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FUTURISTIC TECHNOLOGIES OF WATER & WASTEWATER MANAGEMENT

WATER MANAGEMENT THROUGH EFFICIENT IRRIGATION & WATER TRANSFER

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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, and Nagarjun sagar 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 demands from different sectors and chain management of agricultural production of rice, wheat, edible oil, pulses etc. Steps are being taken to improve soil health, seeds, organic farming and GM crops etc. In spite of all the progressive measures and investment over the last 12 five year plans, the country is lagging behind China and some neighbouring countries in regard to land and water management. Fig.1 illustrates yield of cereals in India vis-a-vis some other countries. In this paper, Author wishes to emphasize on two important aspects of water management in regard to irrigation efficiency and water transfer through river links.

2.0 AVAILABILITY AND DEMAND OF WATER

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 billion cubic meters (BCM). There is considerable variation in precipitation both in time and space. Nearly 75% of precipitation i.e. 3000 BCM occurs during the south-west monsoon

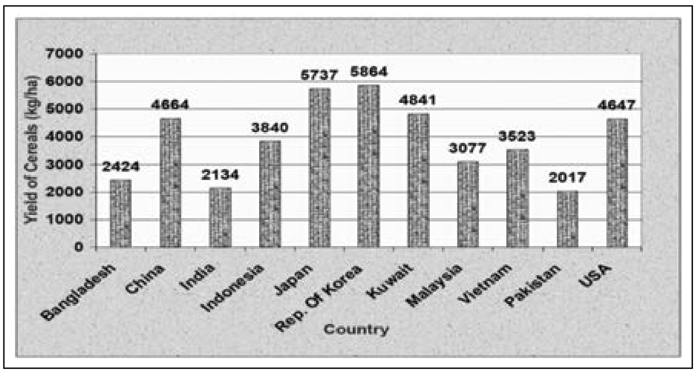

Fig.1 Comparison of Yield of Cereals in India vis-a vis Other Countries in the World

season confined to 3 to 4 months (June to September) in a year. Average annual water availability of India is 1869 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, floods, natural ponds and lakes etc.

Table-1 shows per capita water availability of some of the countries in the world as on 2011. With rise in population, the per capita water availability by conventional methods in India have further reduced to about 1343 m3 per year as on 2021. India will face acute shortage of water by the year 2050 onward when utilizable water resources of Indiai.e.1121 BCM by conventional methods will be insufficient to meet the total demand i.e. 1180 BCM from different sectors e.g. Irrigation, municipal consumption, industries, power etc. given in Table-2 ((INAE,2008). It may be seen that irrigation sector consumes about 70% of the total demand of water. Out of 113 mha area under irrigation in India today, 58 mha is by major and medium surface irrigation schemes, 15 mha area by surface minor irrigation schemes and 40 mha by minor ground water schemes (IWRS-2007). Because of the timely irrigation development, India is self sufficient in food today, producing 300 million tons of food grains for our 1300 million people. Fig.2 indicates the rise in population, food production and area irrigated by conventional method during the period 1951-2050.

Table 1: Per Capita Water Availability in Different countries in The World (as on 2011)

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

Table 2: Water Demand for Different Uses in India

S. 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**
	Irrigation Demand	**78%**	**73%**	**68%**

3.0 NEED FOR PROPER MANAGEMENT OF IRRIGATION WATER

Our meagre storage capacity built so far is only 305 BCM which corresponds to about 30% of the utilizable water (mostly in surface reservoirs), is inadequate to fight drought like situations arising occasionally in different parts of the country. Moreover, loss of live storage (Singh, A. & A. Kanwal, 2021; Mazumder, 2016) 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 irrigation water 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 can be stabilized at 1850 million by the year 2050.

4.0 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 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 surface irrigation schemes:

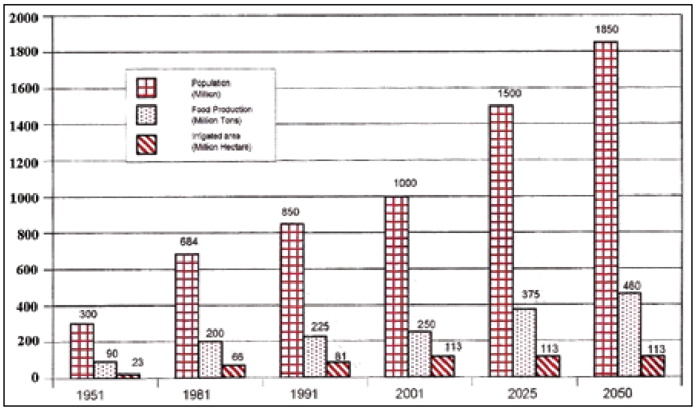

Fig. 1: Growth of Population, Food production and Irrigated area in India during 1951-2050

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

Planning Commission (2007), 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 levelling and sizing of irrigated land
- Poor on- farm management of irrigation water beyond outlets.

