

WATER RESOURCE MANAGEMENT: A HOLISTIC APPROACH FOR SUSTAINABLE DEVELOPMENT IN NORTH BIHAR

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Abstract :

Ample magnitude or potentialities of surface or ground water resource shows the picture of sufficient path for sustainable development on the socio-economic and ecological scenario in North Bihar but on the real surface the above mentioned ample magnitude of the surface water becomes only a part of hydrological cycle. These magnitude of water resource would haven't been only the part of hydrological cycle causing negligible damage to humanity. The factual annual flood scenario indicates the consequent scene of devastation as well as cruel waterlogging with rare boarding position. The whole assessment is that North Bihar with ample magnitude of water resource has the stunted socio-economic development.

Key word: Potentialities, Sustainable development, Ecological scenario, Hydrological cycle, Magnitude of water resource, Damage to humanity, Scene of devastation, Cruel waterlogging, Stunted socio-economic growth.

Introduction :

The area having a solid block of highly dense population has the average density of 866 persons per sq. km. (2001). Nearly 80% of its geographical area is cultivated and agriculture constitutes the main source of the region. The morphological features of the region are characterized by flat, plain and bowl-shaped topography but with south-east ward sloppy landscape. Besides rivers, there are numerous chours, ponds, tanks, lakes, and wet lands and several other water-logged areas waiting for proper water resource management and uses for spatial development. Floods, droughts, power shortage are the vital problems of the region from which the people suffer almost every year.

Location and Extension:

North Bihar being a fertile part of northern Gangetic plain and extending between 23°12' N .Lat. to 27°22' N. Lat. and 83°22' E. long. to 88°20' E long. covering the area of 72200 sq. km. has numerous rivers of which flood jointly makes its annual victims of its above 86% of the total area. Flood occurrence is the spill over water flow of rivers causing a lot of damages to North Bihar. GandakBaya, Bagmati ,BurhiGandak, Kamla, Balan ,BhutahiBalanAdhwara group of rivers (23), Kosi , Mahananda etc. jointly present the flood scenario.

Hypothesis :

The investigator in order to step forward towards the path of sustainable development formulates the following hypothesis:

- Annual occurrence of flood has been devastating the standing crops but its controlling measures may provide relief to the people.
- Along with agriculture, fisheries, aqua-culture, agro-based industries may develop after controlling flood disaster.
- Proper management of water resources may provide the path of around development.
- Employment opportunities may be created up to a large extent.

Sources of statistics :

The present research paper is based on primary and secondary data procured through field survey and government records respectively .The primary data has been collected through a team work led by the researcher . Personal observation and interview after interview were conducted in the different parts of the region. Magazine, Reports prepared or published by governmental or non- governmental machineries were consulted to prepare the present research paper.

The flood data have been collected from KendriyaJalAyog and its various branch offices. The compilation of flood data has been contributed by KendriyaJalAyog, Patna. The Agriculture University, Pusa has also facilitated along with the active co-operation of the district headquarters in collecting the statistics regarding flood damages estimates, river basin catchments area etc.

Research Methodology :

The data or information obtained through intensive field study have been analyzed with the help of quantitative and empirical approaches. Personal as well as group-observation and assessment of the investigator has been the basic ground for interpretation and clarification of ground realities. The help of various available data has been worked

out through water resource management process. The proposed irrigation schemes are depicted by means of different topographical sheets of the region concerned through projecting them superimposed methodology on the contours.

Existing Scenario:

