Journal of Engineering Research and Studies E-ISSN0976-7916

Research Article

ART OF INTRA AND INTER BASIN WATER TRANSFER

[1]Sanjay D. Bonkile* [2]Dr. P. S. Pajgade

Address for Correspondence

[1*]Assistant Professor, [2]Professor, Civil Engineering Department, Prof Ram Meghe Institute of Technology and Research, Badnera (Amravati) Maharashtra – 444701

ABSTRACT

The water resources in the country are limited considering the future demand. Moreover rainfall is confined to monsoon season and unevenly distributed both in space and time. At present various storages have been constructed to store water for various purposes. In case of heavy rainfall water gets spill over or in case of less rainfall there may be drought situation. Most of cases due to uneven rainfall in the basin or sub basin some storages/dams attain its maximum capacity, while some do not. On the other hand some basin has excess water available and some have deficit, while some basin/sub basin have exhausted the use of available water.

This paper represents the review of past work on the use of surface water by checking all possibilities like diversion of water from one basin/sub basin to other basin or sub basin, use of water by diverting it through available natural drain or local nallah from the catchment area of one reservoir to other, allowing spill water from dams to drains/river/local nallah by using existing canal system as a feeder canals etc.Attempts are also made to cover all methodology and techniques for water transfer in inter and intra basin.(Keywords: Interlinking of basins, Restoration , Diversion , Water availability)

1.1 INTRODUCTION

Water is required in almost all activities of man, for drinking and municipal uses, for irrigation to meet production of food, power generation, for industrial use, navigation and recreation. It is most important part of development of country and hence it must be harnessed in most scientific and efficient manner. Based on the water availability India has divided in various basins. At present most of the basin have excess water available, while some have deficite.Verious dam or reservoir are constructed in the country. Because of uneven rainfall there are different problems of getting reservoir full to its capacity. It often happens that due to uneven rainfall in the catchment some reservoir get stored to its full capacity while some do not. In such situation even if water is available cannot be utilized to its full extent. Such situation can be studied and identify to divert the spill water to the river or natural drains. Such available water can divert or pump in adjoining river or nallah which can be optimally used. By making use of such water, it can be properly used in case of drought situation as well as new project can also be undertaken to increase irrigation, domestic and Industrial use. It will also defiantly useful to recharge the ground water levels in the area.

1.2 Water availability and Inter basin water transfer

Luna Bharti, B.k.Anand, et.al. studied evaluation of water availability as against water demand in one of the NRPL link.i.e. From Godavari River (Poluvaram) to the Krishna River (at Vijayawada).The Godavari has been characterized as a surplus basin where as Krishna basin as a defecate one (GOI-1999) Based on annual water balance calculation as well as the current and projected (2025) water requirement, the central Water Commission (CWC) has concluded that the Godavari basin has sizable surplus water that can be transferred to water deficit Krishna basin. Several links have been proposed to transfer water from the Godavari to Krishna. The most downstream link-Palvaram (Godavari River)-Vijayawada (Krishna River) is considered to be a local project as an aim of this link is to transfer the water from Godavari to Krishna basin.

In order to assess the benefits of the proposed Polvaram project, two main scenarios were developed and simulated.

Scenario-1 Reference scenario: Water use under the current supply and demand network. The water source is ground water and river channel.

Scenario-2 with the polavaram reservoir and link canals water supply verses demand after the construction of Polvaram Project. The water source is the Polvaram reservoir and link canal, Ground water and river channel. After simulations with the link canal and reservoir show within the link command area, there minimal unmet demands for agriculture domestic and live stock requirements.

