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Interlinking feasibility of five river basins of Rajasthan in India☆

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Summary The increasing population and large scale growth with the development of modern science and technology has indicated very high stress on water sector in Rajasthan in India. Availability of water and uniformity of rainfall distribution is changing day by day due to shifting of monsoon in Rajasthan. The spatial and temporal variations in the rainfall in different river basins in Rajasthan are drastic due to which flood situation arises in the tributaries of Chambal river basin every year. Simultaneously on the other hand drought situation arises in the other different places in the most of the river basins which are also under dark zone. In totality natural water resources are also limited in Rajasthan so there is an urgent need for its proper planning, development and management of the available water duly taking care of environmental, ecological, socio-economic aspects and their inter-relationships.

Annual surplus water of about 1437 MCM in the river Chambal is going waste and ultimately reaches to sea after creating flood situations in various places in India including Rajasthan, while on the other hand 1077 MCM water is a requirement in the four other basins in Rajasthan i.e. Banas, Banganga, Gambhir and Parbati at 75% dependability. Interlinking and water transfer from Chambal to these four river basins is the prime solution for which 372 km link channel including 9 km tunnel of design capacity of 300 cumec with 64 m lift is required.

Introduction

Water, land and air are the Natural assets which are very essential and much affects the quality of flora and fauna in the in the biosphere on the Earth. The land and water resource in India are sufficient but their space and time distribution is not coinciding with the requirements for

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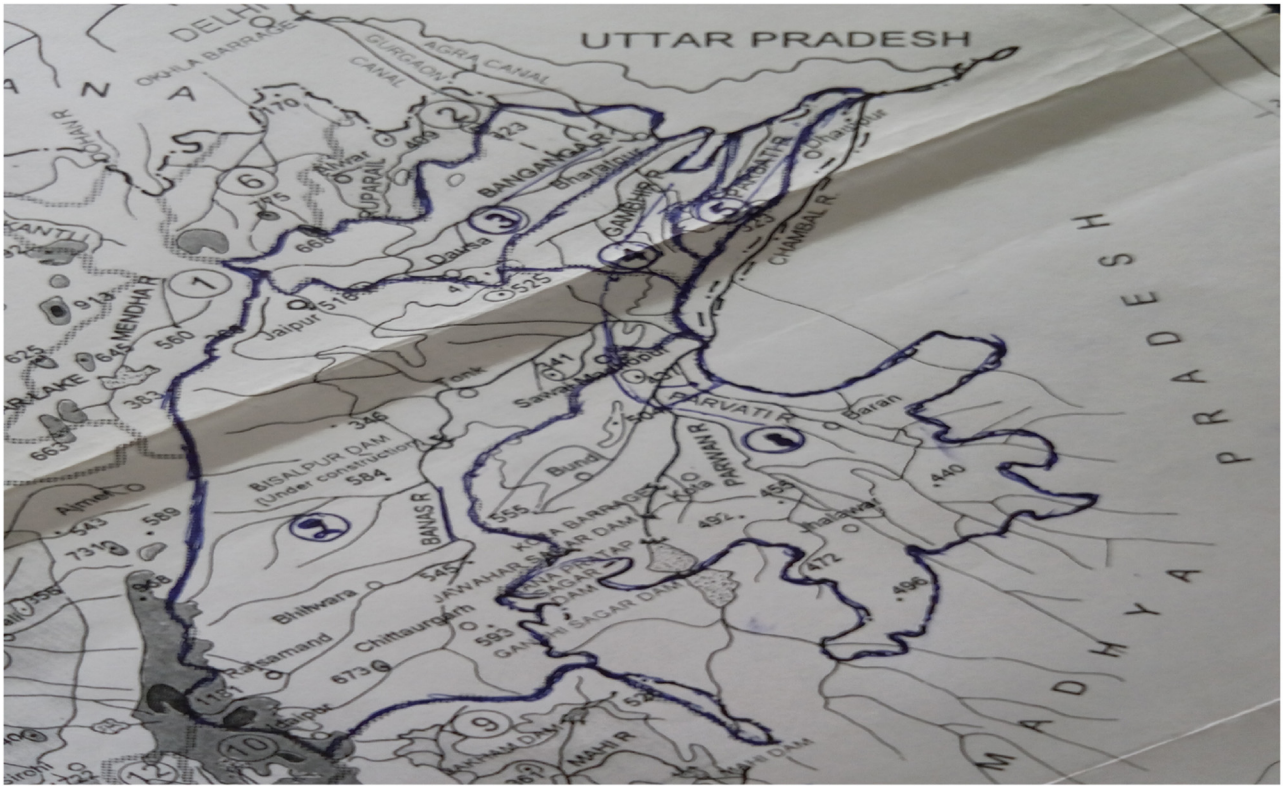

