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River Interlinking

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Abstract – The interlinking of Indian rivers is a highly ambitious and massive project which is always under debate. The project involving inter basin water transfer has canals, tunnels or water lifts, for water to flow from one river basin to another and making use of excess water. It envisages transferring the surplus water from primarily Himalayan rivers like Ganga and Brahmaputra rivers to more deficient peninsular rivers through Mahanadi and Godavari river basins.In India, rainfall is dependent on the south-west and north-east monsoons or on the shallow cyclonic depressions and disturbances and on violent local storms which form regions where cool humid winds of the sea meet the dry winds from the land and occasionally reach cyclonic dimension. Hence some areas are affected by the droughts while other areas are affected by seasonal floods. There is a general perception that with growing human population and rising standards of living, the available supplies of fresh water on the planet are becoming insufficient to meet demand. It will be scarce, expensive to develop and maintain and valuable in use. The present report is an attempt to study scope and future of sustainable river interlink. The core objective is to study issues and challenges faced in interlinking of Indian rivers and their alternative measures.

Keywords – Environment, inter-basin water transfer,sustainable hydraulic structures, water management.

I. INTRODUCTION

The availability of fresh water at various spots on the Earth's terrestrial surface continue to be determined by the hydrological cycle, till such a time when technologies like desalination of seawater is practiced on a reasonably extended scale. The rapid growth in the demand of freshwater driven by growth in the global population and of the economies, has led to this natural resource becoming scarce in many parts of the world. According to the National Water Policy, water is a prime natural resource for humans and, hence, a precious national asset. Nowadays, it is hard to find freshwater due to growth in population, agricultural and industrial activities, and contamination of water resources. India is also expected to face water problem in the coming years. The country receives about 4000 km^3 of water as precipitation annually, but due to different precipitation patterns and mismanagement, it often leads to wastage. Arthur Cotton was the first person who originally conceived the idea of networking the rivers about two centuries ago, but the idea of interlinking Indian rivers was revived independently by M. Visveswarayya, K. L. Rao and D. J. Dastur. In October 2002, the Supreme Court ordered the Central Government to initiate work on interlinking the major rivers of the country. In response to this order, the Government of India appointed a Task Force headed by Suresh Prabhu. Scientists, engineers, ecologists, biologists and policy makers started to ponder over the technical, economic and eco-friendly feasibility of this gigantic project. There is no escaping the fact that for large parts of the human population, water scarcity is a serious problem and this is increasingly exacerbated by a changing climate. Water shortages can be a product of a range of factors apart from drought.Basically, a large amount of water from rivers flows into the sea, which should be prevented to enable transfer of water to water-deficit areas for domestic, agricultural, industrial and other activities.

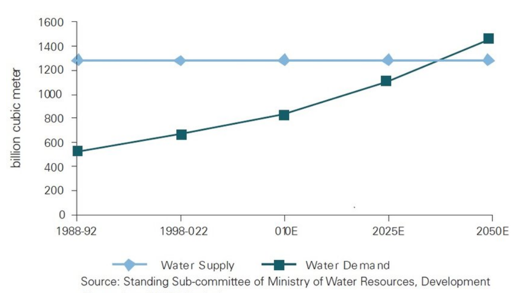

Fig.1 Water demand vs water supply in India

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II. Scope Of The Project

The National River Interlinking Project will comprise of 30 links to connect 37 rivers across the nation through a network of nearly 3000 storage dams to form a gigantic South Asian Water Grid. It include two components:-

- *Himalayan Rivers Development Component –*

This component aims to construct storage reservoirs on the Ganga and Brahmaputra rivers, as well as their tributaries in India and Nepal. The aim is to conserve monsoon flows for irrigation and hydropower generation, along with flood control. The linkage will transfer surplus flows of the Kosi, Gandak and Ghagra to the west. A link between the Ganga and Yamuna is also proposed to transfer the surplus water to drought-prone areas of Haryana, Rajasthan and Gujarat.

- *Southern Water Grid –*

It includes 16 links that propose to connect the rivers of South India. It envisages linking the Mahanadi and Godavari to feed the Krishna, Pennar, Cauvery, and Vaigai rivers. This linkage will require several large dams and major canals to be constructed. Besides this, the Ken river will also be linked to the Betwa, Parbati, Kalisindh, and Chambal rivers.

