleick 1998; Wolff and Gleick 2002:1-32]. While, on the basis of the ground realities, the need for a change in our perceptions about water has been accepted by many, the nature and extent of the required changes are still to be clearly articulated. Nevertheless, it is also apparent that what is needed is a fundamental shift away from the present reductionist engineering paradigm to a holistic and trans-disciplinary one. The new ways of managing water on the basis of such a knowledge base has increasingly been identified as integrated water resource management (IWRM).

Twentieth century water resources planning generally relied on linear projections of future populations, per capita demand, agricultural production and levels of economic productivity [Gleick 2000]. The vision of the water resource planners was limited mainly within supply-side solutions. However, the professional views of water are changing rapidly, based on the scientific analyses of past mistakes and availability of new information. This 'changing water paradigm' [Gleick 1998] represents a real shift in the way people think about water use. For example, in the US, the country that started the old global trend of building large dams, today "there is a new trend to take out or de-commission dams that either no longer serve a useful purpose or have caused such egregious ecological impacts so as to warrant removal. Nearly 500 dams in the US and elsewhere have already been removed and the movement towards river restoration is accelerating" [Gleick 2000]. Continued investments in huge engineering interventions is being challenged by those who believe that a higher priority should be assigned to projects that meet basic and unmet human needs for water [Gleick 1996]. Following these paradigmatic shifts in notions worldwide, various other means to conserve water instream are becoming evident. The Murray-Darling Basin Commission in Australia is seriously contemplating extending financial encouragement to farmers for saving on their allocation of irrigation water and to allow the savings to remain instream. In another instance, Chile's national water code of 1981 established a system of water rights that are transferable and independent of land use and ownership. The most frequent transaction in Chile's water markets is the 'renting' of water between neighbouring farmers with different water requirements [Gazmuri 1992]. In the Indian context, Bandyopadhyay (2004), in his assessment of the new National Water Policy 2002 finds that the old paradigm is still strongly entrenched in the official water administration. There are, however, some others who believe that there is no problem with the present paradigm which is able to address all problems. However, pointing out the exclusively supply-side solutions offered by the present paradigm, Helming and Kuylenstierna (2001) have cautioned that:

> Tapping into new supply sources tends to either impinge on demands by others, or cause serious damage to nature. Each new source of water is also normally more expensive to develop than the previous one. Demand-side management is therefore slowly becoming a new paradigm for water governance.

Reductionist Roots of Concept of 'Surplus' Basins

The proposal for interlinking of rivers is seen in this paper as a simplistic supply-side solution put forward from the existing paradigm of water management, which is fighting for its life elsewhere in the world. The proposed project is critically dependent on the identification of some river basins or sub-basins as 'surplus' ones, from which water may be transferred to some others, identified as 'deficit' river basins. Thus, it is claimed, swapping of floods in the surplus basins with the scarcity of water in the deficit basins would be a win-win solution. The interlinking of rivers will put to use 'the water otherwise going waste in the surplus river basins' [NCIWRDP 1999a:181]. Prabhu (2003) makes a more direct statement in this regard when he claims, "the (interlinking) project is about rationalisation of water that is lost to the sea".

The reductionist engineering concepts of water have seen it mainly in the form of visible flowing water. The totality of the ecosystem services provided by water, from the time of a drop falling on the surface of a river basin to the moment of its flowing to the sea have remained marginal and neglected for a long time [Falkenmark and Folke 2002]. As a result, it is not possible for the existing paradigm to recognise and record these various ecological processes and their values, for instance, in the conservation of biodiversity, its role as a mobile solvent, the pushing of the sediment load out to the sea, and many others. It is this conceptual limitation of the present paradigm that makes it possible for it to describe the outflow of a river to the sea as a 'waste', or finds little difficulty in locating 'surplus' river basins in a limited arithmetic assessment. Thus, the NCIWRDP (1999:181) declares that:

> …creation of storages and interbasin transfers from the surmised surplus river basins to deficit basins has been the guiding objective… it is considered imperative that all the rivers in the country be linked by a national grid to meet the shortages in the various parts of the country.