Figure 1 Index map showing the five interlinking river basins of Rajasthan State.

irrigation, domestic and industrial purposes. Fertile and usable land can never be shifted from deficit water basin to the surplus water basin so the only solution is to inter-basin transfer of water when and wherever it is required. Water budget of the region or basin is decided on the basis of the water status of the region whether it is water-surplus, water-sufficient or water-deficit. The national water policy also weights for inter-basin water transfer from surplus basin to the deficit basins based on the status of water in the interlinking basin (Prakasa Rao et al., 2010). Water transfer aids to counteract the problems arising from the mismatch between requirement and availability in different river basins of India (Jain et al., 2008).

The inter-basin water transfer is only possible if the donor basin has surplus water determined on the basis of availability at 75% dependability including import, export and the existing and future needs of the basin. For most effective surface water management the interlinking should be technically feasible, economically viable and environmentally sound enough with the sustainable development of the deficit basin. Willingness of the politicians and perceptions of the people of both the donor and the acceptor basin is also very important because these will be two opposition parties.

The interlinking concept for the five river basins of Rajasthan in India is planned to connect lower areas of Chambal basin with the lower areas of Banas, Gambhir, Banganga and Parbati basins and is shown in Fig. 1. These all rivers join the Yamuna, Ganga and ultimately to Bay of Bangal.

Water resources status in Rajasthan

The spatial distribution of rainfall in India is uneven. The highest normal annual rainfall of 1152 cm. in the world has been recorded in Mausinram (Meghalaya) while the western part of Jaisalmer (Rajasthan) is one of the driest part of the world recorded 9 cm of rainfall in a year. There is a wide contrast in the amount of rainfall received by different parts of the country. Rajasthan state which receives very low rainfall, is the largest state in India and divided in two distinct areas by Aravalli Mountains range which is spread from south-west to north-east. The western side area is dry, sparsely populated, the rain water flows in westward direction and ultimately reaches to Arabian Sea and mostly relies on imported surface water brought by Indira Gandhi Canal. The eastern side part is humid, densely populated, the rain water flows north-eastly to the Ganga and reaches to Bay of Bangal. Rajasthan is having 10.41% area of India, 5.5% population of India but only 1% water quantity of India. The average annual rainfall in the state is 53.1 cm. Rajasthan has diverse geological conditions as minimum annual average rainfall, lack of perennial rivers, famine and drought conditions, scarce under-ground resources. The 60% area of the state is under inland rivers. The 90% population of the state and 60—70% agricultural activities are dependent upon surface water resources. The environmental causes as global warming and manmade causes as increasing population, food grain production, industrialization, urbanization etc. are causing threat to the water resources. All these reasons are making the survival of the man and

bio-diversity in Rajasthan very difficult. The water resources in Rajasthan are scarce and the demand is evident. Hence it is an urgent need for its proper planning, development and management of the available water duly taking care of environmental, ecological, socio-economic aspects and their inter-relationships.