The existing scenario of North Bihar plain can be expressed after discussion of annual flood scenario, devastation of standing crops, flooded settlement, human beings as well as animals, lack of food stuff, water-logging scenes, stunted industrial growth, out-migration of people in search of bread, closure of agro-based industries, ecological imbalance, annual disruption of roads etc. Floods in N. Bihar often remain peculiar and prove a nightmare. Latest 'KosiPralay' in 2008 broke all the previous records when 19 districts out of the total 23 were completely affected. Flood-water covered the entire landscape causing enormous damages. Two crores habitats and more than 4 lakh buildings nearly 43.42 lakh hectares of cropped land had been destroyed. 1400 kms. of roads were worst affected by the then floods. National highway No. 19, 28, 31, 57, 77, 105 were washed away at different places breaking the linkage of road transportation. At many places railway tracts were disrupted which created major problems of transportation. Total loss estimated due to flood to be more than 8000 crores. On the other hand, 20 to 30 percent loss also occurred due to drought. Above 39% geographical area of North Bihar is quite unprotected or open for flood devastation. The total flood area in Bihar is estimated to be 68.80 lakh hectares which stands for 73.04% of the total area 94.183 lakh hectare while in North Bihar 86.39% areas i.e. 44.46 lakh hectares is annually flooded. No doubt, embankments have been prepared and at present the total length of embankment in Bihar is 3430 km. of which 2952 km. (86.06%) length of embankment is found in North Bihar. In other words, only 27.16 lakh hectares of area in North Bihar remains free of flood. The following table indicates river basins and their catchment areas along with the annual deficit statement particularly by occurrence of flood.

Table-01**River-basins & Catchment areas**

S. N.	Name of Basins	Name of the rivers	Length of river in km.	Catchment areas in sq. km. in N. Bihar	Surface water potential in lakh hect. m.	Name of Hydal Project
1	Ghaghra basin	Ghaghra&Saryu	784	2856	6.96	
2	Gandak basin	Gandak	432	9548	62.8	Gandak Project
3	BurhiGandak basin	BurhiGandak	326	10162	126	-
4	Bagmati&Adhwar	Bagmati,LakhandeiAdhwar, JamuraSika. BurhaKhiro, Singhia, Murha-Rato	-	139102	975	
5	Kamla basin	Kamla&Balan	164	6720	326	
6	Kosi basin	SaptKosi	412	14452	39	Kosi Project
7	Mahananda basin	Mahananda	238		7.41	

Source : Irrigation Department , Government of Bihar, 2011-12

Table-02**Annual Deficit Estimate**

year	Annual Deficit Estimated in croreRs.
1971-72	1034.68
1975-77	1066.01
1986-88	424.00
1995-97	1698.56
1989-90	1189.08
2001-03	963.36
2006-08	1432.12

Source: Bihar State Irrigation Commission, 2011-12

Flood are the natural phenomena and one can't get rid of it completely but their impact may be mitigated or minimized by human technical skill, better flood forecasting as well as warning system, flood information system and various control measures adopted by

the governmental or non-governmental machineries . Annual flood effected area in average situation is being represented in the following table.

Table-03

Flood Affected Area in N. Bihar

S.N.	Name of basin	Total effected area in lakh hect.	Percentage to total that of North Bihar
1	Gandak basin	2.99	6.72%
2	Baya basin	3.86	8.68%
3	BurhiGandak basin	8.55	19.23%
4	Bagmati basin	4.37	9.82%
5	Kamla&Balan basin	6.29	14.15%
6	Adhwara group basin	6.06	13.62%
7	Kosi basin	10.20	23.12%
8	Other basin	2.14	4.66%

Source: Bihar state Irrigation Commission Report, 2011-12.

The above mentioned table represents the total flood-affected areas of various river basins in North Bihar . The report shows the average report of previous 20 years between 1989-90 to 2009-10. The average area affected by flood remained highest in kosi basin ie 4.26 lakh hectares while BurhiGandak basin of Adhwara group of river stands second and third respectively in this regards. The basin of Kamla and Balan accounts 1.9 lakh hectors and Gandak basin affects 1.94 lakh hectors The lowest record goes to Bagmati river basin but it is also known as notorious river next to Kosi in N. Bihar.

Flood Control measures :

A flood control measure mainly includes structural and socio-political engineering measures. Though, flood being a natural phenomena can't be controlled completely but flood affected area can be reduced or minimized and flood hazards may be mitigated. Prof.R.Ward in his book entitled “ Floods- A Geographical Perspective ” has suggested four chief measures for the sake of flood control which is used in the most of the countries being ravaged from flood hazards –

- 1) The construction of embankments and flood walls to confine the flood water.
- 2) The improvement of the river canals to enlarge their discharge capacity i.e. strengthening, widening or deepening.