The methodology for working out whether or not a river basin has any 'surplus' water, is based on an unpublished paper by Mohile (1998) and recommended in the report of the working group on interbasin transfer of water [NCIWRDP 1999b]. In following this approach, a simple exercise in arithmetic hydrology has been employed that externalises the whole set of ecosystem services provided by water in a river basin. Whilst the process for the assessment of the needs of irrigation, domestic and industrial sectors have been dealt with in the report [NCIWRDP 1999b:30], there is no information given on how the water needs for the continuation of diverse ecosystem services provided by water in the various parts of the basin would be assessed. Leaving such parameters out may be convenient for promoting a project, but, as exemplified by Costanza et al (1997), the arithmetic may be in conflict with the total reality. The exercise by Costanza estimated that the value of the world's ecosystem services could be almost twice as large as the global gross national product (33 trillion per year compared with around $ 18 trillion per year). In this regard, Vaidyanathan (2003) rightly argues that simply identifying a river basin on the volume of flood flows is a misleading basis for judging surpluses. Bandyopadhyay and Perveen (2003) have described such a reductionist and mechanical approach to the categorisation of river basins as 'arithmetical hydrology'.

Thus, when the reductionist vision of arithmetical hydrology is replaced by the holistic perspective of ecohydrology, the outflow of a river to the sea is no more seen as a 'loss' but as essential for the continuation of the ecosystem services of the river. Whilst floodwater in eastern India is seen as a 'harmful surplus' from the viewpoint of arithmetical hydrology, the same floodwater is seen as a source of free minerals for the enrichment of land, free recharge for groundwater resources, a free medium for the transportation of fish and conservation of biological diversity and free bumper harvest for humans, from the ecohydrological viewpoint.

Cautionary statements that diversion of water from the 'surplus' to the 'deficit' basins would have significant impacts on the physical and chemical compositions of the sediment load, river morphology, aquatic biodiversity and the configuration of the delta, are not new. However, their assessment is not possible from within 'arithmetical hydrology'. These downstream processes have serious economic and livelihood implications and it is a national imperative to address and assess them as integral to the benefit-cost analysis of the proposal. Considering the diverse factors involved, Singh (2003), who chaired the working group on interbasin transfer of water of the ministry of water resources (MOWR), takes the position that:

> There really seems to be no convincing argument or vital national interest, which can justify this mammoth undertaking (interlinking), in its entirety.

All river basins have evolved over the geological past by making optimal use of available water resources. There are no inherently 'surplus' river basins. It is convenient for the reductionist viewpoint to ignore the totality and the fact that all drops of water in all river basins at all times are performing several ecosystem services. As a result, any transfer of water from one basin to another is not a simple arithmetic exercise, but one of a complex impact assessment.

However, there may always be a good case for interbasin transfer. This cannot be done in an ad hoc manner, without recognising the diverse social, economic and ecological impacts of such transfers. Further, full economic compensations for those affected by the negative impacts should be fully made. In the available information on the proposal for interlinking of Indian rivers, there is no reference to the assessment of any such costs. Accordingly, it is apparent that there are many important reasons for having a close look at the scientific validity of the justification put forward for the proposed interlinking of rivers. For this, all the pre-feasibility, feasibility and detailed project reports regarding individual interlinking proposals need to be made available in the public domain for open professional examination.

III
Assessment of Justifications

As has been mentioned above, beyond some lines drawn on the map, no scientific and technical details of the proposed interlinking of rivers is available in the public domain. Technical information on the flows, storages, link canals, barrages and associated engineering structures, the ecological impacts on downstream areas of the basins, extent of involuntary displacement, and likely costs and benefits of the proposal have not been made available for open professional assessment by the ministry of water resources. However, judging from the media coverage of public presentations of politicians, there seems to be a belief that after this project is completed, there will be no shortage of water in the rain-scarce parts of India, and that the 'problem' of floods in the rain-rich parts will be solved. Information on the mega projects on water with such great positive impacts have, however, remained guarded against any transparent and independent professional assessment [Bandyopadhyay 2003]. The importance of the people is limited to paying the huge costs of the project, whose justifications they have to just assume and to accept a standard of resettlement that is 'deplorable' [Prabhu 2004].