However, majority of our farmers are poor and incapable of investing huge funds needed for land improvement, land levelling, canal lining, irrigation automation etc. for improving productivity of land.

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).

5.0 CHANGE IN CROPPING PATTERN & IRRIGATION RATE FOR IMPROVING IRRGATION EFFICIENCY

Unlike wheat, rice is a water loving crop since rice is found to have highest growth rate at soil moisture equal to field capacity requiring submergence irrigation and causing huge amount of percolation losses. In the case of conventional irrigation supply through canal networks, gross delta for rice varies from 1200 to 1500 mm. Water requirement for wheat and pulses is substantially less as the irrigation water is applied up to field capacity of soil and there is no percolation loss. Consumptive requirement of Rabi crops is substantially less as evapo-transpiration is low and growth is not affected due to depletion of soil moisture up to an optimum moisture content determined by type of crop. Rice cultivation by canal irrigation should be discouraged in rainfall deficit areas like Rajasthan and confined to areas only with high rainfall. Currently, irrigation water rates are so low that only 15% of the total cost of operation, maintenance, administrative and overhead expenditure can be met from the meagre revenue income (Mohile,et.al ,1994).This has resulted in utter negligence in maintenance of the canal system resulting in profuse amount of water loss and poor irrigation efficiency. In long distance irrigation canals, farmers at head end draw more water than needed since irrigation rates are not charged on volumetric basis but on area-crop basis. As a result, farmers at tail end of the canal receive meagre amount canal water forcing them to resort to pumping of ground water. The surface irrigation schemes were planned to make conjunctive use of ground water to the extent of about 30% of irrigation requirement. Presently, 70% of command areas are irrigated by ground water due to poor efficiency of surface irrigation schemes in India resulting in serious problems of ground water depletion and consequent escalation of pumping cost. Overdrawing of ground water has resulted in emptying of shallow aquifers, land subsidence and other harmful effects besides rise of pumping costs. Several states and Govt. of India formed Command Area Development Authorities (CADA), Water Users Association (WUA) etc. with a view to improve upon the performance of irrigation schemes but they have miserably failed to improve upon the efficiency due to several reasons discussed above.

6.0 ROLE OF SERVICE TANKS TO CONSERVE IRRIGATION WATER

In most of the surface irrigation schemes, the main and branch canals are so long that it may take days for arrival of irrigation water released from distant reservoirs. Due to lack of proper co-ordination between regulating authorities and farmers, water arriving at the tail end in the canal system may not be drawn by the farmers if there is rainfall in the intervening period. Huge amount of water is wasted through canal escapes for safety of the canals. Such water can be conserved by construction of service tanks/On-Farm-Reservoirs (OFR) for temporary storage and supplied to farms subsequently. Apart from water conservation, such detention/retention tanks (Mazumder, 2017) are very useful to meet multiple purposes e.g. fish culture, domestic use, recharge of ground water, flood management, sediment trap, water treatment, recreation and above all a flexibility of operation by farmers to apply irrigation as and when needed at their convenience. OFR for storing runoff/canal water for reuse is a very useful method of improving irrigation efficiency and are widely used in Israel where rainfall is scanty. However, their location, storage capacity, inflow and outflow control devices are to be very carefully planned and designed (Zimmerman 1966).

7.0 WATER TRANSFER

Areas with water availability less than 1000m3 per capita per year are designated as scarcity areas. Although, the average figure (1343) 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. Rapid rise in population growth in India will soon render many of the surplus basins in India to be water scarce basins (IWRS, 2007). 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. 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, apart from hydro-power, navigation, ground water recharge, flood control etc. Govt. of India has drawn a perspective plan to interlink Indian rivers (Fig. 3) 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 is being 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. Mer its and demerits of river linking have been discussed at length elsewhere (IWRS-1996, Mazumder-2011).