- 3) The construction of bypass and diversion channels in order to carry some of the excess flood water away from the flood area.
- 4) The construction of reservoirs for temporary storage of flood water.

By applying the above mentioned four measures, the flood's effect may be reduced or mitigated or modified. Modification of flood involves a number of measures such as physical control, land use modification of the catchments or alteration of precipitation patterns through weather modifications. It aims at alteration is –

- 1) the volume of run-off
- 2) the time taken to attain the peak.
- 3) the duration of flood.
- 4) the extent of area flooded.
- 5) the velocity and depth of flood water and
- 6) the amount of sediments and pollutants that the flood usually carry.

All these alteration can be done by means of the applications suggested by Prof. Ward. Besides, Flood Control measures also includes-

- To delay the return of runoff from torrential rainfall to the rivers.
- To reduce the volume of water.
- To divert the flow of water.
- To reduce the impact of flood.
- To hasten the discharge of water.
- To forewarn the occurrence of flood.

Management of Rivers :

In context to N. Bihar ,no remedial measure proved to be capable to control the annual occurrence of flood or drought completely but attempts have occasionally taken to mitigate or minimize up to some extent. River management, basically include flood protection through raising embankment, flood walls, ring bunds, reservoirs, etc. to reduce flood peaks . Watershed management is aimed at reducing the rate of run off and draining of rivers by spurs. Besides, flood plain zoning , raising level of habitats, flood warning system, flood forecasting system, flood information system, emergency evacuations etc. are also helpful in this regard.

Embankments and flood control:

The embankments and flood walls are the most common quickly constructed and economic means of flood management structures which serve as artificial high bank of river during flood and keep the water away from threatened area. The history of

embankments as a remedy of flood control dates back 7th century B.C. in China and even earlier in India . According to a report published in Yojna ,2010 the total length of embankment in N. Bihar is about 3050 kms. Embankments have also been applied in North Bihar as flood control measures as expressed in the following table;

TABLE:-04
Embankments and Protection from flood

S.N	Rivers	Embankments of km.	Protected area in lakh ha.	Unprotected area in lakh ha
1	Ghaghra	148.80	0.92	2.34
2	Gandak	597.20	5.41	8.21
3	BurhiGandak	376.42	2.86	5.13
4	Bagmati	647.54	2.48	3.22
5	Kamla-Balan	483.96	3.82	5.79
6	Kosi	357.20	8.38	10.15
7	Mahananda	438.65	3.26	3.74

Source: Bihar state Irrigation Commission Report, 2011-12.

Most of these rivers have meandering courses and are characterized by frequent shifting of their channels. The major river of North Bihar, which have been embanked in the last 50 yrs. have shown positive signs of raising their beds and consequently the flood level control. The average bed-level within the embankments has gone up by 15 to 25 feet [04 to 08 meters] causing its water to spill over the embankments .Thus , the protecting through embankments now poses a serious challenge to planners . The river being in capable of draining this excess load break the embankments inundate the protected area and cause havoc at the sight of breach. Thus, the exclusive reliance upon embankments for flood control in North Bihar is highly erroneous and misconceived. In spite of that the heavy cost has been incurred during different five year plans. In the light of the aforesaid problems two remedial measures of water resource management have been suggested to face the hardship:

- ❖ Inter linking of river by canals and
- ❖ Dredging of riverbed.

In fact the region faces problems of water mismanagement. There is fluctuation in the volume of water in the time and space .The proposal is in the tune

with the “Garland canal concept” that was propounded by Sri K.L Rao in 1970 for interlinking country’s river including much highlighted Ganga-Cauvery link canal(2640 km. long). Even currently, the National Water Development Agency (NWDA) has initiated some measures of interlinking rivers in India. Out of four proposed link canal in Bihar two (Kosi-Ghaghara link canal and Gandak-Ganga link canal) are directly related to N. Bihar.

Construction of Dams / Reservoirs :

Dams may be very much useful from the point of view of water resource management .Though, dams are not environment friendly even yet , the Irrigation Commission of India Report,1972 cited that dams are the based way to control flood which is intercept them with storage reservoirs so that only moderate flood are allowed to flow though the valley below. Reservoirs should be constructed with multipurpose goals like irrigation, water supply, aqua-culture, hydal power generation etc . Hanuman Nagar Barrage on Kosi River and Valmiki Nagar Barrage on Gandakriver both located on Bihar- Nepal boarder.