Hydrology of the interlinking basins

Water availability in the water surplus basin

Parwati, Kalisindh, Mej and Chakan tributaries of Chambal river basin have surplus water which after meeting the Chambal, Yamuna and Ganga ultimately wastes to the Bay of Bengal. This wasted/surplus water available in Chambal river basin can be inter-basin transferred to the deficit areas placed in Banas, Gambhir, Banganga and Parbati river basins by constructing a link channel. The average levels of the areas of various basins which are to be interlinked in the range of 200—300 m.

The Barod discharge gauge site on Kalisindh river and Khatoli discharge gauge site on Parwati river are truly representing the discharge at water off-taking point. The combined 75% dependable total surplus water based on 10 daily discharge of Kalisindh and Parwati rivers is 2451 MCM.

Net Surplus water available through the Kalisindh, Parwati, Mej & Chakan tributaries of Chambal at 75% dependability on the basis of SWAT Model from the only Rajasthan catchment is 1437MCM.

Since Madhya Pradesh may construct any project in the up-stream of the proposed interlinking, so the minimum available water of 1437 MCM can be transferred to the other deficit basin. The channel is unlined so assuming 30% enrouted losses, the net available water is 1006 MCM.

Water requirement in the water deficit basins

The water requirement in the proposed four deficit basins for drinking water for 550 villages, towns and cities is 100 MCM, industrial requirement is 150 MCM, irrigation requirement and filling the enrouted tanks is 827 MCM. The total extra requirement is 1077 MCM. Thus as per the tentative final canal alignment, the total water requirement is 1077 MCM against the net utilizable available water of 1006, which is 107% of total proposed diverted water.

Main structures required for interlinking the proposed five river basins

For diverting surplus water available in the tributaries of Chambal river to the enrouted tanks in Banas, Gambhir, Banganga and Parwati basin following works are proposed.

1. *Dam at Kalisindh river*: a dam at the location 25°19′00″ (latitude) and 76°34′00″ (longitude) is proposed across Kalisindh river with gross storage capacity 80 MCM & live storage capacity 70 MCM respectively. The lowest bed level of the river is at elevation 217 m and the top of the dam is at elevation 230 m. The length of the dam is 1000 m.
2. *Dam at Parwati river*: a dam at the location 25°14′00″ (latitude) and 76°15′00″ (longitude) is proposed across Parwati river with gross storage capacity 60 MCM & live storage capacity 48 MCM respectively. The lowest bed level of the river is at elevation 210 m and the top of the dam is at elevation 230 m. The length of the dam is 1000 m. It is proposed to divert inflow of Parwati river to Kalisindh river through the proposed feeder channel. The feeder channel will off-take at elevation 215 m from this dam. It will join river Kalisindh at elevation 206 m.
3. *Feeder channel*: it is proposed to construct a feeder channel of approximately 24 km length from Parwati dam to the Kalisindh river on the up stream of the proposed pick up weir. The proposed discharge to be diverted from this feeder channel is 300 cumecs. The water shall be diverted from the month of July to September
4. *Pickup weir*: a Pick weir at the location 25°29′30″ (latitude) and 76°19′00″ (longitude) has been proposed on Kalisindh river down stream of Kalisindh dam near Aibra village in Kota district. The top level of the pick-up weir shall be 222 m whereas the lowest level shall be 205 m. Hence the height of the pick-up weir will be 17 m. The water shall be diverted from this pickup weir to the channel at an elevation of 220 m.
5. *Aqueduct across river Chambal*: the diverted water shall be transferred to the left bank of Chambal by constructing an aqueduct having capacity of 300 cumecs.
6. *Pumping station*: water is to be lifted at three places having total lift as 64 m for which three pumping stations are proposed that requires roughly 332.12 MW energy along the alignment of channel.
7. *Carrier channel*: it is proposed to construct 348 km long channel to feed the enrout tanks & proposed schemes on river Chambal.
8. *Fall*: there are two places along the alignment where two falls are proposed to carry the water.
9. *Tunnel*: a tunnel of 9 km length will be constructed.
10. *Other structures*: it is proposed to construct 7 large structures which are aqueduct across big rivers and rail lines. Approximately 174 small structures mainly cross drainage works are proposed to be constructed along the alignment.
11. *Channel details*: a channel of discharging capacity 300 cumecs having bed width 50 m, FSD 5 m, free board 1.5 m, side slope 1.5:1, longitudinal slope 1 in 10 000, design velocity 1.05 m/s and Manning coefficient 0.025 have designed.

