IRRIGATION MANAGEMENT BY LOSS REDUCTION, RECYCLING AND WATER TRANSFER

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ABSTRACT:
After independence, India has made substantial progress in irrigation sector which consumes nearly 70 to 80 percent of available water resources of the country. However, there is an urgent need for improved management in the sector. Water which is lost in conveyance and application can be saved by improving irrigation efficiency. Productivity of land can be further improved through on farm irrigation development and drainage. Water and land so saved can be diverted for other important uses. In order to control severe water pollution, waste water generated from domestic, agriculture and industrial sectors must be reused after appropriate treatment. Problem of recurring drought in some part of the country can be addressed by transfer of water from surplus to deficit basins.

1.0 INTRODUCTION:

In 1947 when India woke to freedom, the country was facing stark realties of recurring famines and floods. There were hardly any moisture conservation or watershed programs or any storage to meet the demands for domestic use, irrigation, industries and hydro-power generation. Based on limited experience and inadequate technological strengths, the country embarked on its journey into water world of the future. Several multi- purpose river valley projects like DVC, Bhakra-Nagal, Nagarjunsagar etc. were completed.

A national water mission has now been set up by the Govt. of India to explore pathways and future option to reduce emerging water stress and to meet increased marketing demands and chain management of agricultural production of rice, wheat, edible oil, pulses etc. Soil health, use of good seeds, organic farming and GM crops etc. are also included in the agenda. Inspite of all the progressive measures and investment of enormous resources over the last 12 five year plans, the country is lagging behind China and some neighboring countries. Table-1 gives a comparison of wheat and rice production/productivity in China, India and some other countries in the world.

Pollution of river water is imposing high cost on health and for treatment for reuse and recycling. Civilizations decay when structural interventions of policy, pricing or inputs and outputs and the unchecked misuse, is not sustainable. Using 2011 census figures, the population of India in 2025 is now being projected as 1394 million, when average per capita availability of water will fall to just 1340 m^3 in an average year to meet all requirements. The earlier concepts had implied reducing water losses in conveyance of irrigation canals, increasing the operational efficiency in distribution at minimal cost. Storages were built in upper reaches in mountains, or in downstream rocky terrains, for subsequent releases/abstractions, The current search is for innovative techniques to increase conservation, water harvesting and increased artificial recharge of ground water. Water

savings, treatment and reuse techniques continue to be on priority lists in urban cities and process industries (Kumar and Mazumder, 2016).
As per the report of the National Commission on Integrated Water Resources Development (NCIWRD-1999), India has roughly four percent of the world's fresh water resources to feed its 17% world population. India receives an average precipitation of about 1170 mm which corresponds to an amount of annual volume of 4000 BCM. There is considerable variation in precipitation both in time and space. Nearly 75% of precipitation i.e. 3000 BCM occurs during the monsoon season confined to 3 to 4 months (June to September) in a year. Table-2 shows per capita water availability of some of the countries in the world as on 2011.

Table 1: Some Agricultural Statistics for Wheat and Rice (as in 2009)

Crop and Country	Area under Cultivation (million hectare)	Total Production (million tonne)	Productivity (tonne per hectare)	% share in world production
1. PADDY				
World	158.30	685.24	4.2	100.0
1. China	29.88	196.68	6.5	28.7
2. India	41.85	133.70	3.1	19.5
3. Indonesia	12.88	64.40	4.9	9.4
4. Bangladesh	11.35	47.72	4.2	6.9
5. Vietnam	7.44	38.90	5.2	5.6
2. WHEAT				
World	225.62	685.61	3.0	100.0
1. China	24.29	115.11	4.7	16.7
2. India	27.75	80.68	2.9	11.7
3. Russia	26.63	61.74	2.3	9.0
4. U.S.A.	20.18	60.31	2.9	8.8
5. France	5.14	38.33	7.4	5.5

Table-2 Per Capita Availability of Water in Different countries in The World (as on 2011)

USSR	USA	China	Australia	India	Ethiopia
19500	9900	5000	2420	1545	250

Principal source of India's water resources is monsoon rainfall which varies from place to place, year to year and lasts for only 3 to 4 months in a year. While some parts of our country are devastated by floods, some others suffer from acute droughts. Solution lies in water storage-both surface and sub-surface- and transfer of water from surplus to scarce basins. Storage of flood water in surface reservoirs and underground aquifers is necessary for fighting recurring floods and droughts in India. Excess flood waters should be transferred to drought prone areas by interlinking rivers. Recycling of waste and sewage water after proper treatment will be highly beneficial not only in water conservation but also in prevention of river and ground water pollution.