River Diversions :

River Diversions may be temporary or permanent. A temporary diversion in the form of bypass for saving urban areas of the region from high floods may be very much useful in order to control the flood. This envisages taking off a channel upstream of the area in order to reduce the peak flood and bringing it back to the same river downstream while a permanent diversion becomes useful in taking part of the flood away from the stream into another stream or to a depression

Inter-basin transfer :

Inter-basin transfer involves diversion of water from one stream of the basin to an adjacent stream or drainage basin. This method is economically much feasible in the case of small streams and where the watershed is separated by flood- ridges, because otherwise huge excavation or tunneling through the ridge is involved in the case of larger streams.

Ring Bunds :

An earthen bund around habitation tagging it with high bank / ground is constructed to keep the floodwater away. This ring bund keeps the habitation free from inundation during floods but the rainwater which accumulates within this bund needs to be either drained out or pumped-out. These ring bunds combined with main bund may function as spur projecting into the flood away.

Check Dams :

Check dams are constructed in the gully course which are neither stabilised nor having vegetation on their sides and coarse particles on the surface. All gullies encountered within sub-catchments will have to be projected with suitable check dams.

Percolation Ponds :

The percolation ponds are constructed across natural water courses to impound the water of stream for a longer time with the object of effective recharge of ground water. Besides the water table in the well within the zone of influence of the pond, get recharged by deep percolation.

Silt Detention tank:

Silt detention tanks are constructed on the streams in order to prevent the flow of sediment into river. Due to construction of silt detention tanks, considerable amount of silt is being detained. But for the construction of silt detention tank the enormous amount of transported silt would have been swept into the reservoir and dams.

Watershed management :

Watershed management is a process which aims to create a self- supporting system essential for sustainability. Watershed management is an integrated technological approach within the natural boundaries of a damage area for optimum development of land water and plant resources to meet the basic minimum needs of the people in saturated manner. Bali stated that harmonious development and management of land and water resources within the natural boundaries of a watershed so as to promote or produce on a sustainable basis abundance of plants and animals and their products and still deliver clean and controlled flow of water to the downstream is known as watershed management.(J.S. Bali,1988, Soil Conservation Society of India) Thus, an attempt to put into optimum use of the natural resources occurring within the watershed (land, water,livestock,plants and energy) under a single action programme on sustainable basis with full participation of the people is called Watershed Management. Here in N. Bihar , it is required for the following purposes –

- To control damaging runoff.
- To manage and utilize runoff for useful purposes.
- To control erosion affecting reduction of sediment production.
- To moderate floods in the downstream area.
- To enhance ground water storage wherever applicable and
- To appropriately use land resources in the watershed.

Watershed management scheme have also generated employment for the rural people by increasing land under cultivation, intensity of cultivation and formation of self-help groups. This has checked their migration towards towns, cities, and other states for job. Watershed management scheme has imparted vocational training to village youths and made them earning members. Due to this scheme the productivity of different crops has increased appreciably.

Strategy for solving the problems :

The analysis of the problems suggests a strategy for approaching the sustainable management of the land and water resources of the region concerned. Through the proper management of water resources, the bane of flood and drought can be changed into a boon through adopting the following remedial measures-

- Clearing the valley-beds from time to time.
- Transferring and storing the flood water to drought prone area .
- Construction of dams , embankments , reservoirs and natural water detention basin.
- Channel-improvements, river-diversion, inter-basin transfer, raising of surface and underground storage.
- Modification of flood plain zoning.
- Establishing and proper functioning of Flood Warning System (FWS), Flood Forecasting System (FFS), Disaster Mitigating System (DMS) and Disaster Management System (DMS).
- Satellite-based remote sensing technology should be brought to bear upon land and water resource management.
- Integrated steps towards Natural Resource Management System and Integrated Mission for suitable development.
- Conceptual integrated plan formulation for the whole region .
- Steps to zoning approach :
 1. Preparation of the base map of the flood affected district.
 2. Preparation of thematic map.
 3. Identification of disastrous areas, spatial constraints and social considerations.
 4. Listing of zone-wise possible alternatives .
 5. Zone-wise assessment of water harvesting scheme
 6. Zone-wise preparation of watershed management.
 7. Zone-wise plan for implementation of these steps on participatory basis.