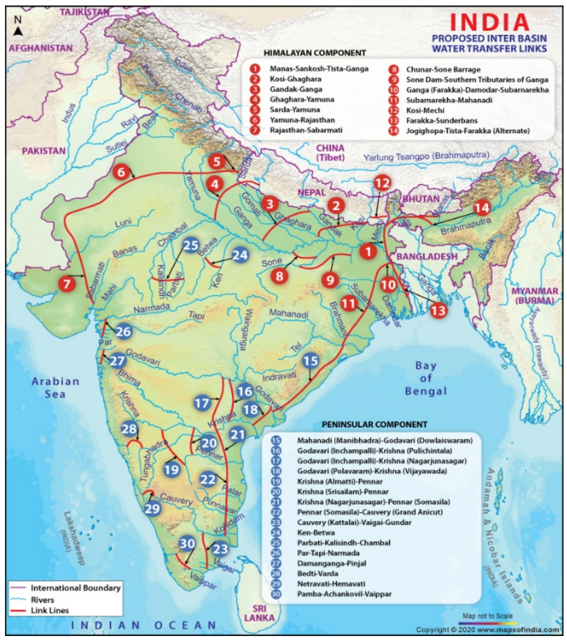

Fig.2 Proposed Inter-basin water transfer links

Proposed Benefits of the Project –

- This will lead to addition of 35 million hectares for irrigation.
- These projects will lead to the generation of 34,000 megawatt power.
- Round the year navigation.
- Employment generation.
- Resolution of problem of droughts and floods.

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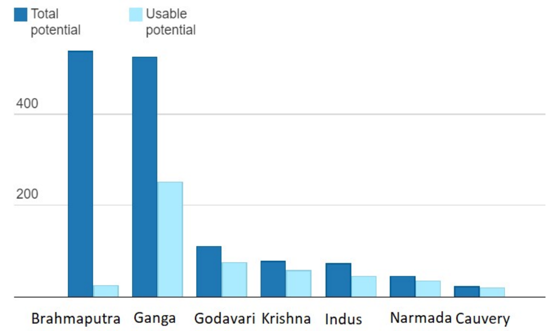

Fig.3 Water-carrying potential of Indian rivers. Unit is billion cubic meter. Data is for 2000.

The Opposition –

- Concerned scholars questioned the merits of inter-link projects citing lack of full assessment of social-ecological impacts like water-logging, salinization and the resulting desertification.

Ken-Betwa river link entails a 231 km canal between the two rivers in the states of Madhya Pradesh and Uttar Pradesh, along with two dams and reservoirs; the felling of more than 1.8 million trees; and the usage of 6,017 hectares of forest land, including the Panna Tiger Reserve, with special mention of endangered wildlife species that will be impacted. The project is also expected to consume nearly 6,000 hectares of non-forest land, with approximately 5,000 homes being submerged as per the National Water Development Authority feasibility report.

- The concerns about sediment management, especially on the Himalayan system will emerge large. When the idea is to transfer water from the 'surplus' Himalayan river systems to 'deficit' basins of the southern part of India, the differential sediment regime defining the flow regimes need to be plugged into the equation. This will entail changes in ecosystem structures in both parts.
- Damming India's east-coast rivers to take their water westwards will curtail downstream flooding and thereby, the supply of sediment—a natural nutrient—destroying fragile coastal ecosystems and causing coastal and delta erosion
- The spirit of federalism is ignored in the river interlinking project. There is dissent on the part of the state governments. The top-down model presumes of near-unanimity of every state.
- A new analysis of rainfall data reveals that monsoon shortages are growing in river basins with surplus water and falling in those with scarcities.

This raises questions about India's Rs. 11 lakh crore plan to transfer water from "surplus" to "deficit" basins.