2.0 NEED FOR PROPER MANAGE MENT OF IRRIGATION WATER:

After independence in 1947, most of the irrigated land went to Pakistan. In the year 1951, when first five year plan started, India had a population of about 300 million and the area covered by irrigation was only 23 million hectares (mha) producing 90 million tons of food grains. A large number of irrigation schemes have been completed over the years to assure firm water supply to the agricultural community. Out of a total of 113 mha area under irrigation in India today, 58 mha is by major and medium surface irrigation schemes, 15 mha area is by surface minor irrigation schemes and 40 mha is by minor ground water schemes (IWRS-2007). Because of the timely irrigation development, India is self-sufficient in food today, producing 250 million tons of food grains for our 1200 million people. Fig.1 (Mazumder, 2002) shows the projected growth in population, food grain production and irrigated area up to 2050.

With uncontrolled rise in our population and increasing demand of water from other sectors, there is a sharp change in demand pattern. Estimated demand of water for different sectors from 2010 to 2050 is given in Table-3 (INAE, 2008). Irrigation consumption is the highest-varying from 68% in 2050 to 78% in 2010.

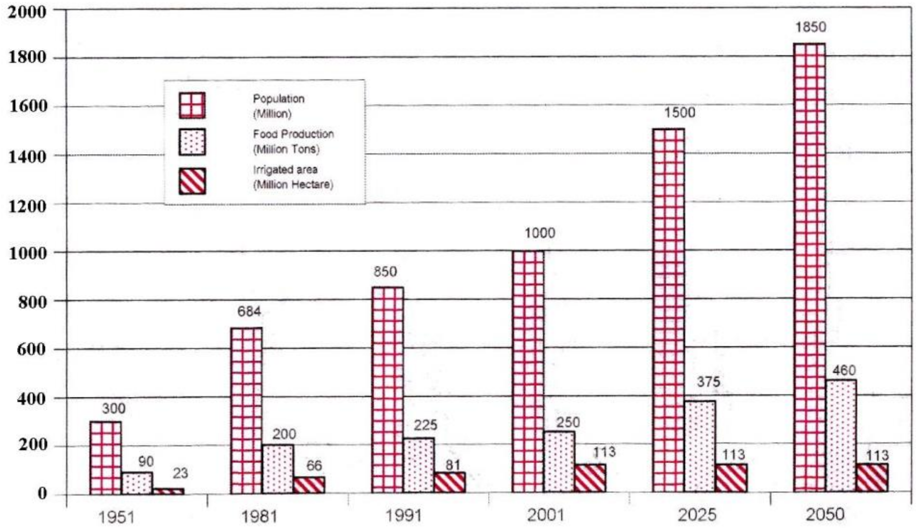

Fig. 1 Growth of Population, Food production and Irrigated area in India during 1951-2050

Average annual water availability of India is 1869 billion cubic meters (BCM) from different river basins in the country CWC (1993). The utilizable water with conventional approach is 1121 BCM which comprises of 690 BCM of surface water and 431 BCM of replenish able ground water. The remaining water i.e. 748 BCM is lost to the atmosphere through evapo-transpiration from rain fed agriculture, barren lands, forests, natural vegetation, natural ponds and lakes etc.

Our meager storage capacity built so far is only 305 BCM which corresponds to 33.88% of the

Table-3: Water Demand for Different Uses

Sl. No.	Total Water Requirement for Different Uses (in BCM)			
	Uses	**Year 2010**	**Year 2025**	**Year 2050**
		High Demand scenario	**High Demand scenario**	**High Demand scenario**
1.	Irrigation	557	611	807
2.	Municipal	43	62	111
3.	Industries	37	67	81
4.	Power (Energy)	19	33	70
5.	Others	54	70	111
	Total	**710**	**843**	**1180**

