

Sustainable Solution for Augmenting Domestic Water Supply in Urban Areas through Inter Basin Water Transfer

S/Shri M K Srinivas, G A Rajkumar, P V Ramaraju

National Water Development Agency, New Delhi, India

srinivasmk@rediffmail.com

Keywords

Urban Water Supply, Inter Basin Water Transfer, National Perspective Plan, Inter Linking of Rivers, Dams

ABSTRACT

The Department of Economic and Social Affairs of United Nations has estimated that more than half of the world population resides in urban areas. As per the census of India – 2011 the level of urbanization has increased from 27.81% (2001 Census) to 31.16% (2011 Census) while the Greater Mumbai with a population of 184.14 lakhs continues to be India's biggest city. As per the assessment of Municipal Corporation of Greater Mumbai (MCGM), there will be a gross shortage of about 1053 Mm³ of water for the domestic requirements of Mumbai. Preliminary water availability studies carried out by National Water Development Agency (NWDA) for the west flowing river basins between north of Mumbai and south of Tapi revealed that surplus waters are available in the Damanganga basin at the proposed Bhugad and Khargihill dam sites which can be transferred for augmentation of water supply to Greater Mumbai to meet its domestic needs. Damanganga – Pinjal (D-P) link proposal was taken up by NWDA for establishing its feasibility in diversion of surplus waters of Damanganga and Vaitarna basins to Greater Mumbai city. A tripartite Memorandum of Understanding was signed by the states of Gujarat and Maharashtra and the Union Government in May, 2010 in the presence of the Hon'ble Prime minister of India at New Delhi for preparation of Detailed Project Report (DPR) of D-P link project. D-P link project envisages construction of two dams viz., one across river Damanganga near Bhugad village and another at Khargihill across river Vagh (a tributary of Damanganga) along with two tunnels connecting Bhugad reservoir with Khargihill reservoir and Khargihill reservoir with Pinjal reservoir. The basic objective of D-P link being augmentation of the domestic water requirements of the Mumbai city as such the project has been planned at 100% dependable water availability. Based on studies it has been ascertained that about 210 Mm³ water from Bhugad reservoir and about 369 Mm³ of water from Khargihill reservoir (total 579 Mm³ from Damanganga basin) at 100% success rate, can be transferred to Pinjal reservoir. Thus the combined surplus waters of Bhugad and Khargihill reservoirs of Damanganga basin to the extent of 579 Mm³ along with surplus waters available at Pinjal reservoir of Vaitarna basin (316 Mm³) totalling to about 895 Mm³ can be transferred through D-P link to Mumbai city for augmenting its domestic needs. The combined surplus waters of Damanganga and Pinjal rivers will be taken further to Mumbai city as per the planning of MCGM and Mumbai Metropolitan Regional Development Authority (MMRDA). The preparation of DPR of the D-P link project envisaging various Survey & Investigation and consultancy studies is under progress. In view of the acute scarcity & stressed water conditions prevalent owing to rapid increase in population and depletion of natural water resources in urban areas, the augmentation of domestic water needs in urban areas can be tackled effectively through provision of surface water even if it has to be transferred through long distance pipe lines. As we near the time when water has to be arranged at any cost, transfer of surface water through interlinking of rivers appears to be a sustainable solution.

1.0 INTRODUCTION

The Department of Economic and Social Affairs of United Nations has estimated that more than half of the world population resides in urban areas. The world population is expected to increase by 2.3 billion between 2011 and 2050 and the urban areas of the world are expected to absorb the population growth in the next four decades while at the same time drawing in some of the rural population. The report of the United Nations "World Urbanization Prospects – The 2011 revision", depicts that, by 2020, half of the population of Asia will live in urban areas.

1.1 India & Urbanization

As per the census of India – 2011, the population has increased from 102.9 crores (2001 census) to 121.0 crore. The population of India as per 2011 census in comparison to 2001 census duly indicating the Rural-Urban distribution is presented in Table 1.0 below.