Large water projects have usually been justified by considering the direct cost of construction and operation of the engineering structures. Such practices have invariably generated popular discontent and have disgraced water-related project in the public eye. Careful analysis and evaluation of all costs (intrinsic social, economic and environmental), therefore, becomes a sine qua non for a more informed decision-making. On the basis of the very general description of the proposal as available in the public domain, such a detailed assessment cannot be taken up. What can be undertaken is merely an assessment of the justifications given for the investment and how the proposal for interlinking stands against the other available option for providing the claimed benefits. This section examines some of the important justifications, believed to be the pillars on which the very costly project of river interlinking is being placed. The identified questions are:

– Does the proposed interlinking of rivers offer the most cost-effective solution to the scarcity of water in the drier parts of the country?

– Does the food security of the common people of India depend on the proposed interlinking of rivers?

– Who would bridge the knowledge gap in the Himalayan component?

Issues of Cost-effectiveness

Satisfaction of domestic water needs should receive top priority in policy and be seen as a part of human rights [Gleick 1999; McCaffrey 1992]. Domestic water requirements are of the highest priority in terms of supply. However, in terms of quantity, these requirements are small compared with that for irrigation. Surprisingly, the official method for the identification of 'surplus' or 'deficit' river basins, clubs together all the various water requirements, thus obscuring the priority attached to separate water needs and demands. If the objective of providing domestic water security is given the highest priority, and is not clubbed with irrigation or industrial requirements, most areas in India would probably come out as self-sufficient. Nigam et al (1997) had undertaken systematic case studies in a few areas of the country considered to be water scarce. Their study makes it clear that if the precipitation available within the respective watersheds or sub-basins is harvested and conserved properly, the satisfaction of domestic water needs would not be a problem in most parts of the country. For promoting domestic water security, local level water conservation is a suitable option compared with developing large storage and long-distance diversion facilities, as these often carry high financial, social and ecological costs [World Commission on Dams 2000]. This observation is completely in consonance with the results of numerous community initiatives for water harvesting in India, whether in Maharashtra, Gujarat, Rajasthan, Tamil Nadu, Uttaranchal or anywhere else in the country.

The problem of scarcity gets further compounded by the growing tendency in India to hurriedly get short periods of scarcity or inundations identified as 'droughts' and 'floods', clearing the way for obtaining funds for relief. There is little concern about whether these 'natural disasters' are the results of natural extremes or of human interventions. Bandyopadhyay (1989) has analysed the risks associated with such opportunistic identification of human induced water scarcities with naturally occurring drought conditions. Under climatic conditions dominated by the monsoon, droughts and floods are quite expected events. Moreover, though fluctuations in the precipitation cause one form of drought, there are also many other forms of drought that lead to water scarcity. These distinctions of diverse forms of drought are reconfirmed by R R Kelkar (*Businessworld* 2001), when he warns that:

> If the rainfall over a given region is more than 25 per cent below normal, meteorologists call it a drought. However, this does not always bring out the true picture since crops could still survive if they get enough rain at the critical growth stages. On the other hand, a statistically normal rainfall but with a few spells of very heavy rain interspersed with long dry spells can cause agricultural drought as opposed to a meteorological drought.

The impression that this mega-project offers all the solutions to the problems of water scarcity in India has diverted public interest from promoting local-level initiatives for the harvesting and conservation of water. A belief has been created that there is 'enough' water in the 'surplus' rivers to cater to all the needs of all the people. What is to be done is only to invest in this mega-project for transfering water from one basin to another. This is why, when a higher than average rain falls on water scarce states like Rajasthan, as has been the case during the monsoon months of 2003 and 2004, serious official plans for rainwater harvesting are difficult to come by. Non-governmental initiatives, however, have achieved a great deal in this direction, establishing that local and cheaper options do exist for providing domestic water security in drier regions. Accordingly, Verghese (2003) has pointed out that:

