

BIHAR FLOODS : 2007

(A Field Report)



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In recent past flooding and the associated risks have been rising with increased frequency in India which could be attributed to a number of factors, including changes in rainfall pattern, increased frequency of extreme events, in land use changes and development into flood-prone areas as a result of socio-economic demand. Of late, it has been realized that climate changes is causing significant impact on the hydrological system and increasing the risk and vulnerability to flooding. Human lives, property, environment and socio-economic are at increasing risk due to flooding.

Bihar is highly vulnerable to floods on account of its geo-climatic conditions and various other attributing factors. The State is the most flood prone in the country in terms of percentage of land susceptible to flooding. Total flood prone area of the State is about 68.80 lakh hectares which accounts for 73.06 percent of its total geographical area and 17.2 percent of the total flood prone area in the country. The State has witnessed devastating floods in recent years. In fact, South West Monsoon rain has become a synonyms of floods in North Bihar plains resulting in enormous loss of life and property and bringing untold human miseries and sufferings to the people.

The floods in Bihar during the South West Monsoon 2007 (July to September 2007) portray yet another familiar picture of the State's vulnerability to recurrent flood and is a grim reminder of the extensive devastations destruction and disruption caused by floods. The floods of 2007 make a break from the past in terms of; its intensity, unpredictability and its un-seasonality. About twenty days of incessant rains, 300 to 400% over and above normal trends in second half of July, had been unprecedented. This was again repeated in August and simultaneously, heavy rainfall in the upper catchments areas of Nepal compounded the problem.

The purpose of documentation of this disaster event by the National Institute of Disaster Management is to draw important lessons from floods and its management. The focus of the study is to highlight on the practical problems, dilemmas and challenges and to suggest measures for reducing the loss of life and property due to major floods. The study clearly establishes the needs for a comprehensive approach on flood hazards with a broader perspective of flood plain management, non-structural approaches, and institutional innovations which may be used for integrated, comprehensive flood control strategies.



Satendra
(Executive Director)

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**Professor Santosh Kumar
Arun Shadeo
Sushma Guleria**

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INTRODUCTION

“Bihar is one of the most disaster prone states of the country. Floods, droughts, earthquakes, heat/cold waves, river erosions, fire incidence etc. are various forms of disasters prevalent in the state. Among natural disasters, flood is the most common and a regular annual phenomenon in Bihar resulting in enormous loss of life and property. In addition to floods, the seismic vulnerability of the State to earthquakes is another constant danger. Increasing population pressure, high density of buildings and their poor construction quality, the settlement in vulnerable areas and inadequate or no investment on mitigation/ Preparedness measures has further increased the vulnerability of the population to these natural hazards. In addition to extensive damage to life and property, these disasters over the years have also adversely affected economic development in the State”.

Bihar State Disaster Management Policy

- 1.1 Bihar is one of the States of the Indian Union located at 25.11 N Latitude and 85.32 E Longitude. Bihar lies mid-way between the humid West Bengal in the east and the sub humid Uttar Pradesh in the west which provides it with a transitional position in respect of climate, economy and culture. It is bounded by Nepal in the north and by Jharkhand in the south. The Bihar plain is divided into two unequal halves by the river Ganga which flows through the middle from west to east. Thus the very geographical setting of the State coupled with **hydrometeorology, hydrology, geomorphology and topography** prevailing in the region. make it one of the worst flood affected region in the world. The entire North Bihar is crisscrossed by the major rivers such as: the **Ghaghra, the Gandak, the Bagmati, the Kamla-Balan, the Kosi and the Mahananda** which all, meet the mighty Ganga on its left bank. All these rivers originate in Nepal from the Himalayas. With the increasing deforestation due to the reclamation of areas for occupation and obtaining fuel for domestic requirements, the vegetative cover in the catchments areas of Nepal have been increasingly getting eroded. With this, rivers carry more silt and over time their carrying capacity has significantly reduced. These factors combined with heavy and sustained rainfall lead to floods in North Bihar. The trend shows that the intensity and frequency of floods in Bihar Plains have increased over the years causing human suffering and destruction of agriculture, habitation and infrastructure.
- 1.2 United Nation Development Programmes' global report on "Reducing Disaster Risk: A Challenge for Development observes that "About 196 million people in more than 90 countries were found to be exposed on an average every year to catastrophic flooding. Some 170,010 deaths were associated with floods worldwide between 1980-2000." The same report also tells us that based on the same data set of 1980-2000, the relative vulnerability of India is among the highest in the World, next only after China. There are many Indian States which are prone to floods; some of them witness flood as a routine phenomenon every year while some experience draught as well as flood in the same

region in different years, and in different seasons of the same year. The States like Assam, Bihar and Orissa have seen increase in the intensity of floods from year after year. Floods in these States have been killing people and cattle, destroying property and infrastructure and rendering agriculture lands useless in massive scale. There have been large number of interventions both structural and non-structural to prevent and control floods but even after these interventions and many other development programmes "**Flood prevention and control**" remains elusive in the country; particularly in Bihar.

VULNERABILITY OF INDIA TO FLOODS

- 1.3 Floods are probably the most recurring, widespread, disastrous and frequent natural hazards of the world. India is one of the worst flood-affected countries, being second in the world after China and accounts for one fifth of global death count due to floods. About 40 million hectares or nearly 1/8th of India's geographical area is flood-prone. Floods are a recurrent annual feature in India particularly in eastern and north eastern regions. Floods cause enormous damage to life, property and disruption to infrastructure. Hence, management of floods constitutes an important element of India's national development activities. Flood management does not aim at total elimination of floods as it is neither possible nor achievable. However it seeks to prevent the fury and havoc caused by floods and mitigate its effects. As per statistics on flood damages, it is seen that on an average 7.56 million ha. of area is affected annually out of which about 3.55 million ha. is the cropped land. Floods have claimed on an average 1595 lives and 94,772 livestock every year. 1.2 million houses are damaged fully or partially by floods alone.
- 1.4 Uttar Pradesh, Bihar, Punjab Assam, Rajasthan, Haryana and Orissa are the most flood prone States in terms of area liable to flood. The rivers Brahmaputra, Ganges and their tributaries carry tons of debris and water through out the year. In monsoon, the rain in the catchments area provides more water to the river, eventually the water flow exceeds the capacity of river resulting to flooding in the whole area with enough water to cause havoc. State wise areas liable to floods are given at table below:

State-wise areas liable to Floods:

S. NO.	STATE	AREA LIABLE TO FLOODS (MILLION HA.)
	ANDHRA PRADESH	1.39
	ASSAM	3.15
	BIHAR	4.26
	GUJARAT	1.39
	HARYANA	2.35
	HIMACHAL PRADESH	0.23

Contd.

Contd.

S. NO.	STATE	AREA LIABLE TO FLOODS (MILLION HA.)
	JAMMU & KASHMIR	0.08
	KARNATAKA	0.02
	KERALA	0.87
	MADHYA PRADESH	0.26
	MAHARASHTRA	0.23
	MANIPUR	0.08
	MEGHALAYA	0.02
	ORISSA	1.40
	PUNJAB	3.70
	RAJASTHAN	3.26
	TAMIL NADU	0.45
	TRIPURA	0.33
	UTTAR PRADESH	7.336
	WEST BENGAL	2.65
	DELHI	0.05
	PONDICHERY	0.01
	TOTAL	33.516

Source: NIC

VULNERABILITY OF BIHAR TO FLOOD

- 2.1 The plains of north Bihar are some of the most susceptible areas in India, prone to flooding. A review by Kale (1997) indicated that the plains of north Bihar have recorded the highest number of floods during the last 30 years. The total area affected by floods has also increased during these years. Drained by two major rivers, the Kosi and Gandak, and several smaller systems such as Burhi Gandak, Baghmata and Kamla-Balan, the plains of north Bihar have experienced extensive and frequent loss of life and property over the last several decades (Sinha and Jain, 1998). The Kosi River (The Sorrow of Bihar) is well-known in India for rapid and frequent avulsions of its course and the extensive flood damages it causes almost every year. The Kosi is one of the major tributaries of the Ganga River, and rises in the Nepal Himalayas. After traversing through the Nepal Himalayas, it enters India near Bhimnagar. Thereafter, it flows through the plains of north Bihar and joins the Ganga River near Kursela, after traversing for about 320 km. The river has been causing a lot of destruction by lateral movement and extensive flooding. As its waters carry heavy silt load and the river has a steep gradient, the river has a tendency to move sideways. Thus, in about 200 years the river has moved laterally by about 150 km (Gole and Chitale, 1966; Wells and Dorr, 1987). To check the lateral movement as well as for flood control, embankments on both sides of the river were constructed, five to sixteen km apart. Although this has confined the lateral shift of the river within the embankments, but the problem of flooding is still a challenge in this area. The problem of river flooding in Bihar is getting more and more acute due to human intervention in the flood plain at an ever increasing scale. There must be a realization that minimizing the risk and damage from floods may be more rational way of flood management rather than formulating structural measures along the dynamic rivers such as the Kosi.

