SPECIAL ARTICLE

Interlinking of Rivers and Efficient Water Management

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...it is very essential that the government must take action seriously for the inter linking of rivers in the country to use all the available water in the rivers (195 MHM) without postponing further. As discussed earlier, the water availability in the country is plenty, but it is unevenly distributed and hence, the water scarcity problem exists in many parts of the country particularly in south and in the west

India is endowed with plenty of water and land resources. India's land area is about 2.5 per cent of the world, water resources is 4 per cent of global availability and the population is about 17 per cent of the World. The available area is about 165 M.Ha., which is the second highest in the world. In the 1990's, about 65 per cent of the population of India comprised of cultivators (farmers) and agricultural labour indicating the country's dependence on agriculture i.e. land and water. Therefore, the need for water resources development for over all social and economic development was duly recognized from the very beginning.

India has abundant water resources, but the water problem is very serious in many states. This year (2016) water problem /scarcity was noticed in about 10 States i.e Maharashtra, Rajasthan, Karnataka, Telangana, Andhra Pradesh, Madhya Pradesh, etc. About 32 crores of the population does not have access to drinking water. As a scientist working in this field for more than 60 years, I have been indicating for the last 30-40 years that the water problem in India is a man made problem and not the fault of nature. India gets an annual rainfall of 1150 mm as compared to the world average of 840 mm and about 400 mm in Israel. Israel is managing the water successfully whereas in Cherrapunji in India where the rainfall is about 11,000 mm, availability is a problem for 2-3 months before the commencement of monsoon every year.

Water is the most crucial natural resource and its availability greatly influences the health of people and development of that area. According to the standard definition; for water availability from 1000m^3 /per capita / year to 1700 m^3/ capita / year, shortage will be local. Below 1000m^3/per capita/year, water supply begins to hamper health, economic development and human well being. At less than 500m^3 / per capita/ year, water supply becomes a primary constraint to life and countries experience absolute scarcity. The 1000m^3 /per capita/year, has been accepted as a general indicator of water scarcity by World Bank and other agencies.

Water Resources

World wide also, water resources are abundant. The available water is sufficient even if the population of the world is increased to 25 billion (i.e 3 to 4 times of the present population). In India, the total available water is sufficient for a population of 1650 million (1500m^3 / per capita/ year)

River basins are the basic hydrological unit for assessment of water resources of the country. The

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entire country has been divided into 20 basins; comprising of 12 major basins having a catchment area of 20,000 km^2 and the remaining 8 basins are medium and small.

The National Commission for Integrated Water Resources Development Plan had assessed the country's water resources as 195.29 MHM in 1999. According to Central Water Commission, the utilizable water resources in all the 20 basins is 69 MHM which is about 35 per cent of the total surface water. This water will meet irrigation needs for a cropped area of 76 MHa. The inter basin transfer proposed by the National Water Development Agency (NWDA) envisages additional utilization of about 20 – 25 MHM water. Also, according to a very preliminary study, about 16 MHM of water resources can be additionally utilized through artificial recharge of ground water totalling about 40MHM.

The latest assessment of replenishable ground water resource had been made at 43.20 MHM in the year 1994 – 95 by the Central Ground Board. The utilizable ground water had been assessed as 39.56 MHM (7 MHM for domestic and industrial uses and 32.56 MHM for irrigation) which can irrigate about 64 MHa. The total irrigation is about 140 M.Ha (SW=76 M.Ha, & G.W = 64 MHa). The basin wise details of various water resources and their utilization components are given in Table1.

The assessed gross available water and utilizable water are as follows:

River flow (surface water) + ground water	=195.29 + 43.20 = 238.49 MHM
The assessed utilizable water	= 69.00 + 39.56=108.60 MHm

Based on population of India from 1991-2050 (expected), the gross availability of water and utilization water resources per capita / year are given in Table 2.

The utilizable water resources per capita per year varies from 3020 m^3 in Narmada basin and about 180 m3 in Sabarmathi basin. Out of 20 basins, 4 basins had more than 1700 m^3 / p/y utilizable water resources, while 9 basins had between 1000-1700 m^3, 5 basins between 500-1000 m^3 and 2 basins had less than 500 m^3 in the year 1991 when the population of India was 851 million. The population in 2050 is expected to reach about 1650 million and the food grain requirements of the country may be around 550-600 metric tones, including losses in storage and transportation, seed requirements and carry over for years of monsoon failures (allowances of 15 per cent), etc.