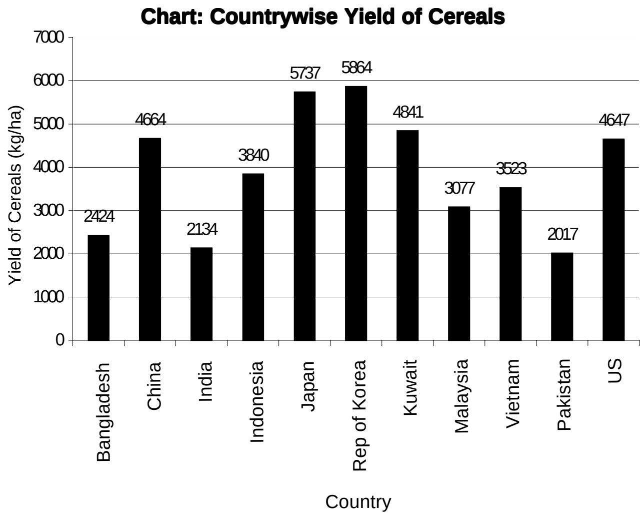
> The interlinking project is not a single stand-alone panacea for the country's water problems but the apex of a progression of integrated micro to mega measures in an overall but unarticulated national water strategy.

There is another factor that needs to be addressed. The supply of domestic water needs in coastal India may soon become more economic through emerging technologies like desalination. The cost of water from desalination plants is going down significantly. It offers great hope for the people living near our long coastline. It may not be unrealistic to say that in the coming decades, there may not be much use of water supply through the interlinking project, as supplies from desalination plants would be forthcoming. Large coastal cities like London have already made massive plans for future water supply based on this technology.

As it stands, for domestic water security in either the uplands or the coastal belts, cheaper and local opportunities are available. Large inland urban areas like New Delhi and industrial towns may still need water through interbasin transfer. For addressing such situations, a clear national plan may be undertaken, with a clear pricing strategy for such supplies. This should not be mixed up with the requirements for irrigation. The case for provision of more water for irrigation, which is the central purpose of the interlinking project, should be assessed separately, specially in respect of whether the food security of the people of India is dependent on it.

Food Security

According to projections, India's population will continue to grow for some more decades and is expected to flatten towards the middle of the century. Food requirements will follow the trend in population growth. Assessment of foodgrain requirements can be made with per capita consumption and total population. India has the largest irrigation network and second largest arable area in the world. Per capita foodgrain production has been the most common indicator of food security. Recent agricultural statistics



Source: Water and Related Statistics, Central Water Commission, 1998

reveal that with improvements in farming technologies and plant genetics, India has achieved a record foodgrain production of 211.32 mn tonnes in 2001-02, which is 15.40 mn tonnes more than that of the previous year [MoA 2003]. Between 1950 and 2000, annual cereal production per capita rose from 121.5 kg to 191.0 kg [Hanchate and Dyson 2004:229]. Food security is, however, not a matter of arithmetic alone. It depends both on the quantitative availability and equitable access. It needs to be remembered that in spite of the large buffer stock of foodgrains, an estimated 200 million people in India are underfed and 50 million are reportedly at starvation levels [Goyal 2002].

Food security and foodgrain requirements: One important and probably the most powerful justification of the proposed interlinking of rivers is the perceived link of the project with India's food security. No scientific justification for this has been given separately by the task force on interlinking of rivers. Based on population projections, socio-economic and demographic changes, and assumed changes in the pattern of food consumption, the NCIWRDP had estimated total foodgrain demand in 2010, 2026 and 2050 at high and low growth rates. These projections were made on the basis of an unpublished work by Ravi (1998), which results in a great increase in the projected foodgrain demand. While, according to the estimates of NCIWRDP, foodgrain demand in India (direct and indirect) in 2010 under the low and high demand scenario is 245 and 247 mn tonnes respectively, Hanchate and Dyson (2004:241), in a systematic review of past work say that:

> …this analysis suggests that in 2026 direct cereal demand will be roughly 220 mmt, with another 30 mmt being needed for other uses, giving a 'ball-park' total of 250 mmt.

This is in conflict with field-level data like those of the National Sample Survey (NSS). According to the Asian Productivity Organisation [APO 1996] "in the last 20 years, there have been no significant changes in average daily food consumption" in India. In this way, the estimates of food requirement by the NCIWRDP for 2010, are the same as those projected for 2026 by Hanchate and Dyson (2004). In addition, task force on interlinking of rivers mentions a foodgrain target of 550 mn tonnes by 2050 [TFILR 2003:11], recording a large discrepancy with other research results. It is necessary to analyse this gap, especially when the whole proposal for the investment in interlinking rivers is sought to be justified on the basis of such figures.