Why Bihar is so vulnerable to floods?

- 2.2 After bifurcation of the State, Bihar has become the most flood prone area in the country in terms of percentage of land susceptible to flooding. Total flood prone area of the State is 68.80 lakh hectares which accounts for 73.06 percent of its total geographical area and 17.2 percent of the total flood prone area in the country. Flood proneness is most severe in the northern plains of Bihar. This is because almost all the major rivers in the State enter Bihar from Nepal in this region. Bed slope of these rivers is very sharp in Nepal and they usually enter the State on plain lands. Because of a sudden drop in bed slope, silt brought by the flow of these rivers get deposited at their base and become the major cause of recurring floods in Bihar plains.

Physical factors- hydrometeorology, hydrology, geomorphology and topography

- 2.3 Bihar on account of its location coupled with *hydrometeorology, hydrology, geomorphology and topography* is one of the worst flood affected region in the world. It lies in

the tropical to sub tropical region and has a monsoon climate with an average annual rainfall of 1200 mm. The river Ganga is considered the lifeline of Bihar, which enters the State from the west and flows towards the east. A large number of rivers join the Ganga from the north and south. Ghaghara, Gandak and Kosi are the main tributaries of the Ganga. Kosi, called “the sorrow of Bihar”, is the widest river and frequently changes its course causing devastation. The Sone, Punpun, Mohane and Gumani rivers are the right-bank tributaries of the Ganga.



- 2.4 The unique geo-physical settings of the North Bihar plain make it one of the most vulnerable areas to floods of the country. The Ganga flowing from west to east bisects the State into two parts. The alluvial plains, north of Ganga are drained by the Ghagra, the Gandak, the Burhi Gandak, the Bagmati, the Adhwara group of rivers, the Kamla, the Kosi and the Mahananda which are the tributaries of the Ganga which acts as the master drain. These rivers originate in Himalayan range of mountains falling in Nepal and meander through North Bihar plains. If we see the map showing drainage area of Bihar we find that the entire Gangetic plain is crisscrossed by the rivers originating in Nepal. These rivers are notorious for changing their course, forming delta and affecting land building. Floods in North Bihar plains are result of interplay of various physical factors such as geomorphology topography, hydrology and hydrometeorology. However floods in North Bihar are not independent physical event. Instead these are a cycle of inter-dependent natural event and processes such as year round rain wash of mountains resulting into spread of sediment in the lower reaches by river spills, ground water situation, storages in water bodies, surface detentions, water logging drainage deforestation, concentrated rainfall etc. The map shows the flood zones in Bihar and suggest that extensive area of Bihar vulnerable to havoc of floods, and unfortunately this is cyclic. The floods in Bihar are not



new natural phenomena. North Bihar plains have been facing the severe flooding of varying intensities through the ages.

- 2.5 Bihar has three distinct seasons- winter from October to February, summer from March to mid-June and the monsoon from mid-June to September. Hot westerly winds begin in March and last until May. The temperature begins to rise in March, and the months of April and May are characterized by great heat and dryness. The monsoon sets in by around the middle of June, bringing in its wake a quick fall in the temperature and widespread rains ending in September. The State receives most of its rainfall from south West monsoon from June to September. The average rainfall is 1200 mm and ranges from 1000 mm to 2000 mm. this coupled with water brought by river originating from Nepal result in flooding of the Bihar plains.

Socio-economic & other factors

Demographic Characteristics of Bihar

- 2.6 As per 2001 census, Bihar with an area of 94,163 sq kms approximately, had a population of 8,28,78,796 persons. Till 1991 Census, the composite state of Bihar was the second most populous State in the country (containing slightly more than 10% of the country's population), next only to Uttar Pradesh. However, after bifurcation of the state of Bihar and creation of the new State of Jharkhand, the rank of Bihar among the States of India has slipped down to third, the States of Uttar Pradesh and Maharashtra occupying the first and the second position respectively. Total number of literate persons in Bihar as per 2001 Census is 31675607. Males greatly outnumber females. Among the total literates

20978955 are males and 10696652 females, that is to say, for every 2 literate males there is only 1 literate female. Male literacy rate is almost double (60.32) the female literacy rate (33.57) in the State according to Census of India 2001.

2.7 Demographic Characteristics of Bihar vis-a vis India, 2001.

Characteristics	India	Bihar
Population (2001)- Total	1,027,015,247	82,878,796
Rural	741,660,293	74,199,596
Urban	285,354,954	8,679,200
Percentage Decadal Growth Rate	21.34	28.43
Literacy Rate		
Persons	65.3	47.5
Male	75.8	60.3
Female	54.1	33.5

- 2.8 The population density is much higher in Bihar than in India as a whole (497 compared with 273 persons per sq km). Further Bihar has been undergoing a slow process of urbanization. The level of urbanization in Bihar (13 percent) is much lower than for India as a whole (26 percent). The sex ratio in Bihar is also lower than in India as a whole.

Development Index of Bihar in comparison to other States

- 2.9 Ranking of Bihar on the basis of a Composite index based on 13 socio-economic indicators is presented in the following Table:

STATE	COMPOSITE INDEX	RANK
GOA	83.71	1
PONDICHERRY	82.7	2
KERALA	81.88	3
CHANDIGARH	79.68	4
TAMIL NADU	78.06	5
DELHI	78.01	6
PUNJAB	73.88	7
KARNATAKA	70.31	8
HIMACHAL PRADESH	70.02	9
LAKSHADWEEP	69.81	10

Contd.

Contd.

STATE	COMPOSITE INDEX	RANK
MIZORAM	69.24	11
DAMAN & DIU	68.95	12
HARAYANA	66.8	13
MAHARASTHA	65.58	14
GUJRARAT	65.22	15
ANDHRA PRADESH	65.13	16
TRIPURA	64.17	17
ANDAMAN & NICOBAR	63.89	18
UTTARANCHAL	60.52	19
WEST BENGAL	59.58	20
SIKKIM	58.64	21
ASSAM	56.35	22
CHHATISGARH	55.44	23
ORRISA	55.40	24
MANIPUR	54.01	25
DADRA & NAGAR HAVELI	51.97	26
MEGALAYA	50.51	27
MADHYA PRADESH	49.33	28
NAGALAND	48.31	29
UTTAR PRADESH	44.09	30
ARUNACHAL PRADESH	43.58	31
RAJASTHAN	43.39	32
BIHAR	39.01	33
JHARKHAND	38.27	34

Source : Population Commission, 2002

The table clearly shows that Bihar ranks very low at 33 out of 34 States. The only State below Bihar is Jharkhand; erstwhile part of the State.

Economy

- 2.10 Bihar is predominately an agricultural State with about 90 percent of the population living in rural areas according to the 2001 census. Bihar is a rich agricultural area,

crossed by the Ganges River. Bihar can be easily described as a fertile alluvial plain occupying the Gangetic Valley. The plain extends from the foothills of the Himalayas in the north to a few miles south of the river Ganges as it flows through the State from the west to the east. Rich farmland and lush orchards extend throughout the State. Bihar grows Kharif and Rabi crops and the major agricultural products include rice, bajra, maize, jowar, sugarcane, tur, potato and pulses. The main cash crops are sugarcane, potato, tobacco, oil seeds, onion and jute and mesta. Kharif and rabi food grains constitute 64 and 36 percent of the total production of food grains in the State, respectively. The principal fruits are: mangoes, banana, jack fruit and litchis. This is one of the very few areas outside China which produces litchi in abundance. Despite its agricultural wealth, Bihar is India's poorest State, with high illiteracy and infant mortality rates.

- 2.11 Bihar is richly endowed with water resources, both the ground water resource and the surface water resource. Not only by rainfall but it has considerable water supply from the rivers which flow within the territory of the State. Ganga is the main river which is joined by tributaries with their sources in the Himalayas. Some of them are Saryu (Ghaghra), Gandak, Budhi Gandak, Bagmati, Kamla-Balan and Mahananda. There are some other rivers that start from the plateau area and meet in the Ganges or its tributaries after flowing towards north. Some of them are Sone, Uttari Koyal, Punpun, Panchane and Karmnasha. These rivers make the water available for irrigation purpose and also help in generating the hydro-thermal energy for the State. Apart from this they provide a medium for water transport, provide fishes for fishery industry and enrich the natural resources of state in many other ways.

Poverty

- 2.12 Nearly 43 percent people of Bihar live below poverty line, as against national average of 26 percent. It shows that the economic condition of Bihar is very poor. The absolute level of poverty continues to be high in Bihar, making it one of India's poorest States. Both, rural poverty ratio at 41% and urban poverty ratio at 24.7% are significantly higher than the national average (26.3% for rural; 12% for urban). The level of rural poverty varies widely across regions and sectors in the State, North Bihar is significantly poorer than South Bihar.