The total storage build up in various basins through major and medium projects upto 1995 is about 17.37 MHM. The major and medium projects under construction and identified account for 7.54 MHM and 13.23 MHM respectively. The total being 38.15 MHM. After taking into account the minor storage structures including tanks/ponds (about 4 mhm), the total storage capacity would be about 42 MHM. This accounts for the population of 1210 million as per storage capacity created in the country per person which comes to about 350 m^3 compared to

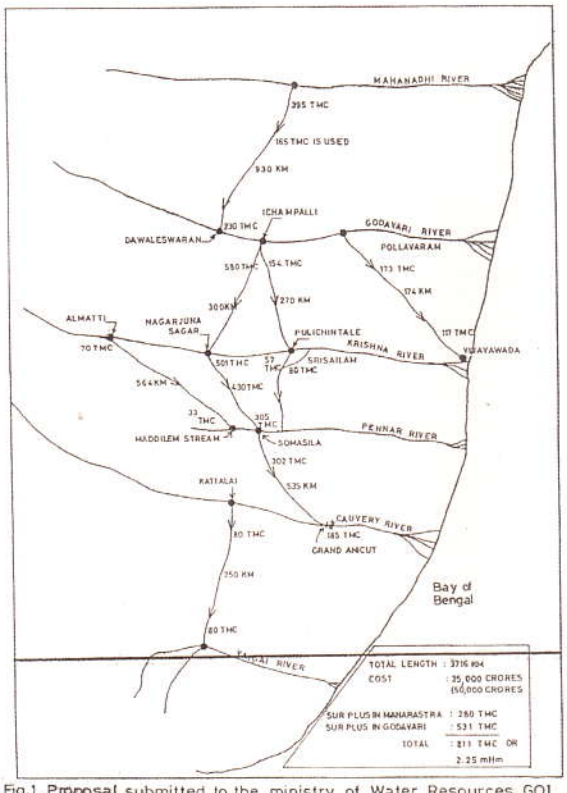


Fig.1 .Proposal submitted to the ministry of Water Resources GOI for approval and for central legislation

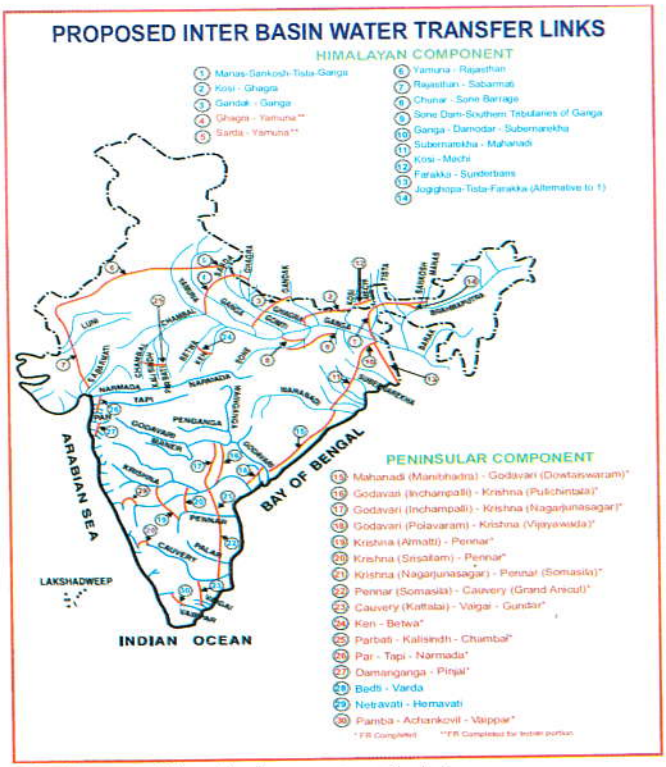


Fig. 2 Proposed inter basin water transfer links

(Source: Hydrology & Water Resources Information System for India, National Institute of Hydrology

USA 5961 m^3 and China 2486 m^3. In this connection, it is not out of place to mention that there are about 45000 large dams in the world, of which, 46 per cent are in China, 14 per cent are in USA and only 9 per cent in India. Japan and Spain are having 6 per cent and 3 per cent respectively. The above facts indicate that India's water storage capacity and dams constructed are very meager compared to various countries of the world taking into consideration their population.