N. Ohara, A.M.SCCE, et.al. (2011), Detailed about significant increase in population in the Middle East has created new concerns about water needs for food production. Because water resources are very limited as a result of arid and semiarid climates of the region. Many Middle Eastern countries are highly sensitive to potential shortages in their water resourses.In the Tigris-Euphrates (TE) river basin, the largest water shade in the Middle East; the water resources have been intensively affected by the development of dams and barrages to store water for irrigation, hydroelectric power generation and general use by the region's population. The author has pointed out that water regulation by dams in Turkey as well as these in Syria and Iraq, would eliminate critical water supplies from lower Euphrates and Tigris River that have sustained the ecosystem in the marshlands. These remarks were largely based on static water balance studies (e.g.Kolars and Mitchell 1991) that used average river flow volume and irrigation water demands. Hence resulting water budgets used balances of the average water supplies and water demands during a historic period of record or estimations of future irrigation water demands.

In this study, historic water demands-logic data sets over the TE water shade climatic and hydrologic data sets over the TE water shade were reconstructed buy using a regional Hydro-Climate Model (Reg HCM-TE).Because the model is described in detail in the accompanying paper by chem. et.al.(2011).In addition to climate and hydrological data sets, irrigation water demand under various water resource utilization scenario needs to be estimated (i.e. Irrigation activities are, by far, the most significant consumer of water resources in this water shade).Then corresponding to each utilization scenario the operation of the water resources system should be simulated to quantify dynamic water balances under the hydro climatic condition of the historical critical dry and wet periods. Within this frame work critical period analysis of available stremflows records in the TE water shade were performed to determine the historic critical dry and wet periods. Mean while irrigation water demands under various water resources utilization scenario were estimated by using vegetation pattern that corresponds to the historic critical dry and wet period. To compute the dynamical water balances within the water shade under utilization scenario, the computer model for operation of the system of reservoir within the water shade was used in this case study. Within this dynamic water balance-modeling frame work the effect of chronologically sequential water balances with daily temporal resolution over the whole TE water shade under various water resources utilization scenarios were quantified and assessed.

Turkey has constructed 14 dam, five on Tigris and nine on the Euphates.Syria has eight dams in the basin; the largest is the Tabqa Dam on Euphrates River. Iraq which lies downstream of the Turkey and Syria has 19 dams and barrages. Several reservoirs in Iraq are off-channel and make use of land depression where limited land gradient exists. Reservoir in Iraq is used for hydropower production, irrigation, and flood control and flow irrigation.

An objective of accurate assessment of water availability in the TE river basin under historically adverse water deficit and flood conditions is essential. The critical dry period is defined as the period with the list amount of water resources available in the historic record, where critical wt period is defined as the period with the largest water surplus on record. Such period represent the most extreme hydrologic conditions that have occurred in the basin. Because the water balance may be transferred from year to year, cumulative water resource need to be considered when critical dry and wet periods are determined.

As described earlier, past studies in the TE river basin has focused on static and annual water balance(Kolar and Miccell 1991).Such balance did not considered daily, monthly and seasonal fluctuations that can significantly affect water flow of its ability to meet demands in given year. To accurate evaluate a water resource to meet demand its operation during extreme hydrological condition at monthly or finer time increment should be simulated. Such simulation is called as dynamic water balance. Daily dynamic water balance was computed under various utilization.Scenerio for the TE water shade and series of scenario were studied.

To develop optimum water management policies over the TE water shade that minimizes substantial reservoir evaporation losses while meeting current irrigation water demands, water balance in Iraq and Syria were quantified under various water releases from Turkish sector. The simulation result showed that it is possible to meet the current irrigation demand in Iraq and Syria. According to simulation result, the highly efficient water allocation would be activated by arranging the release from the Euphrates sector of Turkey according to monthly reasonability of irrigation water demands in Syria and Iraq and by diverting water from Tigris to the Euphrates through Sammara Thakur Complex during the irrigation season. To regulate water release from dam in the Tigris sector of the TE water shade downstream is seasonally varying pattern to optimize storage in the dam at the cool sector of the water shade with low evaporation rates to minimize water losses whole meeting irrigation demand in downstream nation.