Unemployment

- 2.13 The underemployment in rural Bihar is very high as compared to the national average. Out-migration is a crucial survival strategy for the rural poor in Bihar. Bihar has the highest rate of gross inter-State out-migration in India. The wage employment in agricultural labour accounts for nearly 40% of the rural workforce in Bihar. Agricultural labour and cultivation together account for around 80% of occupations in Bihar. There is still very limited occupational opportunity outside the agricultural sector in rural Bihar.

The poor are far more likely to be agricultural wage workers or casual non-farm laborers, rather than cultivators employed in a regular non-farm job. Self-employment activities include a wide variety of occupations that could be as vulnerable as casual labour, especially for the poor.

- 2.14 In urban areas more than 40% of households are self-employed and around 30% have regular employment while casual wage labour represents only around 10% of occupations among all urban households.
- 2.15 The poor and socially disadvantaged households tend to own low-quality live- stock (goats rather than cows and buffaloes). Social or caste characteristics are associated with constraints and lack of opportunities in the State. The caste identity is a strong indicator of poor in the State.
- 2.16 In Bihar, the SC/ST are reported to be around three times poorer than the upper castes, and appreciably poorer than other backward castes and muslims.
- 2.17 Societal analyses focus on determining the vulnerability of people of different ages, income levels, education, capabilities, and experiences to a hazard or group of hazards. Vulnerable populations are typically those who are below poverty line. High density of population below poverty line in vulnerable areas increase physical exposure and hence the vulnerability. Income analysis of the population in the State is important because it is one of the most important indicators of poverty and consequent vulnerability.

Floods - a familiar story in Bihar – As we have seen flood in Bihar is an annual phenomenon. There is hardly any year which does not witness flood in the State. The State has witnessed some major floods in the last 50-60 years.

- 2.18 History of major Flood in Bihar:

1954 Floods: Talk to any elderly person in North Bihar and he would tell you something about the devastation caused in the floods of 1954. This flood was limited to North Bihar only with an affected area of 2.46 MH and a population of 7.61 million (out of 18.393 million). This flood had affected 8119 villages (out of 21,107 villages) of North Bihar leading to the loss of standing crops over 15.96 lakh hectares, about 1,79,451 houses were destroyed and 63 persons lost their lives in this flood. 1944 cattle had also perished in this flood. The composite flood loss was estimated at Rs 50 Crores.

1974 Floods: The impact of this year's flood was felt south of the Ganga also in the districts of Munger and Santhal Parganas and had a spread area of 3.182 MH. It had hit a population of 16.39 million and crops over 1.751 MH were lost. 5,16,353 houses were destroyed in this flood that killed 80 persons and 288 cattle. The total losses were put at Rs. 354.59 Crores.

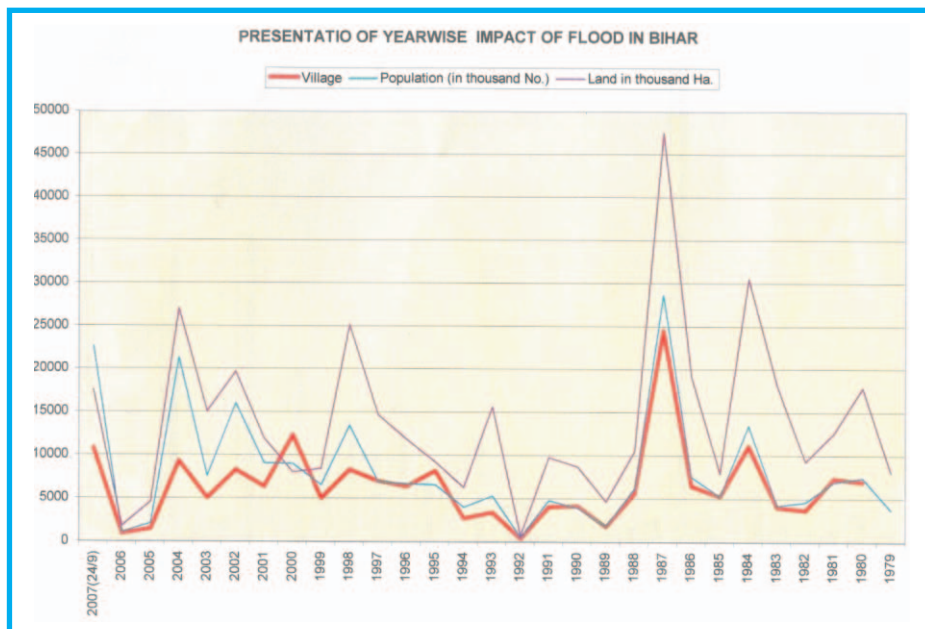
1987 Floods: This was the worst recorded flood of the 20th century. The records set by that flood have not been broken so far (2007 included). This flood had not only mauled North Bihar, its impact was felt in South Bihar as well as Jharkhand (it was a part of Bihar those days) also. An area of 4.668 million hectare of present day Bihar and a population of 282.38 lakhs was hit by the flood that had engulfed 23,852 villages and destroyed crops over an area of 2.51MH. It further destroyed 16,82,059 houses killing 1373 persons. The rains that started on the 11th August continued almost non-stop till 19th August and no food packets could be dropped in flood affected districts of Madhubani, Darbhanga, Samastipur and Khagaria for about 3 weeks despite deployment of 13 helicopters and 58 Army boats. Blocks like Alauli and Beldaur remained marooned till the end of October. The floods repeated five spells and its gravity can be ascertained from the fact that Jhanjharpur Sub-division of Madhubani was inundated even after Diwali.

2004 Floods: This year's flood was spread over 20 districts of North Bihar with an area over 2.772 MH (4.99 mh according to CWC) and affected population of 21.3 million. This flood had engulfed 9346 villages, destroyed crops over an area of 1.399 MH and swept away 9,29,773 houses killing 885 persons.

2007 Floods: The floods in Bihar during the South West Monsoon 2007 (July to September 2007) portray yet another familiar picture of the states vulnerability to recurrent floods and is a grim reminder of the extensive devastations destruction and disruption caused by the floods. The South west monsoon has become a synonyms of floods in North Bihar districts which bring untold human miseries and sufferings to the people who have been cursed to live in abject poverty for generations, struggle for subsistence and get caught in the whirlwind of floods, poverty and indebt ness. The floods 2007 in the State has been designated as unprecedented in its intensity; unpredictability; unseasonality in its timing; its spatial coverage; its successive spells and its extended duration.

The magnitude, intensity and frequency of Bihar floods 2007 may be unprecedented but the State has been bearing the brunt of floods since time immemorial. More so, it is considered as one of the main causes for putting the State at the bottom of the development index of the country. The poor are always the most adversely affected in any disaster situation and recurrent floods in the State are no exception. Poverty and inequality that prevails in the State has further been accentuated by recurrent floods which are a grim reminder of the fact that the flood control measures undertaken by the Government has miserably failed. The question arises as to whether the flood control and flood management measures in the State are on the right track or whether there is an urgent need to have a comprehensive re-look at the whole gamut of flood control and management. In the year 2007, it is reported that in Bihar, around 20 Million persons and 0.60 Million animal have been affected. The affected area is approximately 0.18 Million ha with 0.17 Million ha. agriculture land and 0.07 Million ha non-agricultural. The total crop loss

estimated is worth Rs. 300 Million. The flooded water aggravated *public health risk* in the entire area and the people had to suffer in want of medical treatment. Subsequently epidemic in forms of diarrhea, jaundice & influenza engulfed in the entire flood affected pockets of Bihar.



FLOODS IN BIHAR 2007

- 3.1 Facing the tormenting floods had been trying for the people. However, its aftermath could have been even more difficult. Livelihoods of many, especially the poor, might have remained lost for days and months to come. Also, as the water recedes, the consequent health hazards can pose greater danger. Lost houses can render the affected population homeless and living in shelters for a longer period. Damaged roads, bridges, and schools, to name a few, may limit the possibilities of getting back to normal rhythm of life. Fully cognizant of these implications, the state government worked on all such fronts to see to it that these disrupting factors were overcome as quickly as possible, and people got help and empowered to reconnect to their normal lives.
- 3.2 The floods in Bihar during the South West Monsoon 2007 (July to September 2007) portray yet another familiar picture of the State's vulnerability to recurrent floods and is a grim reminder of the extensive devastations destruction and disruption caused by floods. The South west monsoon has become a synonyms of floods in North Bihar districts which bring untold human miseries and sufferings to the people who have been cursed to live in abject poverty for generations, struggle for subsistence and get caught in the whirlwind of floods, poverty and indebtedness.
- 3.3 The recurrence of floods in Bihar every year with varying intensity has been a perennial problem. However, the floods of 2007 make a break from the past in terms of;
 - Its intensity;
 - Its unpredictability;
 - Its Unseasonality -in its timing;
 - Its spatial coverage;
 - Its successive bouts;

Genesis of the floods 2007

- 3.4 In 2007, about twenty days of incessant rains, 300 to 400 % over and above normal trends in second half of July, had been unprecedented. This was again repeated in August and simultaneously, heavy rain-fall in the upper



catchments areas of Nepal compounded the problem and its consequences. Indian Meteorological Department's official data set for 1 July to 22 August 2007, provides disaggregated figures of rainfall for severely flood hit districts, which demonstrates that district wise picture is even worse. The Central Water Commission's data showed that, the water level of many rivers rose sharply during the second half of July 2007, and in many cases went up 2-3 meters, or even higher, well above the danger mark. This perilous situation continued for about six days in July and about 15 days in August, thus almost for 21 days at a stretch. While it receded and came close to the danger level by 16 August, however, it again rose since then and went up to about 2 meters above the danger level, which had resulted from a second spell of heavy downpour that Bihar once again unexpectedly witnessed towards middle of August to add to its miseries.