Benefits and important aspects of this interlinking project

1. It will fulfill the drinking, industrial and irrigation requirements in the Sawai-Madhopur, Dausa, Jaipur, Alwar, Bharatpur, Karauli and Dholpur districts in Rajasthan.
2. Project will fulfill the water deficit of the enrouted existing Irrigation Reservoirs/Tanks.
3. It will mitigate the drought and flood situation in the vicinity of proposed Channel and the interlinked basins.

Interlinking of these five river basins will certainly be fruitful for sustainable development of this region.
4. It will help in raising the Ground Water Table along and near-by areas of the proposed Channel that comes under dark zone.
5. Controlled drought and flood situations will provide the balanced micro-climate/environment in the Crocodile Santury which is declared on Chambal from Kota Barrage to Dholpur.
6. The proposal on completion shall assure drinking water supply to approximately 550 number of cities, towns and villages including capital city Jaipur even in the drought affected years to fulfill the objective of welfare state.

Limitations of this interlinking project

Although benefits are more but some of the following limitations are also here —

1. The surplus water available in the Kalisindh and Parbati rivers is available for 72 days short duration period in the month of July, Aug. & September. Therefore, the diversion of water to fulfill the demands of deficit basins and to replenish the storage of proposed tanks shall be carried out in these 72 days, irrespective of the inflow in these tanks by their own catchment. Other than these 72 days, the assets i.e. diversion channel, pump house will remain idle for rest of the year which will need constant watch and ward.
2. Though final alignment of channel was decided in the best possible route to avoid the forest area. As per the proposed alignment 4 km length of the diversion channel will pass through the protected or reserved forest. Besides a small forest land will also be affected by storage reservoirs and pick up weir. The clearance from the Ministry of Environment and Forest, Government of India will be needed. Similarly the Chambal river is declared as crocodile sanctuary and to cross the Chambal river, an aqueduct is to be constructed which will also need the clearance from National Wild Life Board & Further from C.E.C.
3. The 372 km length of diversion channel will require land acquisition. Tentatively 70% of land has been considered as private land. The acquisition of this private land with new land acquisition act is a difficult task.
4. The diverted water is to be lifted for which additional electric power energy is required.
5. There will be higher annual operation & maintenance cost.
6. The project will involve crossing of major rivers, many small streams and railway lines. The cost of such CD works will be higher. Besides, for communication and transportation on both sides of channel, a number of district road bridges, village road bridges, etc. shall be required.
7. Drinking & nonirrigation requirement are to be fulfilled through-out the year, therefore the storage area for the demand of remaining period of the year will have to be explored.

Conclusion

Rajasthan has diverse geological conditions as minimum annual average rainfall, lack of perennial rivers, famine and drought conditions, scarce under-ground resources due to that the survival of the man and bio-diversity in Rajasthan is very difficult. The dams and diversion channels should be planned in such a way that least submergence of fertile agricultural land and valuable forest land is used. The water resources in Rajasthan are scarce and the demand is evident. Hence it is an urgent need for its proper planning, development and management of the available water in Rajasthan duly taking care of environmental, ecological, socio-economic aspects and their inter-relationships.

The surplus water available in Chambal river basin creates flood situation every year in the Chambal vicinity while the other four basins are facing the drought situation. Water is lifted from the Rajasthan boundary and carried through the Rajasthan area so the approval of the neighboring states is not required. This is intra-state interlinking project which will connect the area of five River basins of Rajasthan i.e. Chambal, Banas, Gambhir, Banganga and Parbati river basins. Thus this surplus water certainly utilized in any aforesaid four deficit basins in Rajasthan. This proposed interlinking project is very fruitful and essential for the sustainable development of these five river basins in Rajasthan.

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