Importance of Risk and Hazard Assessment of River Projects in India

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Recommended Citation
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Abstract: Rivers are the lifeline for every country as they provide water for proliferation, sustenance and propagation of life since time immemorial. With increasing population pressure, water demand increased for drinking, irrigation, and industrial consumption. This water deficit required utilization of available water resources in the best possible manner through various hydrological projects like construction of dams, weirs, barrage, etc. There is a disparity in water availability between north and south India as most of the perennial rivers are situated in the north while seasonal rivers in south India. To resolve this disproportionate distribution and to maintain the balance of water between flood and drought-prone rivers, interlinking of rivers is proposed. This proposal has garnered a lot of attention from scientists and environmentalists around the world. These human interventions affect the ecological flow of rivers. There are various risks associated with these projects which require prior assessment. In this study, risks and environmental hazards associated with river projects in India have been discussed with a special focus on the ongoing river projects like the interlinking of rivers. Various factors which determine the feasibility of the proposed projects were studied. There are many risks associated with the change in gradient and environmental flow of rivers with the construction of such projects. We have reviewed risks on humans, like displacement of population and impact on their livelihood as reported for various projects. There are various social implications of such projects which need to be assessed and their mitigation measures need to be undertaken.

Keywords: environmental flow, gradient, hydrological projects, interlinking of rivers, social implications, water quality

1. Introduction

Human civilizations have thrived on the water banks of rivers which have played a significant role in every aspect of the expansion of civilisation-social, political, economic, and ecological. There may be the difference in opinion about the level of influence but every scholar agrees that the early civilization was dependent on water supply for all their basic needs- irrigation for cultivation, navigation for trade and commerce and water for consumption of humans and cattles. Rapid industrialization and advanced technology created need for production of electricity and for this purpose water of rivers was harnessed through hydroelectric power projects. Humans devised various methods to overcome the challenges posed by natural barriers. Construction of canals, dams, rainwater harvesting structures, etc are testimony to the fact that human have found ways to meet their growing needs and diversion of river water to the required areas are not new. Even there is evidence of elaborate canal and drainage system during Harappan civilization. There is huge water scarcity in our country as the per capita water availability (1486 cubic meters in 2021) making it water stressed country. According to The Water Gap – The State of the World’s Water, 2018, India ranks amongst the top 10 countries where there is lowest access to the clean source of water nearby home. This Interlinking of rivers is however in nascent stage of development as this requires elaborate changes in course of a river to meet another river where there is water deficit. This manmade intervention with natural course is associated with many risks which require proper assessment. It also requires proper assessment of feasibility of such projects since they involve huge economic, social and ecological costs.

2. Interlinking of Rivers in India

A British Irrigation Engineer, Sir A. Cotton in 1839 first proposed to link rivers of Southern parts of India to promote inland navigation. However it was only partially implemented due to growth of railways network (Mirza et al. 2008). The interlinking of rivers in independent India has been first proposed by Dr. K. L. Rao in 1972 to link the Ganga River with the southern Cauvery River (Ganga-Cauvery Link)but it was not implemented due to economic constraints (Bandyopadhyay and Perveen 2003; Mirza et al. 2008). Captain D.J. Dastur proposed the ‘Garland Canal scheme’ to connect Himalayan and peninsular rivers at two points (Delhi and Patna) but it was found to be technically and economically infeasible (Bandyopadhyay and Perveen 2003). National Water Development Agency (NWDA) was set up in 1982 for study and execution of interlinking of river projects. Its major function is to prepare Pre-Feasibility Reports (PFRs)/Feasibility Reports (FRs) and Detailed Project Report (DPR) of River Link proposals under the National Perspective Plan (NPP). Since 2002, this project has garnered lot of media attention as Supreme Court asked the government to complete the
project within 12 years (Bandyopadhyay and Perveen 2003). In the present budget, it was announced that Rs 43 billion were allocated in Revised Estimates 2021-22 and Rs 14 billion in 2022-23 have been made for the project.

National Perspective Plan has two components

1. Himalayan Rivers Development
2. Peninsular Rivers Development

A map of the proposed scheme of links on both the components of ILR is shown in Fig. 1 and Fig. 2.