It is relevant to point out that the basis for such a drastic increase in annual per capita foodgrain requirement is probably rooted less in reality and more in the use of income demand elasticity for estimating future foodgrain demands. The work of Hanchate and Dyson (2004:233-35) does not indicate any large changes as projected above:

> According to the NSS, annual consumption of all cereals combined fell from 175 kg per person during 1972-73 to about 147 kg during 1999-2000. The FBS (FAO) figures, however, suggest that consumption rose slightly from around 153 kg in 1972-73 to about 157 kg in 1993-94, before increasing to 164 kg in 1999-2000...The NSS data on per capita food consumption underpin the projections because they provide the only state level figures.

While making projections of cereal demand for India in 2026, Hanchate and Dyson (2004:237) accept that:

> Accordingly, here we have simply assumed that for the rural and urban populations of each state, levels of per capita consumption will remain constant, as in 1993-94. For all India, this corresponds to annual consumption of 154 kg per person – a figure which is almost identical to the average of the NSS and FBS estimates for 1999-2000.

Yield improvement as a measure of food security: One important factor related to food production and security is the yield. In spite of the availability of good water and land, India's agricultural productivity is very low compared with that of other countries. Yield improvement is as much an important factor in food security as expansion of irrigation. China faces challenges similar to India in terms of food production, probably more acutely. It has a larger population to feed, with much less arable land. As Swaminathan (1999:73) has pointed out, China produces 13 per cent more foodgrains per capita than does India. Data from the FAO [CWC 1998: 223-24] indicates that while cereal yield in India stood at 2,134 kg per ha in 1995, that of China was 4,664 kg per ha (see the chart).

Agricultural scientists in India are foreseeing great technological breakthroughs that would push agricultural productivity upwards in the coming years. The NCIWRDP (1999a:57) has pointed out that wheat yield in experimental farms in India is already over 6,000 kg per hectare. However, the calculations of India's food production in the coming decades, which have been done to show the interlinking project as an essential step for food security, are based on the assumption that even 50 years from now, India will have attained field-level yield levels that are only two-thirds of what has already been achieved on experimental farms. The NCIWRDP (1999a:57) has assumed yield levels of 4,000 kg per hectare in irrigated land as the basis for making the projection for crop production in 2050.

Similarly, in rain-fed land, NCIWRDP has projected that food crop yield is expected to grow from the present 1,000 kg per ha to 1,500 kg per ha only 50 years. However, Singh (2003) takes the view that India is "already producing enough food; production can be further increased by at least 25 per cent from existing irrigated area itself by improved inputs and agricultural technology". Carruthers and Morrison (1994) reiterate this view, when they say that:

> We do not anticipate or call for an increased rate of capital-intensive investment in irrigation infrastructure but we do need to see that more is achieved with what is presently developed.

It is important to note that China, with only half as much arable land per capita as India, is today not thinking in terms of drastically increasing volume of water in agriculture, but increasing the water use efficiency in existing irrigated areas. Wang (2002:15,110), the water resource minister of China, writes that:

> Irrigation is no longer 'watering the land' but supplying water for growth of crops …At present, the average agricultural water use efficiency is 0.43 in China. If water saving irrigation is extended to raise the figure up to 0.55 (some experts consider 0.6), food security can be guaranteed when the population increases to 1.6 billion in 2030 without increase of total agricultural water use.

In India, which is blessed with more arable land and more irrigation potential, while similar figures for improvement in efficiency of the use of irrigation water (from 0.35 at present to 0.60 in 2050) have been projected on paper [NCIWRDP 1999a:58], there is no clear policy perspective to achieve higher water use efficiency and reaching the declared targets. The lack of interest in end-use efficiency in irrigation will push the farmers to the soft but costly solution offered by the interlinking of rivers. Swaminathan (1999:93) has thus cautioned that:

> The inefficient and negligent use of water in agriculture is one of the most serious barriers to sustainable expansion of agricultural production. Public policy regarding the cost of water supplied by major irrigation projects and low cost or free distribution of power for pumping underground water aggravate the problem...Water consumption can be reduced radically, by as much as five-to-ten fold, at the same time significantly increasing crop yields.