Table 1.0 Population (in Crore) (as per Census 2011)			
	2001	2011	Difference
India	102.9	121.0	18.1
Rural	74.3	83.3	9.0
Urban	28.6	37.7	9.1

Since Independence, this is the first occasion which has witnessed the absolute increase in population more in urban areas than in rural areas. Further, as per the census of India – 2011, the level of urbanization has increased from 27.81% (2001 Census) to 31.16% (2011 Census). The increase in urbanization can primarily be attributed to rural-urban migration, extension of existing areas as 'Urban' & to a natural increase. The tendency of steady upward revision levels in urbanization, though could be seen as an indicator of economic development & progress of the country also demands the attention of the scientific & engineering fraternity to provide feasible, assured and long term solutions to the already water stressed scenario so as to ensure sustainable & efficient domestic water supply in urban areas.

1.2 Inter Basin Water Transfer for Effective Water Resources Management

The availability of water is scarce with steady increase in demand of water owing to increasing population, rapid urbanization, etc. and hence there is an immense necessity to augment water availability for domestic utilization. Also, the National Water Policy evolved by Government Of India (GOI) in 1987 and revised in April 2002 emphasizes the need for Inter Basin Water Transfer (IBWT) while assigning highest priority for drinking water supply needs followed by irrigation, hydro-power, navigation, industrial and other uses.

2.0 NATIONAL PERSPECTIVE PLAN

The National Perspective Plan (NPP) for Water Resources Development formulated in 1980 by Ministry of Irrigation (now Ministry of Water Resources) and Central Water Commission (CWC) envisages IBWT from surplus to deficit basins to minimize the regional imbalances and optimally utilize the available water resources. The NPP comprises of two components: (a) Himalayan Rivers Development (b) Peninsular Rivers Development.

(a) Himalayan Rivers Development:

Envisages construction of storage reservoirs on the principal tributaries of the Ganga and Brahmaputra in India, Nepal and Bhutan along with inter-linking canal systems.

(b) Peninsular Rivers Development:

This component is divided into four major parts viz., (i) Interlinking of Mahanadi-Godavari-Krishna-Pennar-Cauvery rivers and building storages at potential sites in these basins (ii) Interlinking of west flowing rivers, north of Mumbai and south of Tapi (iii) Interlinking of Ken-Chambal Rivers and (iv) Diversion of other west flowing rivers.

The NPP is estimated to provide additional irrigation benefits of 35 Million hectare over & above the ultimate irrigation potential of 140 Million hectare along with generation of 34 Million KW of power, apart from the benefits of flood control, navigation, water supply, fisheries, salinity, augmentation of flow at Farakka and pollution control etc.

To give a concrete shape to the NPP of GOI, the NWDA, an autonomous society under the Ministry of Water Resources was set up in 1982, with a mandate to promote optimum utilization of water resources of country. NWDA after carrying out detailed studies assessing the quantum of availability of water resources in various river basins/sub-basins of India, on a scientific & realistic basis, firmed up 30 IBWT proposals viz., 14 under Himalayan component and 16 under Peninsular component. The figure showing the IBWT proposals both under the Himalayan & Peninsular component is enclosed as Fig.1.

3.0 STEADY URBANIZATION OF MUMBAI – CHALLENGES & INITIATIVES

As per the Census 2011, Greater Mumbai with a population of 184.14 lakhs continues to be India's biggest city. Looking at the trend of development in Greater Mumbai it is predictable that there would be acute shortage of domestic & industrial water needs by the year 2050. As per the assessment of MCGM, the projected domestic water demand for Greater Mumbai will be 2555 Mm³ while the cumulative water supply available from various sources including from middle Vaitarna, Bhatsa and Gargai projects would be 1502 Mm³. Thus, there will be a gross shortage of about 1053 Mm³.

3.1 Study by NWDA

Preliminary water availability studies carried out by NWDA for the west flowing river basins between north of Mumbai and south of the Tapi revealed that surplus waters are available in the Damanganga basin at the proposed Bhugad and Khargihill dam sites which can be transferred for augmentation of water supply to Greater Mumbai to meet its domestic needs. In consonance to the above findings, D-P link proposal which is one of the 16 link proposals of Peninsular Rivers Development Component under NPP was taken up by NWDA for establishing its feasibility in diversion of surplus waters of Damanganga and Vaitarna basins to Greater Mumbai city for augmentation of its existing water resources, keeping in view of its future domestic and industrial water requirements.