Jayant Bandopadhyay, (2005), Investigated about heavy investment in engineering structures have opened the possibilities of withdrawing more and more water from natural sources like lakes, rivers, and the ground water aquifers. More than half of all accessible global freshwater runoff is currently withdrawn for human uses. The consequences is that drastic reductions have been taken place in amount of water remaining in stream causing degradation of aquatic ecosystem and affecting negatively the various services provided by ecosystem. The Nile in Egypt, the Ganges in South Asea, The Amu Darya and Syr Darya in Central asia, Yellow river in Chana, the Colorodo river in North America etc.are among the major watercourse whose flow have been obstructed and diverted to such extent that for part of the year, little or none of their freshwater flow reaches the sea (Postal 2000).

Transfer of water from river basin with higher rainfall to the drier basin with objective of irrigation started to encourage policy makers to think on IWTS.In this line; Rao (1975) proposed three links of canals between Brahmaputra and Ganga, between Ganga and Cauvery, and between Narmada and parts of Rajasthan with the purpose of transferring water to the drier areas in southern and western India. Such proposal was not favored by CWC of India on various grounds including cost. The main idea of transferring water from the Ganga-Bramhaputra river system to the less water endowed areas in southern and western parts of India by linking canals, nevertheless, remained alive in the minds of official in India's Ministry of water resources and CWC.With the formation of National Water Development Agency (NWDA) in 1982, it got in circulation again. The NWDA was, subsecuatly entrusted with the task of developing plans for interbrain transfer of water to examine the possible storage site and interconnecting link in details. After detail studies, he proposed 30 links in the Himalayan and peninsular components which are now important part of the recent proposal for ILR in the country (TFILR 2003).

Secured supply of the domestic water needs is a basic human right and should receive top priority in policy. For this, water may transfer across river basin at all costs. In term of quantity, the domestic requirements are small and transferring such quantities across basin will not be costly.

Nigam et al. (1997) had undertaken water availability studies in few water scares areas of India and their study made it clear that if the precipitation available within the concern water shades or sub basins is harvested and conserved properly, supply of domestic water needs would not pose serious problem in most of the parts of the country. For promoting domestic water security in dries area of India, local level water harvesting and conservation has been proven technology. It is a cheap and socially acceptable technological option even today when compared with large storage a long distance diversion facilities, which often carry high financial, social and ecological costs (WCD, 2000).This article stressed that in hydrological science there is no differentiation of river basins as surplus or deficit. Through an analysis of whatever is available in the open, this article questions whether a) the ILR can control floods in high rainfall areas and provide water security in the water scarce area of India .b) India's food self sufficiency depends on irrigation from the proposed ILR and c) a comprehensive knowledge based for the Himalayan component available.

1.3 Diversion of water and Restoration

Jean-Philippe Venot, et.al (2010) has carried out multilevel analysis of the dynamic of irrigation and land use in the Nagarjun sager project (South India) in times of changing water availability (2000-2006) highlights that during low flow year, there is large scale adoption of rain fed or supplementary irrigation crops that have lower land productivity but higher water productivity and that a large fraction of land is followed. Paper deals with

- Main features of NJS multipurpose project
- Changes in land use over period 2001-06
- Fram level adjustment
- Evaluation of economic impacts of variable water supply
- Managerial adjustments by comparing water demand and water supply.

This multilevel analysis of the dynamics of irrigation and use in the NJS irrigation project during times of changing water availability (2000-06), suggest that water supply shocks have dramatic effects on farmer's practices, cropping pattern and food production in large irrigated project in South-India. Multitemporal remote sensing techniques and high resolution statistics, supported by micro level information on farmers practices, allowed mapping "hot spots", where land use and cropping practices dramatically changed during a water supply shocks(2002/2003) with the clear shift from Paddy cultivation to follow,rainfed grain crops or supplementary irrigation cotton and Chillies.Cropping pattern changes lead to lower agricultural value produced at the regional level, to lower land productivity but in same time water productivity showing that same time to higher water productivity showing that farmer optimize the scarce production factors