From the data /details in Table 1 and 2, it is seen that even if the entire surface water and ground water available in the country is taken into account i.e. 238.50 MHM for the physical population of 1650 million in 2050, the per capita availability of water per year comes to 1450 M^3 which is less than 1700 and this indicates water shortage-the country will face water stress condition according to World Bank / U.N norms. If the utilizable water alone is taken into consideration (108.60 MHM) for the projected population of 1650 million in 2050, per capita water is 680 M^3 which is less than 1000m^3/P/Y which indicates that the country will face severe water scarcity and severe constraint on food production and economic development.

Inter Linking of Rivers:

Under these circumstances, it is very essential that the government must take action seriously for the inter linking of rivers in the country to use all the available water in the rivers (195 MHM) without postponing further. As discussed earlier, the water availability in the country is plenty, but it is unevenly distributed and hence, the water scarcity problem exists in many parts of the country particularly in south and in the west. The unused water is 65 per cent which is flowing into the sea and which should be utilized profitably by diverting from surplus areas to deficient parts in the country. To solve the water problem, the Govt of India had created the National Water Development Agency (N.W.D.A.) in 1982. It is an autonomous society to work under the over all control of the Ministry of Water Resources, G.O.I.

The main objectives of the NWDA are to study the following 3 inter linking of river projects to find out the possibilities of the project:

1. Ganga- Brahmaputra-Cauvery linking or Himalayan River Development.
2. Inter linking of Peninsular Rivers ie Mahanadi, Godavari, Krishna, Pennar, Cauvery and Vaigai or Peninsular Rivers Development.
3. Divert the west flowing rivers in Kerala, Karnataka, Goa and Maharastra to East ie to Tamil Nadu, Karnataka, Andhra Pradesh, and Maharastra.

We can, easily and economically without disturbing the environment and ecology of the forests and without displacement of people, divert the West flowing water to the East Tamil Nadu across the Ghats through pump storage schemes, utilizing the wasted existing thermal power in the night time, during monsoons for removing shortage of supplies for irrigation, industry and drinking water.

Though, all the 3 proposals are feasible and workable, immediate action can be taken for items 2 and 3 simultaneously as the detailed study has been undertaken and the cost is within the reasonable limit.

a) Inter Linking of Peninsular Rivers

The NWDA has done an excellent job. It has identified 17 links under Peninsular River Development Plan. It has also prepared the pre-feasibility reports of all the 17 links along with completing feasibility reports of most of the links.

Among the various Peninsular rivers, Mahanadi and Godavari do have enough surplus supplies, even after meeting the ultimate projected demands of the basin states. It is proposed to provide Mahanadi – Godavari link running along east coast, to transfer excess supplies of Mahanadi and Godavari by gravity flow. This proposal is likely to irrigate drought prone areas of Maharastra, Andhra Pradesh and Tamil Nadu. The Krishna - Pennar link is to meet the enroute irrigation requirements in Krishna and Pennar basins.

The Pennar – Kaveri link shall fall into Cauvery at Grand Anicut. After utilizing the enroute, about 180TMC will be reaching Grand Anicut. Of this, about 100 TMC is proposed to be utilized in the Cauvery basin and

balance of about 80 TMC will be used in Vaigai and Vaippar basins. The area which can be irrigated from this water is about 2 M acres. The NWDA has estimated the cost 10 years back at Rs. 30,000 crores for connecting Mahanadhi – Godavari – Kaveri and Vaigai having a length of 3716 Km to divert the surplus quantity of about 1000 TMC. (see Fig.1)

The author has collected data and worked out the water requirements (demand) of Kerala state according to which surplus available is about 500 TMC though the NWDA has estimated about 1000 TMC. If this quantity (i.e.500 TMC) is diverted to East (Tamil Nadu), it is possible to bring 5 million acres under irrigation in the southern districts of Tamil Nadu.

As part of diversion, the NWDA has prepared blue prints to divert the west flowing rivers in Kerala State to East in Tamil Nadu state, according to which, the Pamba and Achankoil rivers which carry about 250 TMC in Kerala can be diverted to Vaippar river in Tamil Nadu to an extent of 22 TMC that can be used in the drought prone area of Tirunelveli, Toothukudi, Virudhunagar districts to irrigate about 2.26 lakhs acres at an estimated cost of Rs.1400 crores.