The Feasibility Report of D-P link project was prepared by NWDA during November, 2004 and consensus was arrived amongst the Central Government and beneficiary states viz., Gujarat and Maharashtra for preparation of DPR of D-P link project. A tripartite Memorandum of Understanding was signed by the states of Gujarat and Maharashtra and the Union Government in May, 2010 in the presence of the Hon'ble Prime minister of India at New Delhi for preparation of DPR of D-P Link Project.

The present paper enumerates the details of the above studies which contemplate augmenting the domestic water supply needs of Mumbai City through the D-P link project.

4.0 AUGMENTING DOMESTIC WATER SUPPLY NEEDS OF MUMBAI CITY THROUGH D-P LINK PROJECT – A CASE STUDY

D-P link project envisages construction of a dam across river Damanganga near Bhugad village in Peint taluka of Nasik district of Maharashtra; a dam at Khargihill across river Vagh (a tributary of Damanganga) near village Behadpada in Mokhada taluka of Thane district of Maharashtra state; a dam across river Pinjal near village Khidse in Wada taluka of Thane district (proposed by Government of Maharashtra) and 2 tunnels connecting Bhugad reservoir with Khargihill reservoir and Khargihill reservoir with Pinjal reservoir. The layout plan of the D-P link project is enclosed as Fig.2. The basic objective of D-P link being augmentation of the domestic water requirements of the Mumbai city as such the project has been planned at 100% dependable water availability.

4.1 Water Availability

Hydrological studies of Damanganga basin have been carried out as a whole and also up to the proposed Bhugad and Khargihill dam sites to assess the water balance position at the ultimate stage of development (by the year 2050 AD). The gross annual yield series for the entire Damanganga basin up to Vapi railway bridge was developed using the virgin discharge data of Vapi G&D site for the period from 1975 to 2004 while the gross annual yield series for the proposed Bhugad and Khargihill dam sites have been developed for the period from 1975 to 2008 based on observed discharge data at Nanipalsan and Ozarkhed G&D sites respectively which are located near d/s of the proposed dam sites. For Pinjal dam the observed discharge data is available for a considerably long period and as such yield series has been developed for the period 1975 to 2008. The average, 50%, 75% and 100% dependable annual gross yields at above locations is indicated below in Table 2.

Table.2 Gross Yield in MCM

	At Bhugad Dam site	At Khargihill Dam site	At Pinjal Dam site	For Whole Damanganga Basin
Average Yield	785	978	684	3335
At 50% dependability	733	929	655	3223
At 75% dependability	518	734	515	2547
At 100% dependability	372	471	420	1839

The net water availability at average, 50%, 75% and 100% dependabilities at the diversion points (Bhugad and Khargihill dams) assessed after considering all the consumptive upstream utilization planned by states for irrigation, hydropower Reservoir evaporation losses, domestic & Industrial requirements, down-stream committed releases and return flow as regeneration from domestic and industrial uses, is indicated below in Table 3.

Table.3 Net Yield in MCM

	At Bhugad Dam site	At Khargihill Dam site
Average Yield	668	865
At 50% dependability	610	810
At 75% dependability	395	615
At 100% dependability	284	395

Thus as seen from the Table 3 above about 679 Mm³ of water (284 Mm³ and 395 Mm³ available at proposed Bhugad and Khargihill dam sites respectively) at 100 % dependability is available in Damanganga basin at the proposed Bhugad and Khargihill reservoirs for transfer to Pinjal reservoir. To assess realistically the quantity that can be diverted from Bhugad and Khargihill reservoirs to Pinjal dam for augmenting the drinking water supply to Mumbai city, simulation analysis considering the inflows, local demands, committed down-stream releases has been carried out for the period from 1975 to 2004.

Based on the results of the simulation analysis it has been ascertained that about 210 Mm³ water from Bhugad reservoir and about 369 Mm³ of Water from Khargihill reservoir (total 579 Mm³ from Damanganga basin) at 100% success rate, can be transferred to Pinjal reservoir. Thus the combined surplus waters of Bhugad and Khargihill reservoirs of Damanganga basin to the extent of 579 Mm³ along with surplus waters available at Pinjal reservoir of Vaitarna basin (316 Mm³) totalling to about 895 Mm³ can be transferred through D-P link to Mumbai city for augmenting its domestic needs.

4.2 Components of D-P link

The principal components of the D-P link project are as follows.