Vaidyanathan (2003), who has examined the methodology and estimates in the NCIWRDP report, questions the very concept of this efficiency underlying the measures. He says that:

> The present available efficiency of surface irrigation, according to the figures cited in the report, ranges between 30 and 50 per cent... The concept of efficiency not being specified, their relation to projections cannot be verified without comparable estimates of current and future water balances and irrigation efficiencies overall for the two major sources separately.

The World Bank irrigation sector report on India takes a similar view on irrigation and says, "from the past heavy emphasis on physical expansion, effort now needs to turn to a much greater emphasis on productivity enhancement" [World Bank 1999:11]. It is clear that the further physical expansion of irrigation is neither needed nor is it the most cost-effective option for maintaining India's food security.

This makes it clear that continued food security does not depend on the proposed expansion of irrigation potential by another 35 mn ha through the interlinking of rivers. There are several other, more cost-effective ways to sustain food security. Hence, it is a national imperative that the costs for maintaining food security along all possible technological options are examined in comparison with the claims of the proposed interlinking. Particular attention should be given to the removal of the obstacles to technological changes in agriculture, because even after 50 long years, future yield from India's irrigated fields has been assumed to be only two-thirds of what has already been achieved on experimental farms (6,000 kg per ha).

In addition, there is a case for the review of the use of the irrigation potential already created and projects that have remained incomplete. Till the end of the Nineth Plan, the irrigation potential created and utilisation achieved in India was reported at 106.6 mn ha and 93.4 mn ha respectively [NCIWRDP 1999a:79]. The reasons for taking the figure of 77 mn ha as the projected irrigated cropped area as far away as in 2010 needs to be examined from the point whether it is a conservative figure. It is quite logical for the country to ensure that the irrigation potential already created be realised with the projected high level of efficiency. In such a situation, there will not be any need for the proposed interlinking of rivers, as far as basic food security is concerned.

Of course, there is another side to all this. The ready availability of additional water transferred through the interlinking of rivers would promote water-intensive commercial crops in dry areas. Such crops could have been produced with much less water and expenditure in the better water endowed areas. This is a rather wasteful way of looking at hydrological equity within the country. In place of transferring huge volumes of water over a long distance through a very expensive process, the transportation of 'virtual water' to water-scarce areas in the form of foodgrain would be cheaper. If at all the transfer of water from 'surplus' basins to 'deficit' basins has to be undertaken for such commercial purposes, it has to be seen from a different policy perspective. A pricing mechanism for payment to the donor river basins should be in place. In this way, interbasin water markets can flourish, which will ensure a more efficient utilisation of water. If such a market gets established, it may be the beginning of mutually agreed interbasin transfers between the states, providing a new way to look at interbasin transfers.

Production of foodgrains should be protected from the variations in climate. For this, however, the interlinking project is not the best available option. The better options are related to more fundamental changes in agriculture by addressing many other factors, in particular those of sustainability. Otherwise, as Postel (1999) has cautioned:

> It is not enough to meet a short-term goal of feeding the global population. If we do so by consuming so much land and water that ecosystems cease to function, we will have, not a claim to victory, but a recipe for economic and social decline.

However, there are no reasons to take a religious stand that interbasin transfers should not be taken recourse to. Such transfers may be taken up for rapid economic growth, which is not partial in favour of irrigated areas while creating millions of development and environmental refugees. If such transfer projects are to be taken up, several serious questions will have to be addressed first. They need to be answered before going ahead with any project. Many of these questions relate in part to the lack of an open and transdisciplinary knowledge base for even making the technical designs, and in part to the social and economic conflicts that have traditionally been inherent in such projects. As and when the project starts to be implemented, if attempts are made to avoid answering these questions, popular opposition will be the result.

Knowledge Gap in Himalayan Component

The essence of the proposed interlinking of rivers is that with the construction of storage dams as proposed, the severity of floods and the extent of flood damage will be drastically reduced. When transferred to other basins with lower water endowment, the water thus stored would reduce the regional imbalance in the availability of water in the country.