Impact

- 3.5 According to the media report, nearly 20 million people got affected during 2007 floods which is considered as one of the worst floods in Bihar in a decade. The flood during the year showed no signs of abating and prolonged for a considerable long time. As per State Government 510 persons lost their lives in the floods. The flood affected 17 out of 36 districts in the State. The overall flood situation in Bihar continued to be grim for more than 2 months severely affecting about 69 lakh people in 110 blocks of the 14 districts of the State which were worst affected by the deluge. The worst affected districts were Muzaffarpur, Sitamarhi, Saharsa, East Champaran, Darbhanga, Patna, Supaul, Bhagalpur, West Champaran, Katihar, Madhubani, Samastipur, Sheohar and Nalanda. According to State Water Resources department sources, swollen rivers breached their embankment at many places inundating vast areas in the worst affected districts particularly Muzaffarpur, Sitamarhi, Saharsa, East Champaran, West Champaran Darbhanga, Samastipur and Begusarai.



The Damage

- 3.6 Apart from causing death of 510 human lives, the floods caused extensive damages to agricultural crop human habitation and infrastructure sector. Some of these are summarized below:

Breaches: 32 points totaling 5130 meters in length, in almost all protection > embankments of various major rivers. Huge number of minor river embankments, canal system, sluice gates too have also been damaged.

Extent of flood inundation: 20 districts mostly of North Bihar; 225 Blocks, covering 9,939 villages.

Persons and families affected: 20 million people; roughly about 5-6 million families.

Crop losses: 1.64 million hectares, leading to a loss of various crops of the value of about Rs 113.6 billion.

House damages: 5.12 lakh houses (mostly kuchcha) causing a loss of about Rs. 5585.18 million.

Lives lost: 510 (including 47 deaths due to boat mishaps).

Animals affected: 1.12 million; 559 dead

Agriculture: This mainstay of Bihar's economy has been severely damaged. Thus Kharif crops in 1.64 million hectare land have been damaged. Additionally 0.25 million hectares under sugarcane plantation have also been damaged. There is extensive damage to other perennial and horticultural activity like Banana, Litchies, Mangoes and Vegetables. Coupled with massive losses of seedlings of various crops for coming Rabi season, the estimated loss in this sector is to the tune of Rs. 113600 million, or Rs. 113.6 billion.

Roads: 480 Kms of National Highways and 36 nos. Bridges and culverts of NHs have been damaged. Road embankments have been breached at 54 points. One bridge has been washed away on NH-105. Important State Highways and major District Roads have been extensively and severely damaged, covering a length of 782.00 Km. Over 66 cross drainage work also need repair and restoration.

Rural Roads: Out of total road length in flood affected area of 7965.28 km, a total of 3193.57 km have been damaged which accounts for 34.78%. Further, 1353 number of bridges and culverts are also damaged.

PHED: The rural and urban piped water supply system, and numerous hand pumps have been damaged, requiring about Rs. 630 million for their immediate restoration.

- 3.7 During the visit of NIDM Team a spokesman of the Disaster Management Department reported that over 1.25 crore people have been reeling under the impact of the floods. The Central Water Commission said Bagmati, Burhi Gandak, Kamla Balan, Adhwara, Kosi and



Mahananda rivers were flowing above the red mark at various places, while the Ganga crossed the danger mark for the first time at Farakka. The flood situation worsened with major rivers including Burhi Gandak, Gandak, Bagmati, Mahananda and Kosi, flowing above the danger level, following heavy rains in their catchment's areas. According to a Central Water Commission report, Burhi Gandak was flowing 155 cm, 139 cm, 237 cm, 259 cm and 14 cm above the danger mark at Lalbegia ghat, Sikandarpur, Samastipur, Rosera and Khagaria respectively. Bagmati was 116 cm and 274 cm above the red level at Benibad and Hayaghat. Kamla Balan was above the danger mark by 146 cm at Kamtaul, 223 cm at Ekmighat and 23 cm at Jhanjharpur, while Kosi was flowing 175 cm, 17 cm and 8 cm above the red mark at Baltara, Basua and Kursela, it said. The Ganga too was flowing 41 cm above the red mark at Sahebganj, while Gandak crossed the danger level at Chakia by 45 cm.



- 3.8 1722 boats were pressed into service to evacuate the stranded people. Around 121 relief camps, 24 veterinary camps and 47 medical teams were functioning round-the-clock to provide succor to the affected people. Over 400,000 people were reportedly marooned by floodwaters and were living on rooftops, railway tracks and river embankments without adequate food and drinking water. With no power or telephone lines in most flood-hit areas communication with the rest of the State was cut off however mobile phones worked. Although surrounded by water, most flood victims had no access to safe drinking water.



- 3.9 It was observed that community initiatives had been able to provide only meager help to villagers. In some areas, locals stayed perched on rooftops and trees for days exposed to sun and rains.



3.10 FIELD VISIT OBSERVATIONS

- About 19 million people in 20 districts were affected, about 450 lives were lost, 867. 171 people were evacuated and No of relief camps setup were 128. It was estimated that total damages accounted for around Rs. 10 billions.
- In the discussions with public officials it was found that people are good in emergency management but lack motivation and attitude towards a holistic disaster management approach.
- Response during this year's flood was comparatively good as relief materials, food items etc. were distributed within the first 24 hrs. in most of the cases.
- There were no Standard Operating Procedures followed for flood response Plans were designed and executed on the basis of day-to-day emerging needs. Again, there was no standard response plan formulated for handling the flood situation.
- Air dropping of relief and food materials was carried out on the basis of topographic details of the villages.
- Issues of rehabilitation, water and sanitation and social security came out strongly which require due attention.
- Huge damage to health infrastructure viz. health centres, dispensary, etc. Approximately 235 public health centres were fully damaged.
- About 500 livestock perished in the floods. It was observed that for the purpose of animal evacuation the concerned department had issued instruction to all its field offices, centers, and animal hospitals for better preparation.
- District Disaster Management Plan though available in districts was not put in to use.
- Bihar Institute of Public Administration and Rural Development (BIPARD) Centre for Disaster Management had set up a Unified Command Centre to tackle the flood situation. A Unified control room was also setup and core group of 7-10 NGOs and other organizations were involved in the post flood management activities. This mechanism of co-ordination between Govt. and Non-Government organizations worked well.
- It was found that during the floods in 2004, Hume pipes were constructed which got broken and led to congestion in water flow through these channels was one reason for this years flooding. Many roads were blocked because the flood water got circulated and led to drainage problem.
- Poor and socially marginalized people were found to be the worst sufferers and there was an increase in migration rate as people migrated to towns / cities in search of employment as explained by them.

- Affected Community wants a permanent solution to the recurring floods issues rather than relief efforts only year after year.
- A strong need was felt for an efficient water distribution and preservation system which must be established. Efficient water-shed management is the need of the hour.
- The rain - fall pattern had changed and Bihar received most of its intense rain fall in mid July within 10 to 15 days. Natural flows of most of the rivers in Bihar have got choked on various accounts.
- Due to road construction natural drainage pattern disturbed which led to water congestion and subsequent flooding.
- From the health view point, it was assumed that health issues were same as during other flood situations but, differed in severity and impact. This time prolonged severity was expected along with threat of epidemics spread.
- Embankment work in Bagmati River was still ongoing. The very heavy precipitation within a short period led to siltation and water retention and is attributed as one of the major causes of floods. No de-siltation initiatives were considered as part of a pre-monsoon flood management planning.
- People in the affected districts have become used to the hardships caused by floods however this year the successive bouts of floods over extended period added to their miseries.
- Loss of human lives was less as compared to other major flood in and most of the mishaps were due to accidents like boat capsizing than due to flooding.
- Most of the schools and colleges which can be used as temporary shelters during flood situations have been constructed on low lying areas with poor road connectivity and therefore were of not much use.
- Sanitation for women is a major issue which is generally neglected by local administration.
- Supply of adequate polythene sheets was a cumbersome task in many districts.
- Reaching of relief materials to marooned villages was a difficult task as road communication was distracted.
- In Begusarai district, ICS was applied to a limited extent from 16 September 2007 onwards whereby a separate logistic, operation (district relief centre), and media sections were set up. These sections worked under delegated powers and were engaged in sending relief materials, boats, providing man power etc. Briefing by the District Collector was taken every day at a stipulated time. The improvisation worked satisfactorily and was found an effective tool. A need was felt to have a separate Security and Health section as well.