- A 851.50 m long dam across river Damanganga near village Bhugad with FRL 163.9 m and corresponding gross storage capacity of 400 Mm³.
- A Power house at the toe of Bhugad dam with 2 units each of 1.0 MW installed capacity each.
- A 572.80 m long dam at Khargihill across river Vagh (a tributary of Damanganga river) near village Behadpada with FRL 154.5 m and corresponding gross storage capacity of 426.7 Mm³. A saddle dam of 272 m length and 21.35 m height with FRL 154.5 m on the left flank of the reservoir.
- A Power house at the toe of Khargihill dam with 1 unit of 0.6 MW installed capacity and 2 units of 1.0 MW near tunnel.
- A tunnel of about 16.85 km long with 5.0 m diameter connecting Bhugad reservoir with Khargihill reservoir.

- A tunnel of about 25.7 km long with 5.25 m diameter connecting Khargihill reservoir with Pinjal reservoir.
- A 545 m long dam across river Pinjal (a tributary of Vaitarna river) proposed by Government of Maharashtra near village Khidse with FRL of 141 m and corresponding gross storage capacity of 418 Mm³ and a saddle dam of about 190 m long and 11.4 m high on the right flank.

The combined surplus waters of Damanganga and Pinjal rivers will be taken further to Mumbai city as per the planning of Municipal Corporation of Greater Mumbai and Mumbai Metropolitan Regional Development Authority. The Schematic diagram of the entire conveyance system as envisaged in D-P link is enclosed as Fig.3

4.3 Environmental Impact Assessment & Management Plan

(i) Ecological Aspects

Various issues such as the impacts on flora and fauna, degradation of riverine ecology, impacts on rare, endangered and threatened species, terrestrial flora, wildlife movement, diversity and productivity of flora, economically / genetically / biologically important plant species, compensatory afforestation, reservoir rim treatment plan, catchment area treatment plan, Dam Break Analysis and Disaster Management etc., are being addressed in the Environmental Impact Assessment (EIA) studies being carried out as part of the preparation of DPR for the link project.

(ii) Socio-economic Aspects

Construction of two reservoirs proposed under D-P link will submerge an area of about 3461 ha out of which cultivated land is 1348 ha, forest land is 1624 ha and river portion is 489 ha, affecting about 4530 people and livestock of about 3450. The no. of villages likely to be affected fully is 1 and partially affected are 23.

The EIA studies are being carried out basically to assess all the positive and negative impacts of the project on the environment and livelihoods of the people. Based on these studies, detailed Rehabilitation & Resettlement Package for the project affected people shall be devised taking into consideration all related applicable acts and policies and whichever is more beneficial would be adopted as the basic minimum criteria. Resettlement package would inter-alia include the benefits like compensation for land, house, shop and other property, allotment of homestead land, transportation charges for household items and cattle etc., providing infrastructure facilities in resettlement area, approach roads, electricity, water supply, education, health centers etc., preference in providing employment in project construction, management and monitoring, training facilities etc., participation in catchment area treatment which in turn would benefit local population.

4.4 Accrued Benefits of D-P Link Project

The D-P Link Project has been planned as drinking water project for augmentation of domestic water supply of Metropolitan city of Mumbai. The project being the water supply project has been planned on 100% dependability basis. Following are the benefits which can be accrued due to the above link project.

(i) Augmenting Domestic Water Supply

The D-P link project will facilitate transfer of 895 Mm³ of water for augmentation of domestic water supply to the Mumbai city while meeting the drinking water requirement of the people in the vicinity of the project.

(ii) Power & Flood Control Benefits

The power potential studies indicated feasibility of power houses at both Bhugad and Khargihill dams. Power house at Bhugad dam will be with 2 units of 1.0 MW installed capacity each while power house at Khargihill dam will be with 1 unit of 0.6 MW installed capacity. In addition power house with two

units of 1.0 MW installed capacity is proposed near Khargihill-Pinjal tunnel. Release of water to the link tunnels and creation of reservoirs will also provide incidental benefit of flood moderation in Damanganga river.

(iii) Other Benefits

Besides direct benefits other indirect benefits such as pisciculture, replenishing of ground water in downstream areas of the proposed dams, development of agro based industries and food processing units due to enhanced water availability, employment generation during and post construction phase, tourism development, development of infrastructure etc. will be accrued from the project. This will result in upliftment of socio-economic conditions of people in the vicinity of the project area.