III. Sustainable Measures

A. Rainwater harvesting **–**

Rain water harvesting is one of the useful effective processes of water conservation. Rain water harvesting is a simple and primary technique of collecting water from natural rainfall. Rain water harvesting is a multipurpose way of supplying usable water to consumers during crisis period, recharging the ground water and finally reducing the runoff and water logging during the season of heavy rainfall. Availability of water of serviceable quality from conservative sources is becoming limited day by day due to huge demand. Rainwater provides sufficient quality of water with small cost. In order to understand the variation between demand and supply, the total demand needs to be known. That could be calculated through population data and per capita demand. Now days there are many new technologies used for rain water harvesting. This include:-

- Rain saucer – the rain saucer system is a barrel accessory that allows users to harvest rainwater anywhere. It looks like an upside umbrella. It is easy to install anywhere and decrease the potential for contamination. It can be used for sustainable gardening, for small scale farming, and for collecting of fresh water.

- Check dams – a check dam is a small, sometimes temporary, dam constructed across swale, drainage ditch, or waterway to counteract erosion by reducing water flow velocity. The purpose of check dam is to retain water up stream, so that water percolates into ground and recharge the ground water table.

B. Sustainable Water management –

SWM is defined as meeting current water demand for all water users without impairing future supply. As water is one resource but it has many uses; it is a central requirement for our food production, health, culture, energy supply, infrastructure and economic growth and proper management of water is a means to improve food production, reduce poverty and water related diseases. SWM involves allocating water between competing purposes and users. This allocation can be represented as a hierarchy, similar to Maslow's hierarchy of human needs. The framework asserts that the foundational biophysical needs must be met before effort can be dedicated to fulfilling higher needs. The second level of hierarchy is "safety", which translates to security of domestic water and agricultural production at the local level. The third and fourth levels of needs in this hierarchy, "social" and "esteem", correspond to border community water services and a focus on maintenance, justice and responsibility, respectively. The fifth level is "self-fulfillment" contrasts with resources sustainability, which emphasizes outward-looking perspectives including the fulfillment of other users both now and in the future.

Although many of the initiatives cross over, they are broadly divided between those for water management, water and land management. These initiatives can meet the challenges through management strategies. Most future resources will involve the reallocation of existing resources, the enlargement of existing resources, the construction of new ones, inter-basin water transfer or water reuse, this will help in reducing the challenges of water management. Along with this water storage, aquifer storage and recovery, rainwater harvesting and grey water recycling, desalination of water supplies, integrating wastewater planning, water cycle studies will also help in reducing the challenges of water management.

SWM evaluation requires accounting for real costs, opportunity costs and competing requirements. These sometimes include vague political and socio-economic components, which is often do not translate easily to the quantitative values necessary for planning, decision making, and rigorous monitoring and assessment. There are three primary evaluation methods for SWM:- (1) indicators and indices, (2) product related assessment, (3) integrated assessment. Water management indicators typically include water infrastructure, environmental quality, economics and finance, institutions and society, human health, and technology. Product related assessments, or life cycle assessments (LCA), can provide information about land, water and energy requirements for a physical system or supply chain. The LCA framework can be used to inventory a set of sustainability indicators across the supply chain of the water system. Integrated assessments tend to be holistic assessments completed using system dynamics models, risk analysis, cost benefit analysis and impact assessments. Beyond the three typical evaluation types, groundwater use is often evaluated by comparing extraction to the aquifer safe yield. Local variations, data availability, and social socio-political objectives may lead to selection of different water quality sustainability evaluation methods.

C. Sustainable Hydraulics structure –

A hydraulic structure is a structure submerged or partially submerged in any body of water, which disrupts the natural flow of water. They can be used to divert, disrupt or completely stop the flow. A hydraulic structure can be built in rivers, a sea, or any body of water where there is a need for a change in the natural flow of water. Hydraulic structures may also be used to measure the flow of water. Hydraulic structures of this type can generally be divided into two categories: flumes and weirs.

Hydraulic design involves the application of flow theory to the design of various water containment and control structures. The designer should ensure that the structure and the systems will function effectively and economically under all foreseeable service conditions. Hydraulic structures must be capable of withstanding flow conditions and forces caused by both static and flowing water loading. They must be so designed as to last over their design life span and be resistant to deterioration, ageing, and spontaneous forces due to weather extremes and earthquakes. In designing a hydraulic structure, the designer chooses from many options available, and from past experience, that particular design believed to be the most cost-effective, functional, and safe.