Our present storage, mostly in surface reservoirs, is inadequate to fight drought like situations arising occasionally in different parts of the country. Moreover, loss of live storage due to silting of reservoir is estimated as 53 BCM by 2050. There are only a few storage reservoirs like Bhakra which can hold flood waters in high rainfall years to fight consecutive droughts due to scanty rainfall. Assured Irrigation coverage is around 90 mha out of 130 mha of arable land. It is very difficult to build dams like Bhakra because of stiff opposition of environmentalists. The only way left is to properly manage the available water resources in a judicious and efficient manner (CWC, 2010). Currently, there is a lot of loss of water in irrigation sector primarily due to heavily subsidized supply policy and poor on-farm development (Ministry of Agriculture, 1979). Even a marginal increase in irrigation efficiency will generate enough water to meet the requirements for our future need of food and other requirements, provided of course our population which can be stabilized at 1850 million by the year 2050.

3.0 LOSS REDUCTION FOR IMPROVING IRRIGATION EFFICIENCY:

The overall efficiency of irrigation projects (also called project efficiency) in India is too low at an average of 35% in the case of major and medium irrigation projects (INCID, 1998) as compared to 55% in China and 70% in Japan. The average project efficiency in three major river-valley projects, determined by the first author, was found to vary from 18.6% to 38.8% (Mazumder, 1984). Most of the irrigation water was found to be lost in conveyance and field application and extremely poor management of water (Mazumder-1986) at the farm level. While emphasizing the present day need of intensive irrigation for maximizing yield per unit of area, Bharat Singh (1991) identified the following major shortcomings of our present irrigation schemes:

- Gap between the creation of irrigation potential and its utilization
- Unreliable and inadequate supply
- Inequitable distribution of water between head and tail Enders.
- Non-responsive and authoritarian administration
- Lack of control and increasing malpractices
- Low efficiency of canal systems and poor on farm management of irrigation water.

Planning Commission (1992), renamed as Niti Ayog by Govt. of India, recognized the three major shortcomings responsible for poor performance of irrigation schemes in India, namely,

- Unlined channels
- Lack of land consolidation, improper leveling and sizing of irrigated land
- Poor on- farm management of irrigation water beyond outlets.

Zimermann (1966) examined several drawbacks of protective type extensive irrigation practice being followed in India where available water is spread over vast areas through a widely spaced unlined canal networks. Most of the water in such a system is lost in conveyance and most of the remaining water is lost because of inefficient irrigation management (IWRS, 2007). Several steps for improving irrigation efficiency by reducing avoidable losses have been outlined by Mazumder (2007).

4.0 RECYCLING OF WATER:

Both surface and sub-surface water available in India are getting increasingly polluted over time with rise in population. Such polluted water is unfit for any use- be it domestic, agriculture or industry. Highest priority should be laid on abatement of water pollution for survival of our people, livestock, flora and fauna and for preserving our eco-system. Conservation of water means not only quantity but quality of water too. Water saved through re-use and recycling is going to not only reduce demands for fresh water but abatement of water pollution also.

4.1 River Pollution

River water is the principal source of water to meet various demands of the society. All civilizations are built around rivers. Most of the rivers are getting polluted day by day, principally due to uncontrolled discharge of waste and sewage water in to the rivers. Although Govt. of India has promulgated several acts to control river pollution, there is hardly any implementation of these acts at field level partly due to an unholy nexus between water inspectors and industries and partly due to utter negligence and indifference of municipal authorities. Although Govt. of India is spending huge amount of money every year under 'Swatch Bharat Avijan' which includes cleaning of river water, the results are not up to expectation partly due to prevailing corruption and inefficiency and partly due to lack of proper technology and trained personnel in the water sector today.

4.2 Ground Water Pollution

Ground water which is the principal source of drinking water and agriculture in the rural areas, is getting polluted with time. Over use of ground water and consequent fall in water table has not only increased draft and increase in pumping cost but also pollution of ground water from harmful salts like arsenic, heavy metals etc. Large scale pumping in coastal areas is responsible for sea water intrusion into ground water aquifers. Solid wastes in cities dumped over ground is responsible for ground water pollution due to leaching and subsequent infiltration of highly toxic water in to the ground.