2.1. Himalayan Rivers Development

There are 14 links in the Himalayan component of which, NWDA has completed feasibility studies of 4 links (http://www.nwda.gov.in/content/index.php):

1. Sarda-Yamuna Link (Indian portion),
2. Ghaghara-Yamuna Link (Indian portion),
3. Manas-Sankosh-Tista-Ganga (MSTG) Link
4. Farakka-Sunderban (FS) Link.

![Figure 1. Proposed Himalayan component of ILR (Source: NWDA).](image)

2.2. Peninsular Rivers Development

NWDA had proposed 16 links of peninsular component of which PFR for 14 are complete except for two links viz. Netravati - Hemavati and Bedti-Varda links (http://www.nwda.gov.in/content/index.php).
3. Advantages of interlinking of Rivers

The interlinking of rivers will resolve the long standing issue of twin problems of flood and drought. The water scarcity faced by southern part of the country due to dependency on monsoon. The inter-basin transfer will ensure that the water deficient region gets water from water surplus regions (Jain et al. 2008), fulfilling the water demands of that region and simultaneously ensuring that the regions which were getting flooded are not affected by floods. It will also help in the generation of electricity and provide means for transportation which will in turn promote economic development (Mukhopadhyay 2008). There will be employment generation during this project as it will require lots of human resources during infrastructure development and it will also promote industrialization near water which will further boost the job prospects of many.

4. Probable risks associated with Interlinking of Rivers

There are various environmental and social costs of the interlinking of rivers. There should be proper impact assessment and redressal of the environmental and social issues before implementing these projects. Environmental impacts are deforestation, soil erosion, disturbance to the biodiversity, loss of habitat, degradation of water quality in downstream, etc. Massive deforestation for building canals may result in negative impact on rainfall and in turn affect biodiversity (Babu and Padmavathi 2016). The interlinking of rivers may lead to an increased frequency of earthquake (Mehta and Mehta 2018) as a result of the construction of large dams for interlinking. There are also concerns over pollution load which may be shifted to a less polluted river due to interlinking of the heavily polluted river to relatively less polluted one. In case the river pollution has some toxic element, this may prove to be disastrous for the biodiversity as well as humans (Mehta and Mehta 2018). It has also been reported that the reduction in volume of fresh water in the sea will negatively affect the biodiversity of the estuaries. Biodiversity of fishes will also be affected as there may arise dominance of invasive species from northern rivers by displacing the endemic species of peninsular rivers after these rivers are interlinked (Babu and Padmavathi 2016). There will be influence on turbidity, flow and depth of rivers which will further causes changes in breeding grounds of fishes causing their migration (Babu and Padmavathi 2016). There are various social impacts such as displacement of local people who needs proper rehabilitation.
and proper compensation for the loss of livelihood and land. This project will also strain our relation with our
neighbouring countries like Bangladesh, Bhutan, and Nepal as they are apprehensive of loss of water availability
to them which might occur due to ILR projects. This will lead to submergence of land, forest, destruction of
rivers biodiversity, concentration of pollution, destruction of groundwater, etc.

Rivers change their course naturally mainly due to flood (Mahmood et al. 2015, Maurya and Yadav 2016), so
the entire exercise done for interlinking will prove futile and the whole process will have to be repeated to link
the rivers again which will again involve large economic, social and environmental costs. NRLP has determined
annual flow volume according to which they have classified the surplus and deficit area. But there is seasonal
flow variability that needs to be considered as most of the peninsular rivers are rain-fed rivers (Smakhtin et al.
2008). There are concern about the coastal erosion and salt water intrusion (Smakhtin et al. 2008) which reduc
land productivity. Bharati et al. (2008) warned that water deficits areas may be interchanged and suggested
introduction of low water intensive crops during dry season as an alternative to ILR project.

5. Present projects and their status

There are 5 priority project links identified by NWDA:

1. Ken-Betwa Link Project
2. Damanganga-Pinjal Link Project
3. Godavari (Inchampalli)-Cauvery (Grand Anicut) Link Project
4. Par-Tapi-Narmada Link Project
5. Kosi-Mechi Intra State Link Project

5.1. Ken–Betwa basin

Ken-Betwa River interlink, which will link Ken River with Betwa river in Bundelkhand region (as shown in Fig.
3), is one of the first interlink which was initiated. It will provide irrigation around 10.62 billion square meter
area of which 8.11 billion square meter is in Madhya Pradesh and 2.51 billion square meter lies in Uttar Pradesh.
It will also provide domestic water supply for 6.2 million (MP-4.1 million, UP-2.1 million) population
and will also generate 103 MW of Hydro and 27 MW of Solar power. However there are several environmental
and social issues which are associated with the project. Construction of Daudhan dam will lead to 90 million
square meter area getting submerged, including 58.03 million square meter of Panna Tiger Reserve. This
constitutes 7.6% of the total Panna Tiger Reserve area of which 41.41 million square meter is of forest area
(NWDA). This will lead to great loss of habitat for various species of plants and animals. The loss of
biodiversity cannot be compensated.