Horigjian Zhou, et.al. (2011), Morphological adjustment in the river system due to urban development can be considered in term of changes in the channel C/S reach and network and basin. This paper deals with 1) examining the linkage between rapid urbanization and alteration of river network in Shenzhen, China and explaining the temporary change in relationship between both variables according to different extent of urbanization during the period 1980-2005 and 2) Analyzing the change in ecological services in the river ecosystem based on the measurement of ecological capital in the Guanlan River sub-basin (GLSB) of Shenzhen.

With the rapid urbanization, the river in cities have been totally altered from their natural states or even obliterated from the urban land scope. Using combination of remote sensing and GIS urban development and river network between 1980-2005 were analyzed .The percentage of urban land changed from 0.6% in 1980 to 8.9% in 1988 and 34.5% in 2005.The river network in Shenzhen experienced a rapid loss characterized by an increase in structural simplicity and restriction of tributaries. The cumulative length of river is shorten, drainage density has been reduced, forest, bodies of water have been decreased due to urbanization.

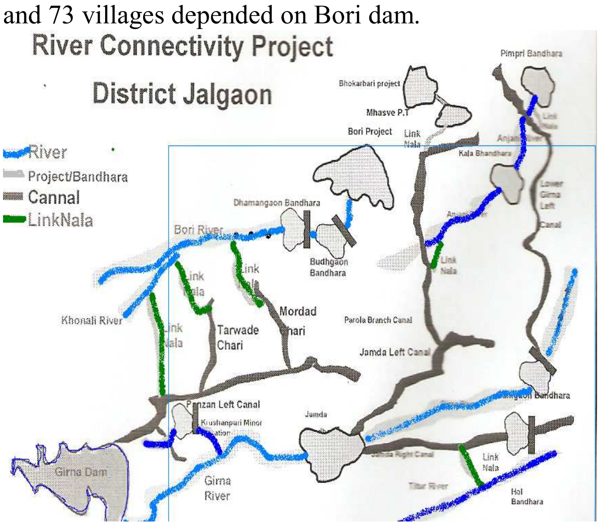
Demand based project through citizen's participation, Jalgaon District is located in the North-West of the state of Maharastra.It receives the rainfall of about 690mm and temperature varies from 10-48 degrees Celsius. In July 2005, the district was unfortunate to receive scanty most of Maharashtra was experiencing flood like situations. The Jalgaon district has received less than average rainfall, i.e.only 15% by mid –July and 73% by end-October 2005, and too in unequal measures. Seven tehsil of Jalgaon district were in particular largely affected. There was no run-off water in the rivers and nalas; consequently, all water reservoirs were empty and groundwater levels was depleting while in the neighboring Nasik district, the Girna dam was overflowing. So this excess water from Girna dam, which was otherwise going waste, had the potential of being diverted to the water scares region of Jalgaon.

The diversion of surplus water from one region to the needy areas will avert the potential danger of floods and thus effectively harness the natural resources available. The objective of the project was ,providing water for drinking as well as irrigation purposes in the drought-bit areas of Jalgaon district by using diverted excess overflowing water, by adopting linking technique. Since less than adequate rainfall in the seven tassels was likely to create drought-like conditions. To overcome this problem and provide water for drinking purposes, useally in times of scarcity, new bore well are dug, temporary water supply schemes (TPWS) or existing water supply schemes are used or as a last mesuree, tanker deployed. But such an approach involves expenditure of crores of rupees every year. Moreover the expenditure does not create any permanent asset. The option of providing water tankers to tackle scarcity is not sustanable.The technique used to overcome the problem is based on innovative methods of linking of natural and artificial water drainage for inter-basin and intra-basin water transfer. This is unique technique of rain water conservation; utilization of flood water runoff and repleshing natural and artificial water bodies through natural and artificial water drainage channels. The excess water in a river is utilized to recharge the ground water bodies and dry wells in its command areas. The project is designed for the optimum utilization of rainfall-runoff for inter-basin and intra-basin water transfer through innovative technologies of both surface water transfer and ground water recharge. The principal water shade management within the command area is used not only for agricultural purpose, but also for drinking water and industrial purpose.