5.0 PRESENT STATUS OF THE PROJECT

As part of the preparation of DPR of D-P link project various Survey & Investigations works such as Topographical Survey, River Surveys, Borrow Area Survey, Construction Material Survey, Testing of Rock Core Samples, Geological Survey etc, and consultancy studies such as Design of Important Project Components, Construction Planning, Equipment Planning and Man-power Planning, Hydrological Study Power Potential and Electrical & Mechanical Studies, Seismic & Morphological studies, socio-economic Survey and Environmental Impact Assessment studies are being firmed up.

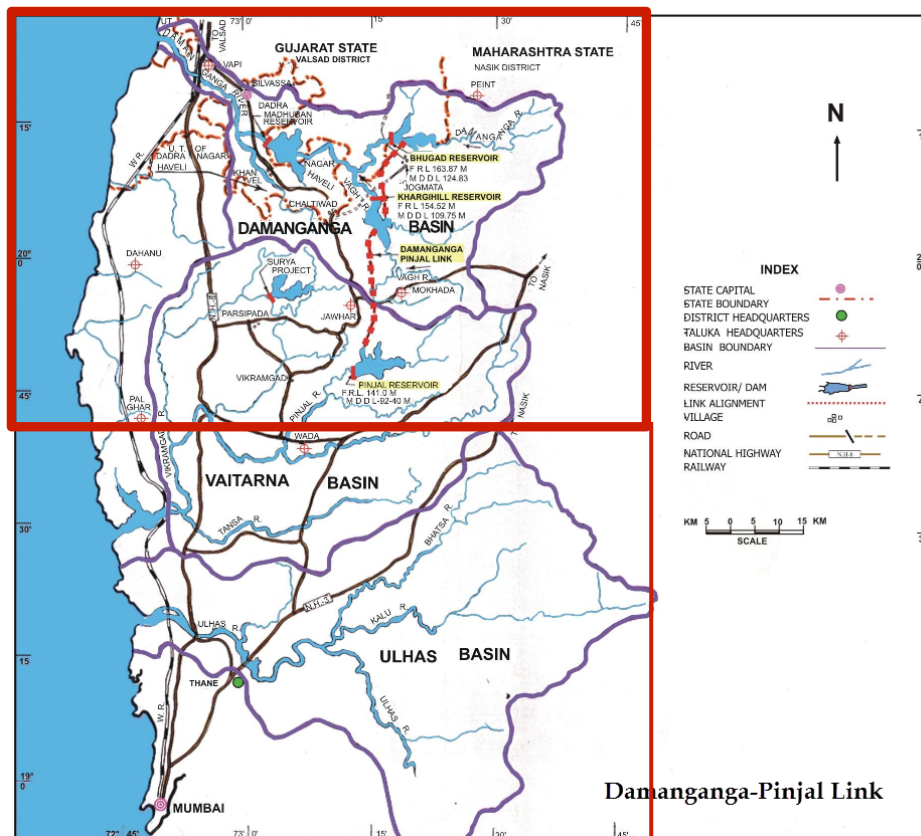
6.0 CONCLUSION

The ground water levels in urban areas are depleting at an alarming rate with the utilization of ground water exceeding the recharge. This is not only resulting in deeper bore wells but also increased consumption of electricity. In coastal cities, the sea water intrusion is increasing thereby affecting the water quality. The roof top rainwater harvesting measures taken up in various cities though augmenting the ground water recharge to some extent, however, are unable to recharge at a rate equal to the drawal of ground water. In view of the acute scarcity & stressed water conditions prevalent owing to rapid increase in population and depletion of natural water resources in urban areas, the augmentation of domestic water needs in urban areas can be tackled effectively through provision of surface water even if it has to be transferred through long distance pipe lines. As we near the time when water has to be arranged at any cost, transfer of surface water through interlinking of rivers appears to be a sustainable solution.

REFERENCES

1. Report titled "World Urbanization Prospects-The 2011 Revision" of Department of Economic and Social Affairs, Population Division, United Nations, New York, 2012
2. Feasibility Report and other related study reports of D-P link project prepared by NWDA.