Figure 3. Proposed Ken Betwa River Link canal.
Various studies have assessed the risks and hazards due to the interlinking of Ken-Betwa. Study by Avtar et al. (2011) found that the interlinking of Ken-Betwa will negatively impact the downstream of the Ken River and the highest impact will be found near the dam region and the Panna tiger reserve forest. However, the Betwa basin will be the least impacted negatively. The rest of the area comes under the medium impact zone. The study also highlighted the fact that waterlogging and construction of dam will cause disturbance in the natural ecological balance (Avtar et al. 2011) which will further cause land degradation which in turn affect cropping pattern. In this project, the reservoir (Greater Gangau Weir) will negatively impact the land in the vicinity of the reservoir edge (Avtar et al. 2011).

Similarly Goparaju et al. (2017) analysed the Landsat 8 OLI data of the proposed Daudhan/Greater Gangau Dam and found lacunae in the results of EIA– EMP report of the Ken-Betwa link project, Phase I when they compared it with their study. They found there is a risk of submergence of the Panna Tiger Reserve which will endanger the lives of various animals and plants (Goparaju et al. 2017). They suggested that Geospatial technology (including remote sensing and GIS) will help in minimizing the loss as they will help in better prediction of spatial view of the proposed submergence area which will help in taking mitigation measures (Avtar et al. 2011; Goparaju et al. 2017). This will resolve not only environmental issues related to the project but will also find out solutions to socio-economic issues related to the project (Avtar et al. 2011).

5.2. Damanganga-Pinjal Link Project

It will link Damanganga River at Bhugad and Khargihill reservoir to Pinjal reservoir in Vaitarna basin as shown in Fig. 4. The collective water of Damanganga and Pinjal rivers is diverted to Mumbai to meet the domestic requirement of Mumbai. The total water supply from this link and Pinjal project shall be 2451 MLD (millions of liter per day) along with the generation of 5MW of hydropower. NWDA has completed the Detailed Project Report (DPR) but there are issues between Govt. of Maharashtra and Gujarat which needs to be resolved for building consensus. There are problems regarding the construction of link tunnel as the presence of plateau in the Sahyadri Hills is interspersed with many weak zones (Thanvellu et al.). For example, Thanvellu et al. reported seven weak zones in the Bhugad-Khargihill and Khargihill- Pinjal section has 12 weak zones where link tunnel will be constructed (Thanvellu et al.). According to their study, 0.4% of the total length of the tunnel was found to be hazardous due to very poor tunneling media (Thanvellu et al.).

Figure 4. Proposed Damanganga-Pinjal Link canal.

5.3. Godavari (Inchampalli)-Cauvery (Grand Anicut) Link Project

It comprises of three links (namely Inchampalli, Nagarjunasagar and Somasila) to connect Godavari – Cauvery as shown in Fig. 5. This link project connects Godavari, Krishna, Pennar, Palar and Cauvery basins and will cover the States of Telangana, Andhra Pradesh and Tamil Nadu. According to NWDA, it will divert 7000 million cubic meters (MCM) of water annually from Godavari basin to Krishna, Pennar and Cauvery basins. It will provide Annual irrigation of 9.44 billion square meter. However, there are disagreements between the party states which need to be resolved for the implementation of this link. Smakhtin et al. (2008) found that this project will have adverse effect on the Singaram Sanctuary and cause submergence of 650,000 square meter land of the Indravati National Park but it does not have any endangered species. Coastal erosion and sea water intrusion may also be the possible result of these projects in Godavari and Krishna basin (Smakhtin et al. 2008). Inchampali Dam faces the problem of loss of water due to evaporation and sedimentation causing reduction in flow of river as well as shrinking of deltas (Smakhtin et al. 2008).
5.4. Par-Tapi-Narmada Link Project

Par-Tapi-Narmada and Damanganga-Pinjal Link Projects are both associated with Maharashtra and Gujarat (as shown in Fig. 6). Par-Tapi Narmada Link Project will benefit Gujarat while Damanganga-Pinjal Link Project will benefit Maharashtra. According to NWDA, this link proposes to provide 1330 MCM of water annually and provide Annual Irrigation of 2.32 billion square meter (2.28 billion square meter in Gujarat State and 0.04 billion square meter in Maharashtra State), 76 MCM of drinking water supply to about 2.75 million human population and 60 MCM of water for local domestic use from each reservoir and 21 MW of hydropower.