In spite of the above mentioned strategies, it will be difficult to achieve the target of sustainable development without implementing long-term sustainable measures for water resource management. A scientific approach has to be adopted for providing a long term land and water resource management that requires the use of all possible scientific and technology development planning design, implementation and operation of schemes, four pronged approaches i.e. political force , enlightened and efficient technical approaches, competent and

Holistic Approach for Sustainable Development :

Holistic approach is a principle or way of proper resource management that tries to achieve the path of sustainable socio-economic and cultural development maintaining the ecological balance. Proper management of Water resource lies in the heart of all other resource-managements in particular context to N.Bihar. Only water resource management will pave the way for the management of other resources also. Flood free zone in north Bihar will provide adequate opportunity for flourishing all other resources.

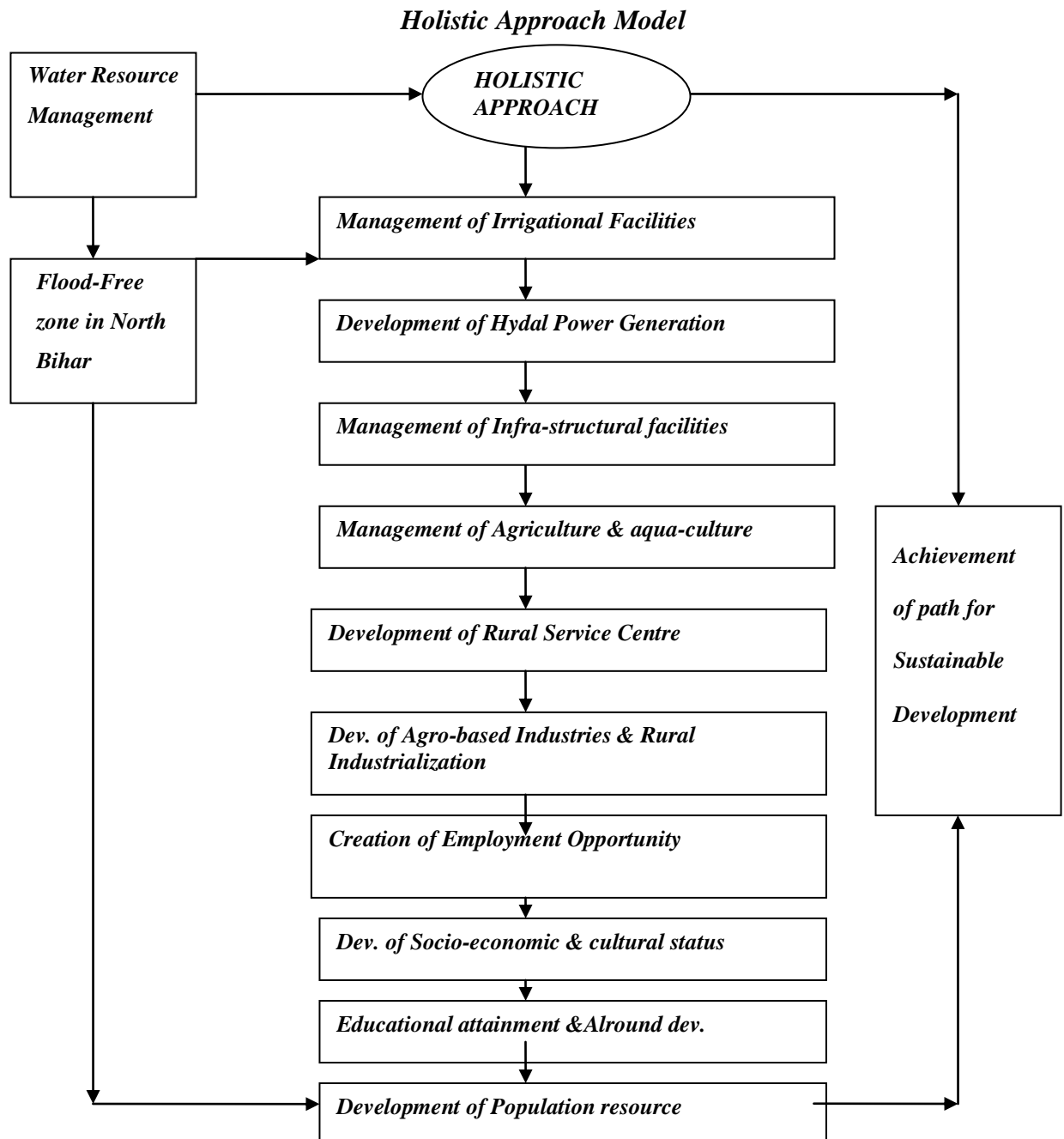
At first, attempt should be initiated to make flood-free zone in N. Bihar that will provide the space for irrigational development and development of hydal power generation at various places . Both the mentioned approaches will result into the development of agriculture and aqua-culture providing sufficient quantity of raw-material for the development of agro-based industries. Simultaneously , infra-structural development will highly be required due to which rural service centres will grow easily. All these development will create better opportunity of employment for the people. A number of persons in N. Bihar who oftenly out-migrate for their livelihood will get employment in their locality. With these facilities to the people , their socio-economic and cultural status of the people will uplift due to which they will be inclined towards educational attainment. Facilities of free books, dress, mid-day meal , bicycles to students attract children for somewhat economic-facilities for the particular time and require all these in continuation . Irregularities of such facilities throw the people back to their root level of thinking scenario. Hence root of development is required to boost-up after that the target of population resource development may be achieved and in the long run, such development will sustain for longer period maintaining the ecological status that is known as sustainable development. The following model may be considered that throws light towards the holistic approach for sustainable development. A holistic approach for sustainable development will provide facilities to the people as follows-