Inter-agency coordination meeting at BIPARD

3.11 A number of Non-Government organizations presented their field efforts. The major issues that came up during the inter-agency meeting are as under:

- Focus should be given to inaccessible villages.
- Health concerns of marooned villagers be addressed.
- Flood management efforts should not become a one organization show and credit should go to all organizations involved.
- It was found that many of the organizations involved were working slowly and should have been more active.
- Duties for each organization should be well marked/demarcated so as to avoid duplication in relief efforts with good facilitation efforts.

Year	PERMANENT LOSS OF LIFE AND PROPERTY DUE TO FLOOD					FLOOD AFFECTED AREA & POPULATION				
	Human	Animal	Crop Damaged (Rs Lac)	House Damaged Value (in Rs Lac)	Public Property Damaged (in Rs Lac)	Village	Population (in Lac No.)	Animal (in Lac No.)	Land in Lakh Ha.	Houses (Nos.)
2007 (24/9/2007)	852		1,28,443.51	84,222.98	–	10,848	226.37	–	17.56	6,70,398
2006	36	31	706.63	1,225.03	8,456.17	959	10.89	0.1	1.81	18,637
2005	58	4	1,164.50	382.79	305	1,464	21.04	5.35	4.6	5,538
2004	885	3272	52,205.64	75,809.51	1,03,049.60	9,346	212.99	86.86	27.00	9,29,773
2003	251	108	6,266.13	2,032.10	1,035.16	5,077	76.02	11.96	15.08	45,62
2002	489	1450	51,149.61	52,621.51	40,892.19	8,318	160.18	52.51	19.69	4,19,014
2001	231	565	26,721.79	17,358.44	18,353.78	6,405	90.91	11.7	11.95	2,22,074
2000	3336	2568	8,303.70	20,933.82	3,780.66	12,351	90.18	8.09	8.05	3,43,091
1999	243	136	24,203.88	5,384.95	5,409.99	5,057	65.66	13.58	8.45	91,813
1998	381	187	36,696.68	5,503.70	9,284.04	8,347	134.7	30.93	25.12	1,99,611
1997	163	151	5,737.66	3,056.67	2,038.09	7,043	69.65	10.11	14.71	1,74,379
1996	222	171	7,169.29	1,495.34	1,035.70	6,417	67.33	6.6	11.89	1,16,194
1995	291	3742	19,514.32	7,510.44	2,183.57	8,233	66.9	8.15	9.26	2,97,765
1994	91	35	5,616.33	494.77	151.66	2,755	40.12	15.03	6.32	33,876
1993	105	420	13,950.17	8,814.00	3,040.86	3,422	53.52	6.68	15.64	2,19,826
1992	4		58.09	16.14	0.75	414	5.56	0.75	0.76	1,281
1991	56	84	2,361.03	613.79	139.93	4,096	48.23	5.13	9.8	27,324
1990	36	76	1,818.88	160.12	182.27	4,178	39.57	2.7	8.73	11,009
1989	26		704.88	160.73	83.7	1,821	18.79	0.35	4.71	7,746
1988	52	29	4,986.32	211.32	150.64	5,687	62.34	0.21	10.52	14,759
1987	1399	5302	67,881.00	25,789.32	680.86	24,518	286.62	33.25	47.5	17,04,999
1986	134	511	10,513.51	647.24	3,201.99	6,509	75.8	*	19.18	1,36,774

courtesy: report of Disaster Management Govt. of Bihar



Breach of embankment as observed in Begusarai District



Breach of embankment at District Begusarai during floods in 2007



Clockwise from top: women expressing their griefs at a temporary shelter; people staying a relief camp; relief material distribution and single housing shelter per family at a relief camp

Relief and Response Measures

- 3.12 The floods 2007 were indeed devastating as it badly affected 20 districts. About 20.5 million people, or approximately 5-6 million families, in these districts were badly affected. The poor people in particular whose thatched and mud houses, usually located in the low lying areas of the villages, were the most affected as their dwelling units got almost demolished.
- 3.13 **State Response:** The State government mounted an all out effort to meet this challenge on a war footing. Working day and night, the officials were utilising all possible means to reach the flood affected families and provide them relief. The following were some of the immediate relief measures taken by the State in order provide succor to the affected people.
- 3.14 **Deployment of Boats:** About 7000 boats were deployed for rescue of stranded people, providing communication and also distributing relief materials. A number of districts, such as Motihari, Muzaffarpur, Bettiah, where local boats either fell short of demand, or were incapable to ply in the strong currents of flood water, truckloads of stronger midsize boats were transported from Vaishali and Bhojpur districts to overcome these limitations.
- 3.15 **Air force Choppers and Army Boats:** A number of critical areas, that were difficult to reach by boats, were served by dropping off of food packets with the help of four Air Force choppers for about nineteen days, dropping about 71,000 food packets, weighing in total 355 tones. Twenty (20) army boats had been pressed into action in 3 districts to ensure distribution of relief materials to the marooned villages.
- 3.16 **Dry Rations:** About 10,559 quintals of dry ration food (chura, sattu, jaggery, salt, etc.) were distributed. In many places people were additionally being provided with cooked food as well. Along with the dry ration, about 2,00,000 pieces of candle and 150334 matches had also been distributed.
- 3.17 **Cash:** Rs. 32.31 crore was distributed in cash till compilation of this report.
- 3.18 **Polythene Sheets:** About 2,36,000 polythene sheets had been distributed. Additional 1 lakh polythene sheets were supplied to help in setting up temporary shelter.



- 3.19 **Drinking Water:** 126 tube wells had been dug on embankments and other places of temporary shelter to people. Help was even sought from the GE water infrastructure, which provided with their gen-set operated water purifier machines, having a capacity of purifying 1500 liters of water per hour.
- 3.20 **Food grain:** The most critical problem, on account of prolonged floods was of food needs of affected people. The government ensured that it was mitigated to a considerable level by providing 1 quintal of wheat and rice per family. This was decided by the CRF committee in Bihar, and was being ensured in right earnest, leaving none who have undergone the sufferings in the floods. About 5,80,000 quintals of wheat and rice had been distributed. While the Central Government was requested for an allotment of food grain under relief head, the State Government went ahead with the available food grain stock, since this had to take primacy over everything else. However, the first *tranche* of the Center's allotment of 10 lakh quintals rice and 5 lakh quintals wheat was already made. A massive coordination between FCI and SFC, as well as district administration, had been worked out through a meticulous forward and backward planning, to ensure that about 600 to 700 trucks, carrying about 55,000-60,000 quintals of food grain per day, deliver wheat and rice to the affected families in 20 districts, so as to ensure that the distribution was not lingered on for long.
- 3.21 **Housing:** This was the second biggest need of the poor, who suffer the most on this count. Rs. 10,000 for fully damaged kuccha houses, and other related norms under the CRF would allow in mitigating this problem to an extent. However, the State government proposed that these houses be redone with pucca construction using Indira Aawas scheme for natural calamity victims. The survey of destroyed and damaged houses had already begun till compilation of this report.
- 3.22 **Health:** Experiences abound that in the aftermath of a massive flood, peoples' sufferings can increase manifold. Health Department was actively working on this, by ensuring a wide scale campaign for disinfection. Treatment and provisions of medicines for diseases likely to occur, diarrhea, skin infections etc. were made by the Government. UNICEF was also supplementing the efforts of the State Government.
- 3.23 **State support to the Farmers:** Considering the massive scale of crop loss in about 16 lakh hectares this year, the State had decided to provide Rs. 2000 per hectare additional support, over and above Rs 2000 per hectare provided under the CRF norms, to the small and marginal farmers. The State government had further taken a major decision to provide Rs 6000 additional support to other farmers, over and above Rs. 2000 per hectare provided under the latest CRF norms (up to a ceiling of 1 hectare).
- 3.24 **Banks' involvement:** It was decided to stop all loan recovery in the flood affected areas, reschedule them, and further provide consumption loan at a very soft interest rate, and also fresh crop loans, to help farmers to move on to alternative cropping and rabi farming.

3.25 **Coordinating Emergency Response and Relief Operations:**

The Disaster Management Department had been working continuously to ensure effective coordination and synergy of efforts between multiple sectoral departments, district administration, the Army and the Air force, and the NGOs. Timely resource allocation to different departments and field units resulted in allotments to the tune of



Rs. 250 crores under different heads of relief. This was the highest resource allocation ever done for flood relief operations in Bihar, using State's own exchequer. All concerned line departments such as Health, PHED, Irrigation, Roads, Animal Husbandry and others worked to ensure emergency responses in their sectors despite heavy odds.

3.26 **Govt. and Non - Govt. partnership:** The Disaster Management Department had initiated massive coordination with a number of NGOs, civil society groups and the like, working with Oxfam, UNICEF, USAID, Action aid, CARE India, DFID's PACS, Adithi, YMCA, NYK and many others. It further went on to evolve to pool manpower, logistical support, survey and assessment operation, and feedback and surveillance to ensure speedy, transparent, and effective distribution of relief.