The DPR of Par-Tapi-Narmada link project was completed in 2015 which was modified according to suggestions of Govt. of Gujarat to include more tribal areas in the command area (NWDA).
There are conflicts regarding water sharing between the Government of Maharashtra and Gujarat which is causing delay in implementation of the project. This delay due to interstate political issues causes huge loss economically since there is increase in the cost of construction of reservoirs and dams due to the inflation in the cost of raw material, labour rate. Mehmood et al. (2014) has also reiterated the fact that there will be severe impact on land use pattern due to construction of seven reservoirs. Kelwan dam will cause submergence of villages Bhondya and Engnipada (Kolbari) villages completely at proposed FRL 144 m (Mehmood et al. 2014). The flood in Par basin has been found to occur more when there is above average rainfall (Patil and Hire 2020) while during below average rainfall it experiences very few floods. In case of deficiency in rainfall the river Par will not have surplus water to provide to the link canal.

5.5. Kosi-Mechi Intra State Link Project

It proposes diversion of surplus 148 cumeecs of water from Eastern Kosi Head Regulator for irrigating 2.15 billion square meter area in Araria, Purnia, Kishanganj and Katihar districts of Bihar (depicted in Fig. 7). The DPR of Kosi – Mechi intra-State link project was completed in March 2014. However Kosi is infamous for changing it course frequently which will make the link worthless and new link will be required to be constructed every time the river changes its course. Another major concern is that submergence of fertile land of Nepal and displacement of people over 300 km of very large link canals (Kosi-Mechi and Kosi-Ghagra Link) (Pun 2009).

![Proposed Kosi-Mechi Intra State Link Project.](image)

6. Risk associated with various river projects

Various river projects like hydropower projects are associated with numerous risks and environmental hazards which are unforeseen. They are subjected to sudden natural disasters like flood, earthquake, landslides which may cause irreparable damage to the project causing loss of life and property. There are serious concerns like problem of sedimentation, reservoir induced seismicity, loss of agricultural land which causes social distress due to loss of livelihood, resettlement issues, loss of wildlife and aquatic biodiversity (Chaurasiya et al. 2013). Hydropower projects causes change in flow and water quality of river that may lead to restriction in movement of aquatic fauna (Opperman et al. 2022). Climate change induced water scarcity and drought may lead to failure of many hydropower projects (Opperman et al. 2022). Huber et al. (2017) has emphasized on the social divide induced by various hydropower projects that causes vulnerable and poor section to face the dam safety risks.
7. Conclusion

There are numerous risks and hazards associated with the interlinking of rivers which need to be properly assessed and taken care of while implementing the project. The Government of India is serious about implementation of the interlinking project and has prioritized 5 projects. These projects have their own issues and challenges which are hindering the timely completion of the project. The common issue with interstate projects is disagreement between the states regarding sharing of water as surplus states do not want to share water with deficit state fearing that they will lose their precious resource. Some of the projects are facing environmental challenge as this may lead to submergence of forest area, like Panna tiger Reserve in case of Ken-Betwa link, which will be huge loss to environment and biodiversity. The social risks associated with these projects are displacement of people due to submergence of numerous villages needs to be rehabilitated properly by providing them compensation and employment so as to reduce the distress faced by them due to sudden relocation and loss of livelihood. Even after completion of the project there will be serious risks associated with flooding caused by deposition of sediments in reservoir. NWDA while implementing the projects need to seriously consider all these factors and take measures to address them. It also needs to address the concern of various states project wise which will help them bring consensus and cooperation for timely completion of these projects.

8. ACKNOWLEDGEMENTS

The authors are thankful and wish to express deep sense of gratitude to Dr. R. S. Kankara, Director, Central Water and Power Research Station (CW&PRS) for constant encouragement and valuable suggestions.

9. REFERENCES