Examples of waterworks and systems comprising many detailed hydraulic structural components are the following: raw water storage reservoirs, dams, hydroelectric power plants, pumping stations, intake structures and diversion weirs, tunnels, canals and pipelines, water treatment and sewerage disposal works, flocculation tanks, clarifiers, control and measuring structures, storm-water draining and confining structures, clear water (municipal) reservoirs, water towers, surge tanks, spiral casings, draft tubes, manifolds, energy dissipating devices, spillways, and stilling basins. In addition to the above listing of structures, which are concerned mainly with water supply and distribution, there are also the following categories of water-related structures and water-control operations. These are also dealt with by hydraulic design engineers, with the aid of hydraulic theory and its application, hydraulic engineering:-

- Harbours, docks, piers, seawalls, breakwaters, coastal and beach protection, locks and canals.
- Ocean pipelines for effluents, gas or petroleum products, moorings, and anchorages.
- Deep ocean construction, floating, guyed, or free-standing platforms such as used for oil rigs.
- Undersea tunnels, manmade islands in oceans and estuaries, coastal engineering, lighthouses.
- Bridges and piers for road and rail, river training works, offshore airport runways, caissons.
- Hydraulic-fill dams, slurry and tailings dams, hydraulic dumping, hydraulic mining.
- Underwater excavation, dredging, deep-drilling, hydrofracturing, tremie-concrete foundations.

Concepts and principles for sustainable hydraulic structures – The following considerations apply to the design of sustainable hydraulic structures – sustainability, stochastic design, modelling difficulties, and structural integrity.

- Sustainability – The concept of sustainability of a water resource development includes the design of structures, which with proper maintenance should last indefinitely or which if destroyed cause only a manageable disruption of living conditions.
- Stochastic Design – Design procedures should provide for any uncertainty in the variables, which enters from input uncertainties to design criteria. For hydraulic structures design in the water resources context, one has the following main sequence of criteria to satisfy, individually and collectively.
- Hydrology – Data must be adequate, well understood, and the information stochastically modelled.
- Hydraulics – Methodology must be sound, adequate to deal with the spatial and temporal variables.
- Hydraulic structures – Components must be designed to resist all loads, be permanent, maintainable, and cost effective.
- Environment – Systems must comply with the social order, be economical, and natural environment friendly for long time.

India has the 3rd highest number of dams in the world. Unchecked construction of dams has inflicted severe damage on river ecosystems.

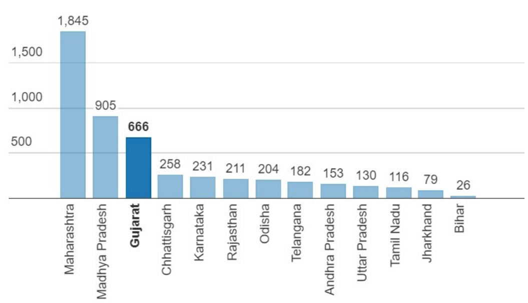

Fig.4 Dams in India. Data is for 2014

Counter measures against various negative impacts of Inter-basin transfer –

1) *Spread of disease due to contamination of water at the source or along the conveyance route and also spread of water pollution.*

IBTs usually feature long distance water delivery line that crosses regions with complex ecological geographic characteristics. This may cause diseases such as typhoid fever, dysentery, cholera, encephalitis, which affects the human health. Water protection areas can be set in necessary places and implement with special requirements and prohibition in order to avoid damaged. Residential and industrial buildings are not allowed to be built in more stringent protection zone, while specified business, sewage treatment plants and transport routes can be established according to the provisions in lesser degree of protection areas; however, gas stations and chemical warehouses which shall be harmful to the water sources are not allowed to be constructed and operated.

2) Salinization on both sides of the conveying channels.

The lack of supporting drainage systems or unreasonable designs of drainage system will cause accumulation and redistribution of salt in the soil once the soil water table is higher than critical depth of groundwater. This results in land waterlogging and salinization.

Waterlogging problem can be solved by efficient surface drainage, under drainage by tile drains, lining of irrigation channels so as to make bed and side of canal impervious, lowering of full supply level of irrigation channels, construction of intercepting drains, and depletion of ground water storage by pumping and change in crop pattern and by plantation near channels.

3) Sea water Desalination.