3.27 **Village Volunteers raised under Bihar DRM Program:** 14 districts of Bihar are covered under the UNDP-GoI DRM Program. 5,000 volunteers in about 500 villages were raised before the floods through a participatory process. Further, they were trained in search and rescue and first aid by a National Disaster Response Force (NDRF). Many of the villages out of this cluster were affected by the flood. These volunteers were found effective service in rescuing and evacuating people, and also in supervising the relief distribution in their villages.

Assistance from the Central Government

3.28 The State sought Central Government's assistance for short, medium and long term measure to address present distress, effect timely rehabilitation by restoring livelihood and income measures. The assistance sought by the State mainly include the following: -

3.29 **Short Term Measures:**

A. Cash Support: Cash needs to be provided under the CRF at the rate of Rs. 20 per adult and Rs. 15 per child for meeting the needs of food for the affected people, who lost their food items etc., or were unable to get it ready due to other hardships. 204 lakh persons have been reportedly affected until 28th August 2007 assuming a ratio of three adult and two children in the population, this cash need comes to Rs. 1105 crores.

- B. Evacuation, and other costs:** The cost of plying of boats, food dropping operations through air force helicopters, deployment of army boats, purchase of polythene sheets, *ex-gratia* payments to the families of those who died due to floods, other related items, which are all admissible under the CRF norms, have been assessed to be in the range of 100 crores
- C. Food Grain Support:** As stated above, about 20.4 million people had been affected which would roughly mean that 5-6 million families require the relief support. Taking the higher figure of 6 million families, 60 lakh quintals of wheat and rice were provided under the relief head to FCI. An assistance of Rs. 945 crore to purchase the required 60 lakh quintals in total (in the ratio of 75% rice and 25%) was made by the State.

3.30 Medium Term Measures:

- A. Agriculture:** The Flood in 2007 has had an all round serious adverse impact in the agriculture sector of Bihar, damaging kharif crops extensively, as well as sugarcane plantations, and seeds for rabi. The floods came at a time when the State was poised for a major jump in productivity, through higher consumption of fertilizer and improved seed replacement ratio. This year flood has been more devastating for agriculture because of its timing and duration, which coincided with transplantation and establishment of paddy crop in the main field. A total of Rs. 362.33 crores was sought by the State Government towards agriculture input subsidy. The State Government reported a total damage of Rs. 1136 crores in the agriculture sector on account of crop damage and rabi seed damage due to floods.

Department of Agriculture has assessed the following assistance under CRF on the available figures of crop losses in area % where such losses are 50 % or more.

- B. Restoration of Embankments:** The floods breached embankments at 32 points and their immediate restoration along with those required to restore the embankments of minor rivers. On the basis of costs incurred on flood fighting and assessment made for restoration of sluices and damaged canal systems, the State Government projected a requirement of Rs. 521.72 crores.

- 3.31 **House Repair:** Rural poor, mostly live in the kuchha houses in the comparatively low lying areas in their villages, and bear the maximum brunt of floods by way of losing their homesteads. With that they also lose their household utensils, clothing, children's educational resources, and other belongings. The State Government estimated that about 6.0 lakh



houses had been destroyed. The CRF norms provide Rs. 10,000 assistance for fully damaged Kuccha houses and Rs. 25,000 for pucca houses. It is roughly estimated that of the estimated likely 6 lakh houses damaged, 20% of it will be pucca houses. Thus, the assistance needed for such 1.2 lakh damaged pucca houses would be around Rs. 300 crores. The rest 80%, i.e. 4.8 lakh kutchha houses, will require an assistance of Rs. 480 crores. This will add up to Rs. 780 crores. However, in case of particularly the kutchha houses, the assistance of Rs. 10,000 per house will be both inadequate and also not provide a durable housing solution to the poor. Since there is already a program running under the rural development ministry of the GOI for providing Indira Awaas to the victims of natural calamities, it was considered to be of great value if Rs. 25,000 per Indira Awaas unit is dovetail with Rs. 10,000 assistance under the CRF, to make it possible to have a durable pucca construction of houses for the concerned flood affected rural poor.

- 3.32 In total, therefore, the State Government sought an assistance of Rupees 1980 crore, out of which Rs. 780 crore would come from CRF, and the rest Rs. 1200 crore from the existing scheme of IAY for the natural calamity victims. This will go a long way in offering a durable and dignified housing solution to the flood hit rural poor, and also containing the recurring CRF expenditure on this count.
- 3.33 **Highways and Rural Roads:** The unprecedented floods also caused heavy damages to National highways, State highways and large network of rural roads. Over topping of these roads at various points had led to erosion of crusts, breaches and other damages in several kilometers. Besides, a number of bridges and culverts had been extensively damaged; in some cases even washed off. The technical estimation by the road construction department as well as the REO looking after the rural roads had estimated the cost for immediate restoration of these commutation links. The costs, as assessed by the RCD department was of Rs. 1586.10 crores.
- 3.34 **Other Sectors:** PHED assessed that damage to its rural piped water schemes, hand pumps, and other related works would need assistance of Rs. 63.44 crore. The Minor Irrigation Department assessed damages to its lift irrigation and other surface water schemes, which play an important role in augmenting the irrigation capacity of the State to the tune of Rs. 203.37 crore.
- 3.35 **Consolidated list of financial requirements for floods – 2007:** The State Government submitted a consolidated requirement of financial assistance under Calamity Relief Fund covering all sectors for urgent repair and restorations of their damaged infrastructures as well as expenditure already incurred towards relief & rescue etc. amounting to Rs 8000 crore (Table 3.1)

Table 3.1

Sl. No.	Department	Amount Required (In crores)
1.	Disaster Management Department	4130.00
	a. Houses for the poor 1980 crores	
	b. Cost of Food grain 945.00 crores	
	c. Cash for ready food 1105.00 crores	
	d. Rescue and evacuation, Temp shelter, special army/ airforce operations, etc = Rs. 100.00 crores	
2.	Water Resources Department	521.72
3.	Department of Health	25.04
4.	Department of Animal & Fisheries	111.572
5.	Road Construction Department	1586.1
6.	Rural Works Department	511.85
7.	Bihar State Electricity Board	62.37
8.	Public Health & Engineering Department	63.4419
9.	Bihar State Food & Civil Supplies Corporation	0.63
10.	Department of Agriculture	362.32
11.	Building Construction Department	71.198
12.	Department of Industries	166.56
13.	Bihar Education Project	74.35
14.	Department of Social Welfare & SC / ST welfare	8.465
15.	Energy Department	0.896
16.	Department of Urban Development & Housing	57.6903
17.	Human Resource Development Department	6.18
18.	Minor water Resources Department	203.37
19.	Bihar State Hydro Electric Power Corporation	32.00
	GRAND TOTAL	7995.75 or say, Rs. 8000.00 crores

Source : Report submitted by Government of Bihar to the Central Team

PAST APPROACHES, ACHIEVEMENTS AND PRESENT PRACTICES

Construction of Flood protection embankments

- 4.1 Over the last 55 years of plan development, Bihar has been able to provide reasonable flood protection benefits. According to one estimate, only about 42 per cent of its flood prone area, has been covered through flood protection embankments. If the State intends to cover most (over 90%) of its flood prone area by flood protection measures in the next 25 years, flood protection embankments will have to be constructed at the rate of 150 km per year. It was estimated that during the 10th and subsequent Plan periods an annual plan outlay of Rs. 150 crore (@ Rs. one crore per kilometre) would be needed. Secondly, the condition of existing embankments is deteriorating day by day. The bed level of rivers is rising every year on account of siltation. The raising and strengthening of embankments, therefore, needed to be taken on a priority basis. Construction of Pucca road on the existing embankments will ensure rapid inspection and execution of anti-erosion as well as flood fighting works and provide all season road communication in rural areas of the State. This will also facilitate other development works in the area.
- 4.2 While dealing with the flood problem in North Bihar, focus has by and large been on construction of embankments aimed at preventing the flood flows from inundation of the overlying plains. Experts are of the view that this approach is too simplistic and ignores vitally related realities. First of all, embankments interfere with the drainage function of a river which serves as a natural drainage channel for the related catchment area, thus disturbing the drainage of the area sought to be protected against floods. Secondly, it disregards a dominant component of the flood flows, i.e., silt transport by the river which carries more than 90% of the annual silt load during floods. This gives rise to several seriously adverse consequences. Thirdly, embankments progressively become more prone to overtopping and breaches. This renders the fury of floods more destructive and devastating.
- 4.3 By the time India got its independence in 1947, there were embankments of a total length of 5,280 Kms in various river systems providing protection to an area of about 3 Mha. Since then the problem of flood management was referred to various committees from time to time. The recommendations of some of the important Committees/Task Forces constituted by the Government of India are **Annex - III**.