Construction of dams on the Himalayan rivers as a component of the proposed interlinking of rivers cannot be undertaken by ignoring vital questions on the uncertainty associated with taking a mechanical and traditional view of development of the Himalayan rivers [Ives and Messerli 1989]. The approximations and assumptions inherent in the standardised mathematical models of hydraulic engineering, have so far slighted and undermined the basic dynamics of sediment generation, discharge and deposition characteristic of the Himalayan rivers, which carry among the highest sediment loads in the world [Bandyopadhyay and Gyawali 1994]. Due to the verticality and the consequent fragility of the Himalaya, large dams on Himalayan rivers will be subject to high levels of seismic hazards, since the potential for earthquakes at the plate boundary all along the Himalayan foothills is well known and widely accepted [Khattri 1987]. The knowledge base required for making a professionally comprehensive assessment of such projects is still in its infancy. To any professional informed of the complexity of the eco-hydrology of the Himalayan rivers, it is clear that the development of systematic knowledge needed for making a credible impact assessment of the proposed dams and canals would need extensive field observations spread over decades. This needs to be seen in the background of the time-span of 12 years given by the Supreme Court as the time limit for the completion of the proposed interlinking.

When such a comprehensive knowledge base gets generated in an open and professional manner, in all probability several of the proposed projects may prove to be technically and economically unfeasible. Recognising the seriousness of the gaps in knowledge, NCIWRDP (1999a:187-88) took the wise view that:

> The Himalayan component would require more detailed study using systems analysis techniques. Actual implementation is unlikely to be undertaken in the immediate coming decades.

One example of the significance of the knowledge gap is related to the declared benefits of 'flood control' from the interlinking project. Floods in the Himalayan foothills and adjoining plains are the result of a complex ecological process involving movement of enormous volumes of water and solids. Simplistic engineering claims about projects that will control floods in Himalayan rivers are not new, and have been made over decades. Efforts to control floods in the Himalayan rivers have resulted in changes in the form of the floods. Loss from floods has not declined over the years. There is no clear scientific evidence of the ability of the proposed dams in controlling floods in the Himalayan rivers. In the background of the inadequate knowledge base, the newer interventions may be counter-productive.

IV
Interlinking of Rivers and Water Conflicts in South Asia

Even as the country receives a preordained quantity of water either through precipitation or as inflows from upstream countries, experts have been warning India of difficult times with regard to water. News of widespread conflicts has been received from many regions. Whether it is between Haryana and Punjab or Karnataka and Tamil Nadu, India has seen several conflicts related to sharing of river waters. The present crisis, however, is a result of factors that have been operating over a long time. One crucial component behind this has been the inherent failure of policy-makers to perceive the dimensions of the upstream-downstream linkages. Such gaps have led to a major source of conflict over water use in river basins all over the world.

Conventionally, the thinking has been that inequitable distribution of fresh water leads to violent inter- and intra-basin conflicts. The statement made by president Abdul Kalam ('Interlinking of Rivers to the Driver of Growth: Kalam', *Business Line,* February 23, 2003) widely supports this view on the basis of which he has said, "The plan to integrate the rivers of India (through interlinking) will be a key driver of the growth of the country and it would not only bring about economic prosperity but emotional integration as well." Mitra (2003) tries to find a justification to this argument:

> Whilst we have failed in the course of more than half a century to resolve amicably the intra-basin quarrels, it will be sheer lunacy if, on top of that, a more contentious issue, that of interbasin water equity, is added to the already confused picture.

Water conflicts are frequently generated not by an inherent scarcity in a region, but over the sharing of additional supplies. The long-drawn Cauvery dispute is a case in point. This is a conflict of interest between a downstream state (Tamil Nadu) that has a long history of irrigated agriculture and an upstream state (Karnataka) that was a late starter in irrigation development (but has been making rapid progress). The situation with respect to the SYL canal in the north is no different. In all such cases, factors like end-use efficiency and sustainability of irrigation practices have given way to war over the quantity of water. In the present context of interlinking, however, it can be safely said that unscientific and wasteful uses of water cannot provide hydrological equity in a country.