4.3 Waste and Sewage Water Treatment

The only way to fight the growing menace of severe water pollution in India is to treat waste and sewage water polluting fresh water in rivers and lakes. With a view to treat and reuse waste and sewage waters , union finance ministry has approved joint water supply and sewage treatment projects with international funding agencies like World bank(2010), ADB (2014) etc.- both for monetary help and use of relevant technologies. Pune Municipal Corporation, for example, proposes treatment plants in association with the Japan International Cooperation Agency (JICA.). The project titled `Pollution Abatement of River Mula-Mutha' in Pune, will be the city's biggest sewage treatment and river restoration project. The total cost of the project is USD 154 million (INR 990.26 crore), of which 85% (about USD 129 million or INR 841.72 crore) will be contributed by the Union government and the remaining 15% is proposed to be borne by the Pune Civic Authorities. Ministry of water resources is renamed as Ministry of water resources, river development and Ganga rejuvenation with a far reaching objective of cleaning and rehabilitation of all rivers in India with a special emphasis laid on river Ganga which is worshipped as mother by the people of India from time immemorial.

4.4 Water logging and Salinity

A vast chunk of irrigated land in India, especially in Punjab and Haryana, is affected by water logging and salinity due to lack of proper drainage of agricultural lands, resulting in loss of productivity of land (table-1). Drainage water from agricultural lands which is highly toxic because of extensive application of inorganic fertilizers, should be recycled after proper treatment.

5.0 WATER TRANSFER:

Areas with water availability less than 1000m^3 per capita per year are designated as scarcity areas. Although, the average figure (1545) for India (Iyer,1989), if taken as a whole, indicates that India may not be water deficit right now, but looked from the spatial distribution of available water from basin to basin, there is a great deal of non-uniformity due primarily to extreme non-uniform rainfall over the country. Table-4 gives the list of surplus and scarce basins in India (IWRS, 2007). Rapid rise in population growth in India will soon render many of the surplus basins in India to be water scarce basins. Water transfer from surplus to scarce basins for sustainable development of water resources in India has been found necessary to fight recurring floods and droughts in many parts of the country.

Table4: Surplus and Scarce Basins in India

Surplus Basins		Scarce Basins	
Basins	**Per Capita Availability in m^3 Per Year**	**Basins**	**Per Capita Availability in m^3 Per Year**
Brahmaputra Basin	18,417	East flowing Rivers between Mahanadiand Pennar	919
Barak Basin	7,646	Cauvery	666
east flowing Rivers between Tadriand Kanyakumari	3,538	Pennar	648
east flowing Rivers between Tapiand Tadri	3,194	West flowing River Basin of Kutch and Saurashtra including Luni	631
Narmada	2,855		
Brahmani-Baitarni	2,696		
Mahanadi	2,546	East flowing River Basins between Pennar and Kanyakurnari	383
Godavari	2,026		
Indus	1,757		
Ganga	1,473		

5.1 Interlinking of Rivers

Only way we can address the recurring problems of water shortage in scarce basins is by transfer of surplus of flood water to drought areas. It is estimated (IWRS, 2007**)** that an additional area of 35 mha of land can be brought under irrigation by river linking. Govt. of India has drawn a perspective plan to interlink Indian rivers (Fig.2) by constructing 30 link canals-14 in Himalayan and 16 in Peninsular regions in India (NWDA, 2005). Few Short distance river links like Ken-Betwa have already been implemented. Long distance links by successive transfer of water from one river to another by constructing some 30 small, medium and large reservoirs are under exploration. Merits and demerits of river linking have been discussed at length elsewhere (IWRS-1996, Mazumder-2011).