Sea water desalination has a promising future. The coastal regions and islands in serious shortage of water may take advantage of membrane technology. The desalinated sea water can be used in municipal water supply and industrial water use, particularly for electronics industry with high demand for water quality. Good benefits have been obtained. The drawback of this process is that this process is costly and the range of application is small and also the by-products of desalination include coagulants, bisulfates and chlorines which is bad for environment, human health and marine life. The only way desalination can be a good option to solving the water crisis is if renewable energy is used, costs are lowered, and environmental protections are put in place for marine life too.UN predicts that by 2025, 14 percent of the world will rely on desalination to meet water needs.

4) Silt deposition in the flat upstream ranges of reservoirs at water level draw down.

In order to increase the useful life of a reservoir it is necessary to control the deposition of sediment in the reservoir. The inflow of sediment to a reservoir can be controlled by constructing check dams and by providing vegetation screens. A check dam is a small dam usually constructed across a stream to trap most of the coarser sediment transported by the stream. Vegetation screens may be developed by promoting the growth of vegetation in the catchment as well as at the entrance to the reservoir, it would trap a large amount of sediment if flood water pass through them before entering the reservoir and hence help in reducing the sediment inflow.

5) Cost consideration.

As this project is of massive estimated cost, a long term planning and a sound financial strategy is required to meet the standard of due diligence for such proposals. The time for construction of these links would vary according to the length of the canals, the number of reservoirs and dams to be constructed and the topography of the region.

Cost recovery through irrigation, adaption high yielding varieties and certified quality seed yielded good results and will increase the demand of exporting food grains. South Africa is developing a system of charges that will reflect and recover direct and indirect costs associated with the discharge or disposal of waste. The charges will include a load-based charge proportional to the waste load. Initially, this charge will relate to salinity, nitrates, and phosphorous in the water discharged. An extra charge will apply if the waste load exceeds the maximum permissible level (Republic of South Africa 2004).

Establishing systems for restoration and compensation to re-establish the integrity of ecosystem –

In the execution stages of the water transfer, eco-compensation measures of ecological restoration and ecological compensation are also essential. Successful Inter-basin transfers are basically equipped with many regulating reservoirs along the route and established with stable bases for water resources, so that to provide the fundamental guarantee for the redeployment of water resources. The function of regulating reservoir is to store excess water during the rainy season and reasonably control discharge volume for the river in order to ensure the balance of surface water and underground water in both the water resources area and the intake area. It helps in excessive exploitation of groundwater in dry seasons and low flow year and makes comprehensive utilization of surface water and groundwater.

IV. CONCLUSION

In general, each way of water transfer will quickly change the water-deficient situation, improve the geological environment, and facilitate social economic development in the recipient basin but it would have huge impacts on biodiversity. Despite the many lessons we should have learnt from past IBT experiences, many decision makers today continue to see IBTs as a technical solution to restore perceived imbalances in water distribution. To illustrate this point, an article in the Hydrological Sciences Journal of 2005 states that "inter basin transfer of water in India is a long-term option to correct the spatial and temporal mismatch of water availability and demand, largely owing to the monsoon climate" (Jain *et al*., 2005).

This is a simplistic point of view based on the false notion that moving water from places regarded as having 'water surpluses', to water scarce areas, can be undertaken without significant social and environmental impacts. The development of IBTs, rather than restoring a perceived water imbalance, usually disturbs the finely tuned water balance in both the donating and the receiving river basin. Regularly overlooked in IBT development are the short, medium and longer term impacts of moving water from one community and providing it to another.

There is no escaping the fact that for large parts of the human population, water scarcity is a serious problem and this is increasingly intensified by a changing climate. Water shortages can be a product of a range of factors apart from drought.These include overpopulation of naturally water-poor areas, over-exploitation of local water resources, inappropriate agricultural practices, water wastage etc. Thus, the question of how to meet the demand for water in water-stressed areas remains an urgent one to be answered.The size of many schemes has meant that a large-scale IBT is rarely the most cost effective way of meeting water demands. In many cases the introduction of an IBT does not encourage users to use the water more effectively, continuing wasteful practices.The alternatives should be considered in the following order:-

1) Reducing water demands;
2) Recycling waste water;
3) Supplementing water supplies locally;
4) Considering an IBT, as a last option.

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