- Irrigation facilities through river, pyne, canal, tank, pond etc.
- Generation of hydal power.
- Development of navigation.
- Development of aqua-culture.
- Agricultural development.
- Development of agro-based industries .
- Development of Plantation agriculture .
- Educational & technological development.

A holistic approach for sustainable development in North Bihar region will also provide in employments to the people in the following fields -

- Irrigational activities in agriculture.

- Aqua-culture-fishing industry ,Makhana, Singhara etc. in primary and secondary activities.
- Agro-based industries like sugar industry , rice mill, flour mill, oil crushing refinery etc.
- Harvesting, Processing, packaging and storage etc.
- Trade and commerce activities.
- Rural service centres.



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Reference:

- 1) Jha, G.P. (1989) , “Agriculture in Flood Prone Region : A Geographical Perspective ”
Inter India Publication,Pp. 35-51.
- 2) Mathew Mammen (1996), “ Floods of Fury” *Hindustan Times, Monday extra , 29 July,P.1*
- 3) Bihar District Gazetteers ,Darbhanga,Purnea,Muzaffarpur, Saran, Champaran.
- 4) Choudhary, S.N. (1992), “Geography of Floods in North Bihar” *LNMU Publication, Darbhanga,PVIII*
- 5) Kumar,A.(2000), “Surface Water Resource of Bihar” *Magadh Geographical Review Vol.-2No.-2&3Bodh Gaya P-23*
- 6) Jha, S.K. (2003), “WaterCrisisGrisp Silk City” *The Times of India, Patna edition,Oct. 11, 2003 P-6*
- 7) Srivastava , K.N. (1972)*Water logging in Bihar and role of Agronomy in its management of areas having high water table P-215*
- 8) E. Ahmad (1965) *Bihar : Physical Economic and Regional Geography*
- 9) Anuranjan (2003), “ Changing Pattern of Landuse& Agriculture in Flood Prone Area : A Case Study of Biraul ,Darbhanga Unpublished doctoral thesis, Patna University.
- 10) Yadav R. P. (2004) , “ Fate of Floody North Bihar” *published in Vartika , annual magazine, R.D.S, College, Muzaffarpur , Pp. 67-68*

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