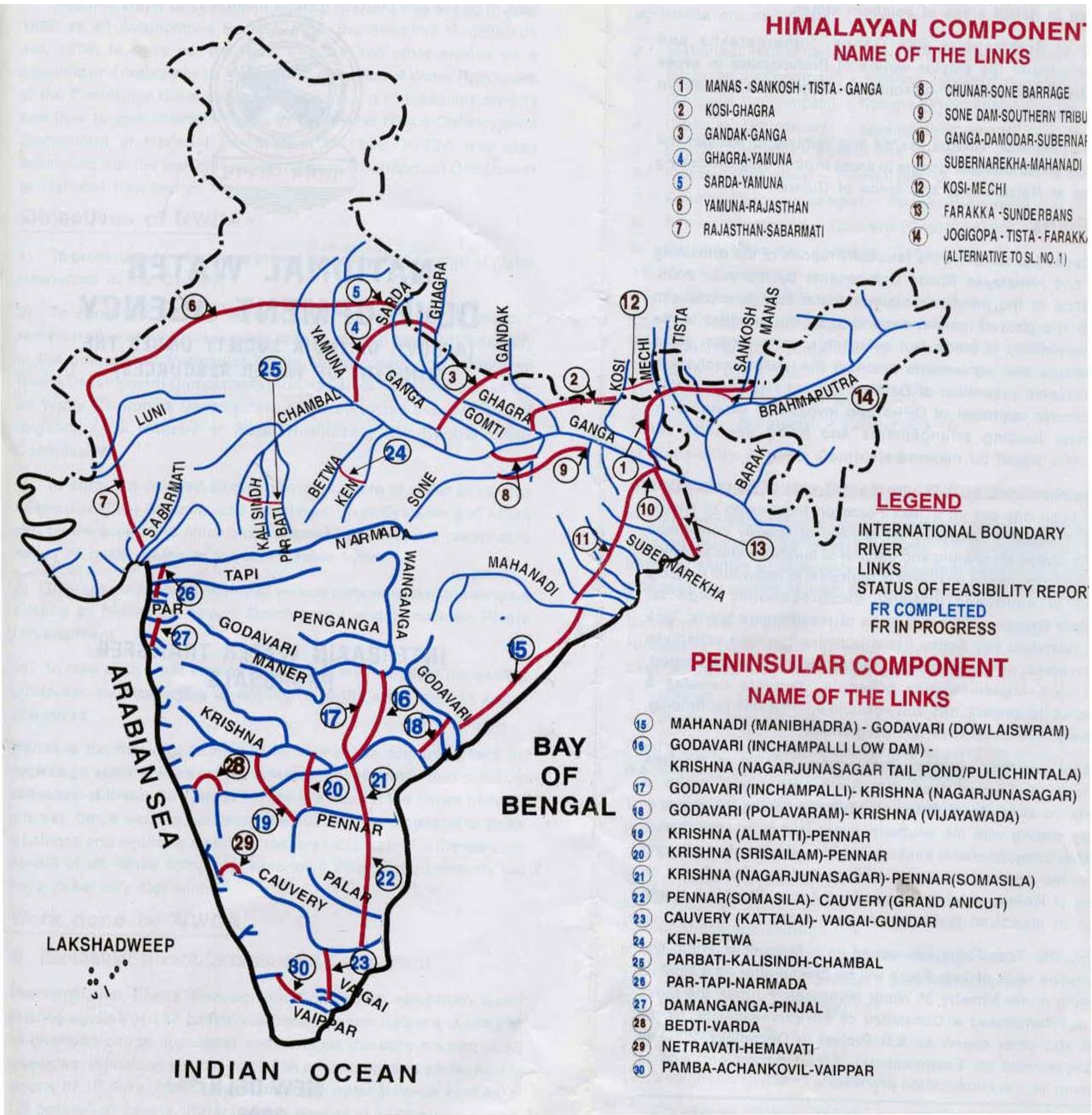

Fig. 2 Interlinking of Rivers in India (Under Perspective Plan by NWDA)

6.0 SUMMARY AND CONCLUSIONS

After independence, India has progressed considerably in water conservation and irrigated agriculture through construction of a large numbers of reservoirs all over the country. However, there is an increasing demand of water from agriculture and other sectors due to uncontrolled rise in our population and for improvement of living standard, presently, about 80 percent of available water resources of the country is used for irrigation. Project efficiency, which is about 35% only, must be improved by reducing losses through proper irrigation management so that the water saved can be used to increase irrigation coverage of agricultural lands still dependent on rainfall. Even a marginal increase of irrigation efficiency will be very helpful in meeting demand for agriculture, domestic and industrial uses. Recycling of waste water and drainage water, after appropriate treatment, will be helpful not only for water conservation but also in controlling the menace of increasing water pollution. Water transfer from water surplus areas by river linking will be effective in meeting demand of water in water deficit basins facing recurring droughts.

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