Irrigation, Water and Flood Management

- 4.4 The various committees constituted invariably recommended that all irrigation projects should address flood moderation. Though the whole of Bihar lies in a humid zone with an annual rainfall of more than 11-1200 mm which is sufficient for kharif crops like paddy and maize, the occurrence and distribution of rains are highly erratic and distinctly seasonal in character. The consequences become very severe where paddy which is

highly sensitive to droughts is the most important crop covering about 66 percent of the net cropped area. By providing water during lean months, irrigation extends the period of cultivation beyond monsoon months and facilitates multiple cropping. In addition, it adds substantially to agricultural output by changing the cropping pattern in favor of high yielding and superior crops

- 4.5 The irrigation potential through surface water sources in the State has been assessed at 67.03 lakh hectares (53.53 lakh hectares through major/medium schemes and 10.5 lakh hectares through minor surface irrigation schemes), while irrigation potential through groundwater in the state is 39.06 lakh hectares. Thus, taken together both surface and ground water sources, the ultimate irrigation potential of the State is estimated at 103 lakh hectares which comes to 7.34 per cent of India's total of 140 million hectares (Table 1). The total irrigation potential, however, far exceeds its gross sown area of around 80 lakh hectares and net sown area of 56 lakh hectares. Even if the cropping intensity in the State rises substantially in future and goes up to 200 percent from the present 143 per cent (Punjab level being 190 per cent) and the total sown area goes up to 112 lakh hectares, the ultimate irrigation potential of the State will be sufficient to cover nearly this entire area

Table 1 : Ultimate Irrigation Potential in Bihar

(in Lakh Hect.)

Source	India	Bihar	% share of Bihar in India
I. Surface Water	737	63.58	8.63
(a) Major + Medium Schemes	585	53.53	9.15
(b) Minor Irrigation	174	10.05	5.78
II. Ground Water	641	39.06	6.09
Total (I + II)	1399	102.64	7.34

Source : Central Water Commission, Dept. of Water Resources, Bihar and Central Ground Water Board.

Potential for Irrigation

- 4.6 Surface irrigation projects suffer from a number of disabilities. They are mostly rainfed and are affected by the vagaries of rainfall particularly during periods of prolonged rain failures. Limited water supplies are mostly appropriated by upper reaches of the command. The most pertinent case in point is the failure of the canal water to reach the tail ends of the command in the Sone canal system during the 1979-80 drought. They also involve large gestation gaps and huge costs in terms of water logging, salinity and gross wastage of water through seepage and evaporation. Some of the major irrigation schemes (including Gandak) are not complete fully even after more than 30 years since inception. The quantum of water logged lands in the command areas of major irrigation projects in India has been assessed at 1.59 million hectares. In this, the share of Gandak Project amounts to 0.33 million hectares which comes to about 35 percent of its culturable command area of 0.96 million hectares. Depending on soil conditions and size

of the project, the conveyance losses in India vary from 20 to 50 per cent of the water released at the canal head. These losses come to around 50 per cent in the Gandak project against projected 30 per cent. Finally, irrigation potential of schemes is often overestimated. The projects have not been properly executed and they are mostly incapable of carrying their designed discharge. They are also beset with major distributional problems and exhibit large gaps between their potential and utilization. Thus, as shown in Table 17, during 2004-05, the actual irrigated area through major/ medium schemes in the State stood at 14.88 lakh hectares which came to 56.82 per cent of their created potential (26.19 lakh hectares).

Poor Maintenance and Decay in Water Carrying Capacity:

- 4.7 A large chunk of capital has been invested in major/medium irrigation projects and they form a very valuable resource for the development of the State. For making their contribution towards enhanced productivity, the system of operation and maintenance must be of high quality. However, in absence of fund availability, the systems have deteriorated. The seventh conference of irrigation ministers of India held on 15.12.1983 recommended a provision of Rs 100 per hectare of the created irrigation potential towards maintenance and operation grants of surface irrigation projects. At 2000-01 prices, the required sum would be around Rs. 400 per hectare. During 2000-01 expenditure on this account came to Rs. 100 per hectare in Bihar against the recommended amount of Rs. 400. Instead of the increased level, the amount spent on the maintenance and repair of these schemes declined over time though things have changed for the better after 1995-96. Therefore, the condition of most of these schemes is far from satisfactory and, they are not in a position to carry more than half of their full designed discharge, even when there is abundant water in the rivers supporting them.

Flood Control and Drainage

- 4.8 As we understand that on account of its geographical location, Bihar is the most flood prone State of India. Nearly all north Bihar rivers originate from Nepal or Tibbet and have around 75 per cent of their catchment outside the State, mostly in the Himalayan ranges which have very high rains aggregating 2500 mm annually in upper portions, of which over 80 per cent occurs during the four rainy months from June to September. Higher rainfalls in upper catchments having very steep gradients result in formation of very high flows in these parts. As the gradients change sharply from very steep in mountainous and sub-mountainous areas to very mild in north Bihar plains over rather a short distance, the carrying capacity of the rivers in the plains are far exceeded by the high monsoon flows, resulting in vast inundations over the plains. A flat area of 21453 sq. miles has to drain off the rainfall of about 60000 sq miles of the Himalayas and its foothills besides its own fairly heavy rainfall aggregating 1300 mm annually. The flood situation aggravates when the Ganga itself is in high spate and Bihar rivers find it difficult to drain in to it

because of poor outfall conditions. The large hill catchments, the relatively small areas in the plains through which all the water has to drain off, the steep gradient in northern parts and the sudden flattening of the gradient in lower southern parts, and excessive silt discharge in rivers. All these contribute to this area being particularly vulnerable to highly destructive floods. Thus, the State contains less than three percent of the geographical area of India but has a flood prone area of around 68.6 lakh hectares which comes to 17.15 per cent of India's total of 400 lakh hectares.

Drainage

- 4.9 A good part of flood prone areas in Bihar also suffers from the problem of surface water congestion and water logging. It has been estimated that about 9.41 lakh hectares of land suffer from the problem of water logging in perpetuity of which 8.35 lakh hectares lie in north Bihar and the rest in south Bihar. North Bihar plains are interspersed by a number of rivers which have meandering tendencies due to too flat topography of the area. For the same reason, the area is full of depressions called *mauns* and *chaurs*. Water accumulates in these depressions, causing acute drainage congestion and water logging problems. It has been found by experts that it will not be economical to free 2.5 lakh hectares of land from water logging due to excessive depth. Such areas are fit for only pisciculture. At present, the irrigation potential created in major irrigation projects in north Bihar is not being utilized fully also because of low lying areas in their command remain under water for most of the year due to surface drainage problem. Without tackling drainage problems, the irrigation potential will continue to be underutilized.
- 4.10 A number of drainage schemes were designed and executed during early eighties but after that due to paucity of funds, the works of drainage schemes remained virtually stand still. Though some schemes were executed partially, they could not produce substantial benefits due to non-completion of these schemes on account of resource crunch. At the beginning of 10th Plan, over 5.0 lakh hectares of water logged area remained to be drained against 6.9 lakh hectares. In the 10th Plan it was intended to free 1.67 lakh hectares of water logged area by completing 36 drainage schemes (11 ongoing and 5 new schemes) with an outlay of Rs. 254 crore.

Mokama Tal Drainage Scheme

- 4.11 The Mokama group of tals (a local name of low lying areas) is a saucer shaped depression running along the right bank of the river Ganga from Fatuha in the west to Lakhisarai in the east-spread over an area of 1.06 lakh hectares. It extends in length of about 105 Km and varies in width from 6.5 to 17.6 Km. The land surface between the tal area and the river Ganga is rather high and the natural drainage across this land is not possible. Hence all river/rivulets flowing north ward between the river Punpun in the west and Kiul in the east take a turn, as they approach the river Ganga towards the east and move along it

before they find a suitable outlet into Ganga near Kiul. In the process, they submerge large areas under deep water during rainy months converting the area into a vast sheet of water. On account of this, cultivation during rainy months in the area is not possible and only rabi crops (mostly pulses) are grown, when rain water is drained out. To improve the situation, therefore the government has formulated and launched a scheme known as Mokama Tal scheme. The main ingredients of the scheme are:

- (a) Construction and completion of the proposed Punpun right bank embankment to prevent the Ganga backflow into Tal through the Punpun at Fatuha.
- (b) Construction of feasible storage reservoirs with adequate flood cushion in the upper catchments of the north flowing rivers draining into the Tal.
- (c) Clearance of encroachments and renovation of the approach and exit channels early draining of Tal area as soon as the Ganga levels go down at different outfalls. Sufficient waterways are required to be provided under road rail bridges.
- (d) Channel improvement of various streams and the main channel i.e., the river Harohar and if so required channelling of the river Ganga in the reach near confluence of Kiul-Harohar-Ganga.
- (e) Conjunctive use of surface and ground water for post monsoon irrigation. Installation of buffer dams at appropriate locations in the streams.