Bandyopadhyay and Perveen (2003) have argued that the proposed interlinking of rivers has the potential for generating four distinct types of conflicts. These are:

– Compensation for resettlement and rehabilitation of the displaced;
– Compensation for environmental damages from the project;
– Sharing the benefits and costs of the project among the states;
– Cooperative management of the project in international river basins.

While the traditionally followed concept of arithmetical hydrology will be able to calculate the supply-oriented requirements and project them in both space and time, the problem will arise on the requirements that arithmetical hydrology fails to recognise. Water being a state subject, the issue of transference of riparian rights under the centralised river link proposal needs to be resolved simultaneously. Though politicians have been talking of the need for shifting control over the water sector from the states to the centre, at least partially, no clear thought has been given on how to alter the present institutional structure to accommodate these modifications amicably. This is one topic that is immensely important and at the same time complex.

Inevitably, interstate trans-boundary water-related conflicts may become inter-country. Iyer warns that the proposal risks major confrontation with Bangladesh, which receives much of its water from the Ganga and the Brahmaputra, after they leave India. The water resource minister of Bangladesh has reportedly said that his government had protested to India but had so far not received any response [Vidal 2003]. In effect of which, it has stated that:

> The north of Bangladesh is already drying out after the Ganges was dammed by India in 1976. Now India is planning to do the same on [many of] the 53 other rivers that enter the country via India. Bangladesh depends completely on water…We want no kind of war, but international law on sharing water is unsure and we would request the UN to frame a new law. It would be a last resort.

From this arises the challenge to organise water related administrations so that the river basin becomes the focus of activity and the various (competing) water use sectors have an appropriate voice [Helming and Kuylenstierna 2001]. Evidently, so far, of the innumerable conflicts that have taken place over water, many have been over quantity and infrastructure. Unfortunately, due to inadequacy of data, many plans for river basin development in developing countries are inflexible and rarely provide alternative strategies. And although more than 300 treaties have been signed by countries to deal with specific concerns about international water resources and more than 2,000 treaties have provisions related to water, countries have not devoted funding to manage surface and sub-surface water jointly, scientific data is not freely shared and the requisite spirit of cooperation is often lacking [Serageldin 1995]. The results are that damages to the ecosyetsm services or losses in downstream population have been ignored. Such a situation applies also to another major project for interbasin transfer, the south to north water transfer project (SNWTP) of China, as seen in the analysis of Berkoff (2003). In the case of the proposed interlinking of rivers in India, the situation is more complex, with the downstream areas belonging to another country. It becomes necessary then to examine whether the interlinking project would end up intensifying the already bitter trans-boundary conflict over water sharing and availability from the village to the country levels.

V
Conclusions

The proposed interlinking of rivers appears more to be a project for an ad hoc transfer of water looking for suitable justifications. It cannot guarantee the security of domestic water supplies to the drier areas of India, in particular, the dry uplands. The only dependable solution to this problem lies in local-level harvesting and conservation of rainfall. If there is free competition, the proposed interlinking will not be able to compete with emerging technological solutions like desalinisation, as far as domestic water supply in the coastal belt is concerned. The projections of foodgrain requirements till 2050, used to justify the project, are exclusively based on unpublished work and are in conflict with results published by other researchers. Foodgrain production may be improved more economically by increasing end-use efficiency in the presently irrigation potential and quicker attainment of yield levels that have already been reached in experimental farms. For providing domestic water security in dry areas and to metropolitan regions, inter basin transfers may be resorted to, if found to be the best option after a comprehensive comparative assessment. That needs to be based on an approach very different from the present one of the NWDA, dominated by objectives of physical expansion of irrigation, whether needed or otherwise. Hydraulic equity at the national level does not mean undertaking projects for transfer of water at public expense, from better water-endowed river basins to dry areas for inefficient and commercial use through socially and economically wasteful projects not approved through open professional assessments. Thus, while interbasin transfer is not being ruled out in principle, the manner in which the proposed interlinking of rivers has been put forward is unprofessional. In the absence of an open professional assessment of the proposals right from the stage of pre-feasibility studies, it will be unacceptable on social, economic and ecological grounds. EPW

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[Opinions expressed in this paper are those of the authors only, and not of the institution they belong to.]

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