I. Linking of Bori and Girna River

The Girna major project is located on the border of the Nasik and Jalgaon districts. In 2005,due to heavy rains, in the interest of flood management,64000 cusecs water was released in the Girna river from the Tapi river, and finally into the Arabian sea.

For regular irrigation purposes, the Girna project has Panzen left bank canal which flows towards Jalgaon district. The excess flood waters in the Panzan left bank canal were diverted and then the canal was breached at 31st km and water was diverted into local nala, which flows and joins the Bori river by travelling a distance of 6km by gravity. The Bori River flows 35 km towards the eastern side and reaches the Bori dam situated at Jalgaon district. This solved the problem of water supply of Parola town and 73 villages depended on Bori dam.



II. Inter-linking of Girna and Anjani rivers.

III. Inter-linking of Girna and Titur rivers

IV. Filling of Bhokarbardi and Mhaswa project

V. Filling of Pimpri Bandhara

The benefits and after effect of Jalgaon River linking project have been validated through an independent socio-economic survey by third party agency. This survey was carried out in 2007-two year after the project's implementation. The finding proves that the project is not only successful, but also sustainable; its benefits are still enjoyed by the peoples of Jalgaon.The project has been positively received by all sections of the society.

SADC RBO workshop (2010), Concept of benefit sharing (BS) is gaining popularity in transboundry water resources management and development. According to Sadoff and grey (2002), four types of benefits can be obtained from co-operation: I) sustainable management of revering ecosystem

ii) Economic growth

iii) Political stability

IV) Regional integration.

First, cooperation can lead to better management of ecosystem, their by leading to 'benefits to the river' or ecological benefit. For example, wet lands, rehabilitation and restoration. Second, efficient cooperation in the management and development of transbondry river can yield major 'benefit from river' or development benefits such as increased food and energy production,i.e.direct economic benefit.Third,the easing of tension and building of confidence between riprapian states will result in a reduction of costs because of the river, as a tension between riprapian states will always be present, to a greater or lesser extent and those tensions will generate cost.Fourthly,co-operation will bring economic integration among riprapian state, generating 'benefits beyond the river'. These benefits according to sadoff and Grey (2002) could be potentially obtained in all international river basins.

This paper uses the Lesotho Highlands water project (LHWP) in the Senque Orange River Basin, between the countries of Lesotho and South Africa as a case study to demonstrate how concept of BS can be applied in the transeboundry management and development of water resources.

The LHWP is one of the biggest international Inter Basin Transfer in the world .Scheme transfers water from highland of Lesotho through gravity to water deficit Vaal region in SA.

The project consist of an interlinked system of dams and tunnels designed to regulate the flows of upper Senque (Orange0 river basin in Lesotho, to store water in Lesotho and deliver it to the Vaal river basin in SA.The river system of the basin namely,Makhaleng and Mohokare and respective tributaries ,flow into SA,becoming the orange river. The South Africa could have impounded water from the Orange River within its borders through the scheme known as Orange Vaal Transfer Scheme but water water is already too far south but the time it passes from Lesotho to be easily accessible to the Vaal region. South Africa then found transporting water from the highlands of Lesotho through gravity as cheap alternative.The LHWP is a classic example that shows the concept of BS can work. Given the Sandoff-Grey typology on benefits, the LHWP portray classic direct economic type as co-operation between the two countries was necessitated by economic or social development needs.The LHWC and the joint permanent technical committee (JPTC) between Botswana and SA served as a basis for the bigger basin management authority. In the orange Senque River Basin, the orange Senqu river basin commission (RASECOM) .The two authorities have been granted an authority to develop and implement policies and procedure of ORASECOM-Ad two bilateral agreements are not affected by the ORASECOM agreement according to its stipulation.