Yet another project in the minds of farmers in Tamil Nadu is Pandiar and Punnampuza Scheme. This scheme

Table 1- Mean flow, Utilisable Surface and Ground Water Resource-Basin Wise

S. No.	River Basin	Mean Flow	Utilizable Flow	Replenishable	Utilisable
		Surface water	Surface water	Ground Water	Ground Water
		BCM	BCM	BCM	BCM
1	Indus	73.31	46.0	26.50	24.3
2a	Ganga	525.02	250.0	171.00	156.8
2b	Brahmaputra	*629.05	24.0	26.55	24.4
2c	Barak	48.36	-	8.52	7.8
3	Godavari	110.54	76.3	40.64	37.2
4	Krishna	**69.81	58.0	26.40	24.2
5	Cauvery	21.36	19.0	12.30	11.30
6	Subernarckha	12.37	6.8	1.82	1.7
7	Brahmani-Bartarni	28.48	18.3	4.05	3.7
8	Mahanadi	66.88	50.0	16.50	15.1
9	Pennar	6.32	6.9	4.93	4.5
10	Mani	11.02	3.1	7.20	6.6
11	Sabarmati	3.81	1.9	-	-
12	Narmada	45.64	34.5	10.80	9.9
13	West Flowing Rivers Between Tapti to Tadri	87.41	11.9	17.70	16.20
14	West Flowing Rivers Between Tadri to Kanyakumari	113.53	24.3	-	-
15	East Flowing Rivers between Mahanadi & Pennar	22.52	13.1	11.22	10.3
16	East Flowing Rivers of Kutch & Saurashtra & Luni	16.46	16.7	18.80	17.20
17	West Flowing Rivers of Kutch and Saurashtra & Luni	15.10	15.0	0	0
18	Area of Inland drainage in Rajasthan	0.00	-	-	-
19	Minor Rivers draining into Bangladesh & Myanmar	31.0	-	18.12	16.8
	Total	1937.99	675.8	423.05	388.0

Source: CWC, Publication 6/93-Reassessment of Water Resources Potential of India. Ground Water Resources of India CGWB-1995

* Includes Additional Contribution of 91.81 BCM being flow of 9 Tributries Joining Braharmaputra

** Assessment is based on mean flow of the yield series accepted by KWDT award. The figure of the CWC assessed from run-off data at Vijaywada is 78.12 BCM

*** Computed on proportionate basis from annual replenishment 10 BCM=1 MHM

Table 2- The Available and Utilizable Water Per Capita Per Year In M^3 in India (From 1991)

Year	Population Million	Available Water 283.5 MHM per capita/ year M^3	Utilizable water 108.60 MHM per capita/year M^3	Remarks
1991	850	2830	1290	500 M^3-Absolute Scarcity
2001	1030	2316	1055	100-Scarcity and stress
2011	1210	1970	910	1700-Shortage will be local
2025	1350-1400 (estimated)	1700	780	>1700M^3-Water-No Problem M^3=Cubic mlter
2050	1650 (estimated)	1445	680	M.H.M-Million Hectarl Meter

Table 3- Annual yield of west flowing rivers in Karnataka state

Sl. No.	Sub-basin	Catchment area (in sqkm)	Average yield (MCM)
1	Kalinadi	412	934
2	Shravathi	3592	8816
3	Chakra River	336	991
4	Netravathy	3222	9939
5	Varahi	759	2263
6	Mahadavi	412	934
7	Bedthi	3574	5040
8	Independent catchment between Sharavathi and Chakra River	401	906
9	Aghanashini	1330	3028
10	Independent Catchment between Sharavathi and Chakra River	1042	3066
11	Independent Catchment between Varahi and Netravathy	3067	9457
12	Independent Catchment between Netravathy and Barapole	1320	4474
13	Barapole	560	1274
	Total		57489MCM or 2000 TMC

Source : Water Resources Development Organisation, Government of Karnataka, Bangalore