Figure 1. Inter Basin Water Transfer proposals

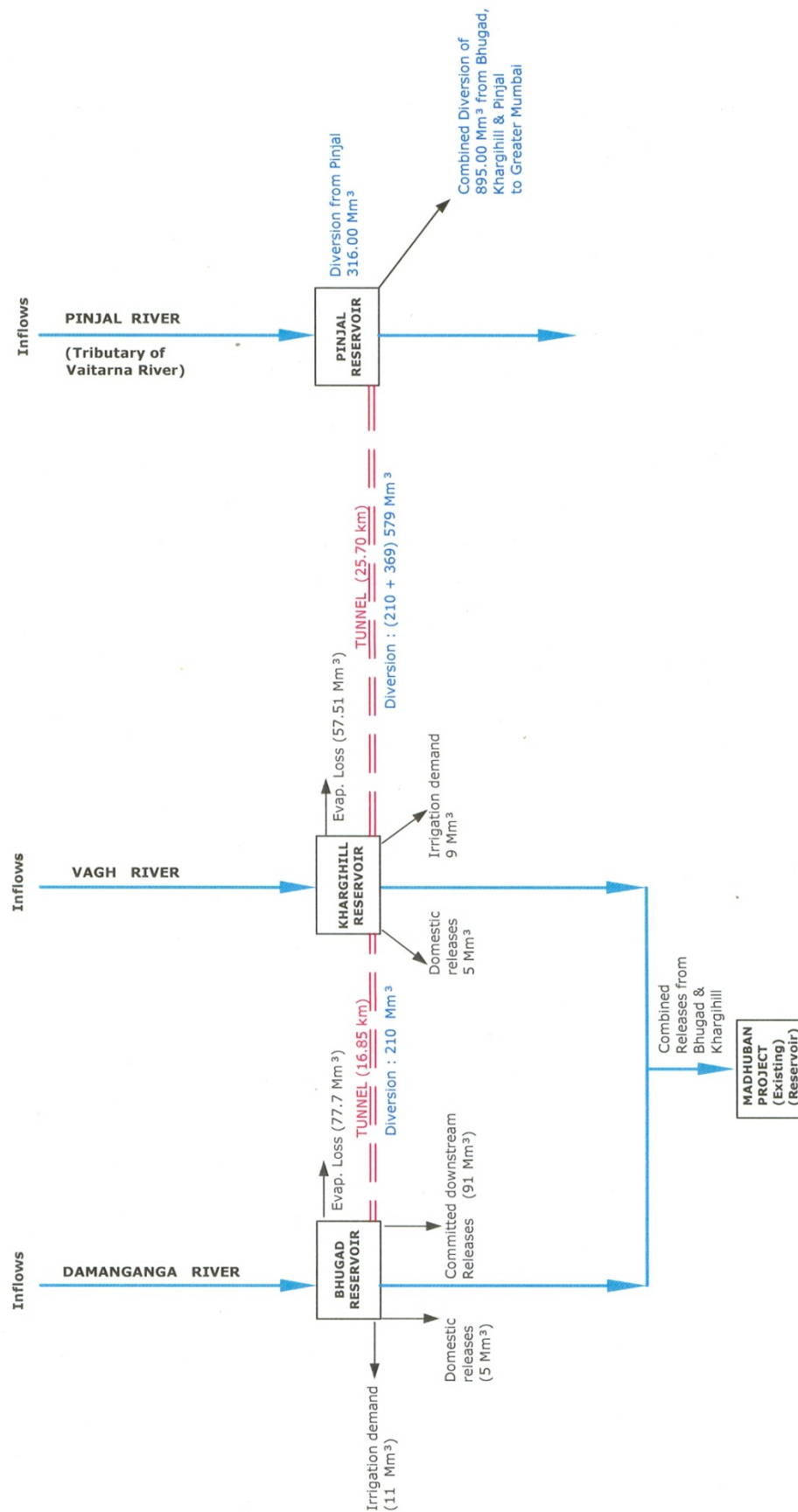


ZOOM



Figure 2. Index map of Damanganga – Pinjal link project

SCHEMATIC DIAGRAM OF PROPOSED DAMANGANGA - PINJAL LINK PROJECT



* The quantities indicated above are tentative and are being firmied up at DPR level of studies.

Figure 3. Schematic diagram of proposed Damanganga – Pinjal link project