J.Nieto; et.al. (2012) Explained about urban flood risk management. Hypothesis is that a simple water balance including rainfall inputs, surface storage and pathways is able to represent the main processes that are responsible for surface water flooding. Main objective are 1) to construct water balance model for urban surfaces2) to test its sensitivity and validity.The model founded on a GIS approach that is widely accessible and capable of analyzing raster data: the most common format for digital Elevation Models(DEMs).GIS is also standard approach for special planning application and in this study ESRIGIS software was used to manage the data and to assemble the surface water balance model.Researcher developed urban water balance model. Excess surface water is that which remains on the surface after accounting for losses. Such as infilteration water that drains to a surface sink is stored according to sink volume and any further water is passed downstream. In development of model land cover, runoff co-efficient, digital elevation model were studied.Water balance is calculated by using standard ESRI Arc tool boxes and special analyst tools which are automated by using model builder and organized as tool boxes. Result of models: 1) Sensitivity analysis, the assumption mode in the model are tested with sensitivity analysis. It is performed for

- The method used for processing multiple outlet sink
- The criteria used to select sinks to be represented in the model.
- The runoff coefficient values used to generate the excess surface water.

Validation –The model is applied to four known catchments where flooding occurs. The runs by using 5, 10, 20, and 50mm rainfall depth. Were carried out and 10mm depth provided the closest match to known locations. It is a simple method that can be used by decision maker to analyze effect and opportunities of development on surface water risks.

Rebecca L.Teasley, (2011) River basin management is as varied as each basin. Rapidly increasing populations and economic development in many basins often tightly constrain the allocation of limited water supplies. Water planning and operations in transboundry river basin that border or pass through two or more countries-can be difficult as it is based on politics, laws and regulations of the countries in those basin and possibly to co-operative agreements among the contries.The benefits of cooperatively managing transboundry river basins are often elusive and opaque to riparian shake holders sharing a basin. However the benefit can be increased through a co-operative allocation of the basins water.In this paper benefits of cooperation to the Sry Darya riparian countries from this new water and energy sharing agreement are analyzed by using co-operative game theory with a water resource model.A river basin model is used to calculate the benefits of various operations for cooperation among the riparian contries.The model includes the two largest uses of Syr Darya water: Hydropower generation and irrigated agriculture.The model allocates water for energy and agricultural production over a 10-year period by using a monthly time step and benefits were calculated to different contries.Model estimates the net benefits to the contries.Model estimates THE NET BENEFITS TO THE CONTRIES UNDER VERIOUS OPERATION COALIATION.The net benefits to each country calculated by model are used to determine the characteristic function for each possible coalition in the game theory analysis. The objectives of the countries are minimizing energy deficits and maximizing agricultural profits.The Syr Darya Basin four riparian countries Kyrgyzstan (kg), Tajikistan (TJ), Uzbekistan (uz) NAD Kazakhstan (KZ) could form 15 coalitions or partnerships among themselves and benefits were calculated on the base of which, it was agreement: Kyrgyzstan may divert 0.5% of water, Tajikistan 7%, Uzbekistan 50.5% and remaining 42% is the limit for Kazakhstan. This paper analyze the draft agreement on allocation of water and energy resources of the Syr Darya Basin from the view point of benefits sharing and quantifies the benefits of co-operation among riparian nations to water resources in trance-boundary river basin. The analysis shows increased benefit to all counties in the basin if they follow cooperative arrangement outlined in the draft agreement.

CONCLUDING REMARKS:

From the above literature it can be concluded

- Surface water can be used by Inter and Intra basin transfer.
- Surface water can be used at reasonable cost as compared with cost of construction of reservoir by diverting or transferring in Inter or Intra basin through existing natural drains, rivers or existing canal system.
- It is helpful for decesion maker to analyze the effect and opportunities of development on surface water.
- Problem drinking water can be solved to some extent.