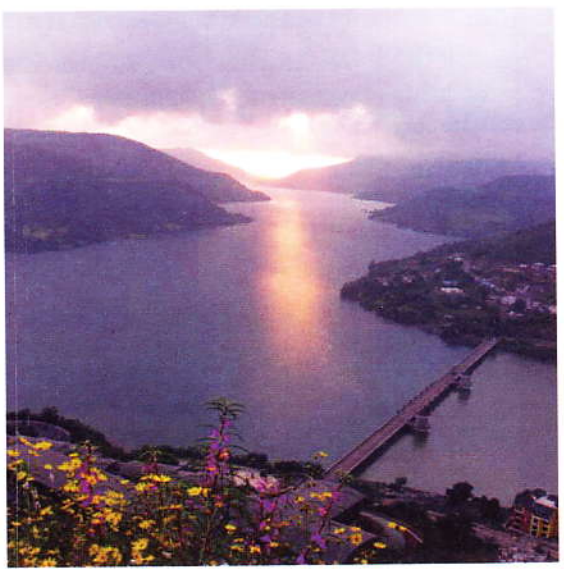
only 40 per cent of the waters for which Karnataka has water disputes with Tamil Nadu and Andhra Pradesh fighting in courts. The West flowing rivers in Uttara Kannada and Dakshin Kannada Districts of Karnataka state like Nethravathi, Kumardhara, Varahi etc have in all about 2000 TMC annually(Table 3) as against Krishna and Cauvery put together of 1300 TMC.

We can, easily and economically without disturbing the environment and ecology of the forests and without displacement of people, divert the West flowing water to the East Tamil Nadu across the Ghats through pump storage schemes, utilizing the wasted existing thermal power in the night time, during monsoons for removing shortage of supplies for irrigation, industry and drinking water. By this, it is possible to use the water in Karnataka and share the excess water with Tamil Nadu and Andhra Pradesh.

was visualized long back as a hydro electric project, but when farmers of Tamil Nadu wanted it as an irrigation cum hydro electric project, the Kerala Government did not give permission. If this project is implemented (only Tamil Nadu water since the catchment area is in Tamil Nadu), about 10-12 TMC of water which is flowing to the Arabian sea can be diverted to Bhavani/ Moyar basin in Tamil Nadu and this water can irrigate about 1.2 to 1.5 lakhs acres in dry districts of Coimbatore, Tiruppur and Erode districts. This project can be implementd immediately as the NWDA has done the detailed survey and it is economical, feasible and viable.

b) Diversion of West Flowing Rivers to East

In Karnataka, the Western Ghats which is about 13 per cent of the geographical area of the state has 60 per cent of the state's water resources in terms of quantity due to high intensity of rainfall and every drop of it is running as waste into the sea. The balance 87 per cent of the area of the state, mostly comprising Krishna and Cauvery basins have



The five projects suggested above, if implemented, can solve the water and energy problem of southern states, namely Andhra Pradesh, Karnataka, Tamil Nadu, Kerala and Puducherry.

c) Himalayan River Development

Meanwhile, a detailed study can be taken up to find out the feasibility for all links to connect Brahmaputra - Ganga to other West and Southern rivers of the country to solve the water crisis of the entire country (see Fig.2). The cost of the project may be about Rs.8 to 10 lakh crores, which is also not much, compared to the benefits. For implementing this project, cooperation of Nepal, Bangladesh, Bhutan may be necessary, therefore we can implement the peninsular river development and divert west flowing rivers to East to start with and linking of Ganga – Brahmaputra can be taken up later.

Efficient Water Management:

The following are the new irrigation strategies – water management practices which can be followed /introduced to overcome the scarcity of water in the country.

- Systems of rice intensification (SRI method) should be followed in paddy cultivation to save water of about 40-50 per cent and to increase the yield by about 3/4 tons/Ha.
- Provide drainage especially in canal / tank irrigation and reuse the drained water, if it is suitable, for irrigation.
- Conjunctive use of surface and ground water.
- Using sprinkler irrigation in canals and tank command areas for all closely spaced crops except rice.
- Introducing drip irrigation in well irrigated areas for all row crops – cotton, sugarcane, banana, coconut and vegetables, etc.
- Irrigation based on water / fertilizer production function curves.
- Training farmers and extension officers in water management.
- Conducting seminars/workshops in villages to bring awareness among all farmers for safe water and to increase yield.
- Demonstrations and workshops may be organised in villages and in the farmer's field to use water judiciously.
- Extension offices in water management should be created in the block level as in the case of agronomy, plan protections, etc.

If the rain water is harvested, conserved and managed properly as detailed above, there should not be any water scarcity problem in the country.

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