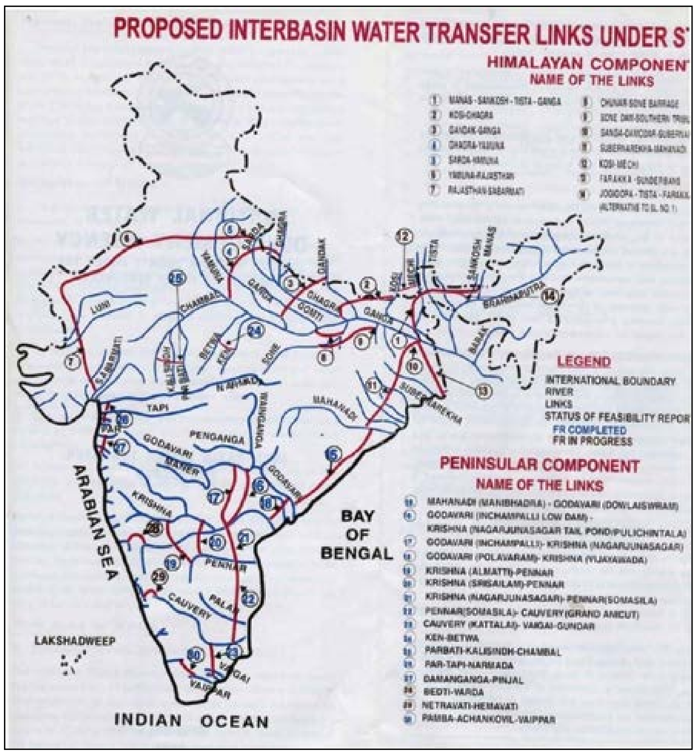

Fig.2 Interlinking of Rivers in India (NWDA)

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About the Author

Prof. S.K. Mazumder, born in 1938, graduated in Civil Engineering in 1959 from B.E. College, Shibpur, Calcutta University (now IIEST, Shibpur). He was Assistant Engineer, (Irrigation & Waterways Dte), Govt. of West Bengal, during 1959-62. He obtained his M.Tech. and Ph.d.in Civil Engg. (Dam & Hydro-power Engg.) from IIT, Kharagpur where he was a lecturer during 1962-67. He was Assistant professor in Civil Engineering at R.E.C. (now NIT), Durgapur, during 1967-75 and Professor of Civil Engineering (Hydraulics & Flood Control) at Delhi College of Engineering (now Delhi Technology University), during 1975-98. He was AICTE Emeritus Fellow during 1998-2000. During Feb-Nov,1991, he was a visiting professor at EPFL, Switzerland. He was Head of Civil Engg. and Dean of Faculty of Technology, University of Delhi. He is Fellows of CBIP, IE(I), ISH & IWRS and members of IAHR, IRC, ISCA, IPHE, CDC, CEAI. He was principal Investigator of several research schemes sponsored by a number of Govt. and Pvt. Organizations.

Prof. Mazumder has published/presented more than 207 technical papers in National and International journals and conferences, written two books, editor in chief of the proc. of a national conference, contributed a chapter in two books by Kluwer and Springer publications. He got several awards for his papers from the Institution of Engineers (India) and Indian Roads Congress. He received life time achievement award in 2009 and best Reviewer Award in 2019 and 2020 from Indian Society for Hydraulics for his immense contribution in hydraulics and water resources Engineering.

After retirement, Prof. Mazumder served several consulting companies in Delhi e.g. ICT Pvt. Ltd., Aquagreen Engg. Pvt. Ltd, Scott- Wilson-India Pvt. Ltd., Mahendra Raj Consultants, B&S Consultants, NOIDA, Rambol India , Infinite Civil Solutions, Ahmedabad and currently retained by Maccaferri India, Gurgaon. in the area of his specialization i.e. Hydraulics and Water Resources Engineering. He is currently, a faculty member of Indian Academy of Highway Engineers (IAHE), NOIDA. He is Member/convener of several committees of IRC and BIS, Govt. of India. For three years, he was an expert member of EAC (Hydro & Irrigation group) , Min. of Env. & Forests, Govt. of India. He was a member of NIH Society, Roorkee, as a nominee of the Minister of Water Resources, Govt. of India. He is a reviewer of several journals published by several societies e.g. Institution of Engineers (India), Indian Society for Hydraulics, ASCE, IRC etc.

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