REFERENCES

1 Bandopadhyay, J. (2003) "and quit flows the river project "The Hindu Business Line (Chennai) 14 March.

2 Luna Bharti, B.k.Anand, International water management Institute, Shrilanka consultant, Banglore,

3 Govt.of India ,Ministry of Water Resourses,1999.Integrited Water Resources Development-A plan for Action, Report of the National Commission for Integrated Water Resources Development,Vol -I,New Delhi, India

4 N.Ohara,A.M.SCCE,M.L.Kavvas,F.ASCE;M.L.Aderson,M.ASCE,Journal of hydrology engineering ASCE/Dec-2011/2071

5 Jayant Bandopadhyay, Breakthrough Vol II No 2 Sept 2005

6 Benefit sharing arrangements in the orange-senqu river basin: The case of Lesotho highlands water project (LHWP) Paper for SADC RBO workshop on implementation of benefit sharing arrangements in SADC April-2010

7 Linking Rivers in the Ganges-Brahmaputra River Basin: Exploring the Tran boundary Effects by Anik Bhaduri,International Water Management Institute, New Delhi and Edward Barbier ,University of

Wyoming,Wyoming,USA
8 Strategic Analysis of the National River Linking Project (NRLP) of India Series 2,Procedings of the workshop on Analysis of Hydrological, Social and Ecological Issue of the NRLP
9 Future Water Supply and Demand in the Okanagan Basin, British Columbia: A Scenario-Based Analysis of Multiple, Interacting Stressors, by Kirsten J.Harma.Mark S.Jonson.Stewart J.Cohen ,published online:03 Nov 2011 (Springer)
10 Interlinking of River Basins:A Mega Harvesting Plan-A Review By B.S.Prakasa Rao and Others in J.Ind.Geophy.Union (January 2010)Vol.14 No.1,pp 31-46
11 Interlinked modeling of large floods by combining one and two-dimentional diffusive wave approaches.4th International Symposium on Flood Defence:Managing flood risk,Reliability and vulnerability Totanto,Ontario,Canada.May 6-8,2008
12 The Interlinking of Rivers:Some questions on the Scientfic,Economic and Environmental Dimensions of the proposal by Jayanta Bandopadhyay and Sharma Perveen,Paper presented at seminar on Interlinking Indian River:Bane or Boon? At IiSWBm,Kolkata 17 June 2003
13 Jean-Philippe Venot,Kiran Jella,Journal of Irrigation and drainage engg ASCE/Sept-2010/595, (Jean-Phillipa Venot et al 2010)
14 National Water Development Feasibility Report of River Linking proposal for 14 Links and other information www.nwda.nic.in
15 Horigjian Zhou,PeinjuShi,Jing'ai Wang ,Journal of Urban planning and development ASCE/June 2011/121,
16 West Bengal Academy of Science and Technology,Procedding of the workshop on interlinking of rivers,(May 23,2003),Kolkata 2004
17 River –Linking Plan to Have Big Impact on Environment" Indian Express,Chandigarh,May 5,2003
18 J.Nieto;D.N.Larner;A.J.Saul etc,Journal of Hydrology engg ASCE/Jan 2012,
19 IWRS (1996) Theme paper on Inter basin transfer of water for National Development Problems and Perspectives Indian Water Resources Society.
20 MOWR (2002) Inter basin transfer planning for Basin Transfer
21 Rebecca L.Teasley,Journal of Water Res Planning and management ASCE Dt Dec/2011,
22 Jalgaon River Linking Project, Demand Based Project Through Citizen Participation.
23 Samya Centre for Equity studies (3003),"Linking of Indian Rivers: Some Concerns and Issues New Delhi :Uthra Print Communications.