Command Area Development Programme

- 4.12 In Bihar the command area development programme has been taken up in command areas of seven major irrigation projects, namely, Sone (main, high level and north Koel system), Gandak, Kosi, lower Kiul-valley, Badua and Chandan. The programme in these projects are being implemented through four CAD agencies consisting of (1) Sone, (2) Gandak, (3) Kosi and (4) Kiul-Badua-Chandan since 1974-75. The cultural command area of these seven irrigation projects is about 22.60 lakh hectares which comes to around ten per cent of India's total of 22.72 million hectares.
- 4.13 The physical progress of the programme in the State till March 2002 is estimated at 14.39 lakh hectares provided with field channels, 2.01 thousand hectares provided with field drains 570 hectares covering under land levelling and shaping 6.58 thousand hectares reclaimed from water logging, and 1.46 lakh hectares covered under Warabandi. From the above account, it is clear that among the various components of the programme the progress has been the least in the field of land levelling and shaping. The progress of field drains too has been meager. There is, in fact, little appreciation for field drains in a predominantly paddy growing area like Bihar. Farmers feel that drainage is not necessary for the paddy crop. The progress has been most impressive in respect of field

PAST APPROACHES, ACHIEVEMENTS AND PRESENT PRACTICES

channels. However, field channels are mostly earthen which often get damaged in a flood prone area like Bihar.

- 4.14 The most disturbing aspect of the programme in the State has been the unprecedented rise in the share of Government establishment charges in total expenditure which has risen from less than ten per cent till 1989-90 to around 66 per cent during 1990-02, leaving very little to be spent on actual work. This, in turn, has brought down considerably the pace of physical progress of the programme after 1991-92 in the State. The problem needs to be probed deeply and remedial measures taken. In fact, the State government has already moved in that direction. The new measures are accelerate the CAD programme.

Present Practices

- 4.15 **Development Strategy:** Water resource development is considered as the key in the development Strategy of Bihar. Therefore, this sector needs a good package of investment and policy direction. Enhancement in Public Investment
- 4.16 The flood mitigation is critically dependent on acceleration in public investment for water resources development. Investment in irrigation (major/medium) sector is being accelerated. However there is substantial erosion in the existing capacity for want of adequate maintenance and repair. Hence, there is a strong case for renovating and strengthening the already completed or partially completed schemes on a massive scale. On economic grounds, given the option, it is more economical to renovate and strengthen the existing system and increase their efficiency rather than go in for new projects.

Completion of Interstate Projects

- 4.17 After separation of Jharkhand, five major on going irrigation schemes, namely N. Koel, Batane, Tilaiya, Barnar, and Upper Sakari have become inter-state. These need to be completed on a top most priority basis in the 10th Plan. They are likely to cost Rs. 800 crore. As the major beneficiary of these projects, Bihar should agree to bear 100 percent of their costs.

Physical Progress of Flood Protection Works in Bihar

Upto March	Length of Embankment	Area Protected (in lakh (in km) hectare)
1964	1108	12.40
1969	1772	12.40
1974	2192	15.00
1980	3059	26.05
1990	3420	28.68
2004	3430	29.16

Source: Department of Water Resources, Bihar, Patna

Region-wise Status of Flood Protection Works in Bihar
(As on end-2003-04)
[Area in Lakh Hect .]

Items	North	South Bihar	State Bihar
Total Geographical Area	53.80	40.35	94.15
Flood Prone Area	44.46	24.34	68.80
% of Flood Prone to Geographical Area	82.64	60.32	73.07
Length of Flood Protection Embankments (in km)	2952	478	3430
Protected Area	27.16	2.00	29.16
Protected Area as % to Flood Prone Area	61.09	8.21	42.38

Source : Water Resources Department, Govt. of Bihar

Physical Progress of Some Key Items Under CADP in Bihar
(in '000 hectares)

Items	1974-80	1980-90	1990-92	1992-02	total
Construction of Field Channels	13.76	824.32	550.58	50.10	1438.76
Construction of Field Drains	0.59	1.42	-	-	2.01
Land Levelling and Shaping	0.092	0.478	-	-	0.57
Reclamation of water Logged area	-	-	-	6.58	6.58
Enforcement of Warabandi	-	71.45	65.54	8.76	145.75

Source : Agriculture (Special Programme) Department, Bihar, Patna.

- 4.18 A rational approach to deal with the problem of North Bihar floods is, first of all, to view the flood events in their comprehensive hydrological perspective in time and space. In this view, floods will not be an isolated physical event but rather will be a part of all interdependent processes and events and will be tackled as such. This will require integrated water resources management of river basins which are shared by both India and Nepal. On an average, 50% to 85% of basins of North Bihar rivers lie outside North Bihar, mostly in Nepal. In this approach, excessive water causing damaging inundation, unharnessed energy causing destructions and silt getting deposited in unwanted places, all contained in floods, will be harnessed to beneficial uses such year round irrigation, cheap inland transport and large hydroelectricity. Thus, the problem of floods will not only be sustainably solved but rather the floods will be transformed from a devastating event into a development scenario.
- 4.19 Structural measures alone are not sufficient to achieve the desired result regarding flood management. The scope for the flood control schemes is dependent on the design criteria to other techno-economical considerations. Therefore, a judicious mix of structural and non-structural measures should be the pragmatic realism in flood management. Flood Hazard Mapping is a vital component for appropriate land use planning in flood-prone areas. It creates easily-read, rapidly-accessible charts and maps which facilitates the administrators and planners to identify areas of risk and prioritize their mitigation/ response efforts. Systems and structures related to flood emergency management also being strengthened.

RECOMMENDATIONS/SUGGESTIONS

- 5.1 The plains of north Bihar are one of the most susceptible areas in India, prone to flooding. Despite enormous efforts made the problem of flooding is still a challenge in this area. The problem of river flooding is getting more and more acute due to human intervention in the flood plain at an ever increasing scale. The need of the hour is to adopt an integrated, multi-hazard, multi-stakeholder, approach with emphasis on disaster risk mitigation, preparedness, streamlining of relief distribution system, with emphasis on self reliance of the community for sustenance with local resources and practices. The Government inter-alia should take up the following structural and non-structural measures to manage floods in a holistic manner.

STRUCTURAL MEASURES

5.2 Construction of Dams/Hydroelectricity Projects

Floods in Bihar plains are caused primarily from the generation of high flows in upper catchments of rivers on account of extremely high rains and steep gradients. The natural and long term solution to the problem, therefore, lies in controlling and regulating the flow of rivers by providing a number of reservoirs in the upper reaches of the main rivers and their tributaries. These reservoirs should be multipurpose in nature which will go a long way not only in reducing the flood fury in the region but also in substantially augmenting the lean period discharge of these rivers which can be utilised fruitfully for irrigation and other purposes through a number of irrigation schemes (both existing as well as proposed) located downstream. These scheme will be mostly in Nepal and north Bihar. Since, the existing irrigation projects in north Bihar latter often suffers from the problem of inadequate discharge during lean months in rivers supporting them construction of dams at upper reaches will be very beneficial. There is potential of generation of huge amounts of hydroelectricity at very low costs which will go a long way towards meeting the energy requirements of both Nepal and Bihar which form one of the most power starved regions of the world.

- 5.3 Sites for multi-purpose hydroelectric projects on the tributaries of river Kosi have been investigated and a high dam at Barahshetra (in Nepal) is proposed. This will generate hydro-electricity and will extend irrigation benefits to a large area both in Nepal and Bihar. Similar projects can be investigated and proposed on other major rivers originating in Nepal and flowing through the State.
- 5.4 Many long term solutions lie in a coordinated effort with the Nepal, particularly the re-forestation in the upper catchments areas as well as river taming programmes in the higher reaches both for better flood management and generation of Hydro-electric power. In view of their immense economic benefits to both the countries, both the parties should come forward and cooperate with each other in harnessing the same.

- 5.5 **Construction of Embankments:** Under the National flood management programme launched in 1954, a total length of 3430 kilometers of embankments had been constructed in the State. A total area of 29.16 lakh hectares has been provided with a reasonable degree of flood protection benefits in the State till March 2004, which covers about 42.08 per cent of the total flood prone area of the State. However, this percentage is much lower than the all India average of over 61%. Moreover, there has been a significant deceleration in flood management programme during the nineties in the State, both in financial and physical terms. During 1990-2004, the State has been able to add annually hardly one kilometer length to its embankments and hardly 5 thousand hectares to its flood protected area. The situation, therefore, needs to be remedied so as to substantially accelerate the pace of flood management works in the State.
- 5.6 Of late, a number of breaches have taken place in the embankments. A study needs to be initiated on causes of breaches in the embankments along with strengthening and maintenance issues. There is also a need for putting in place mechanism of community involvement in maintenance of embankments for effective implementation in the pre-monsoon seasons itself.
- 5.7 Though, embankments are good to channelise the flow of rivers in normal times, embankments also effect the natural drainage pattern of rivers and this leads to water logging in the other side of the embankments. This is a major problem and needs solution with the active participation of people. Each water logged area is unique and requires local solution. Therefore, extensive study requires to be undertaken before construction of embankments.
- 5.8 **Drainage:** A good part of flood prone areas in Bihar also suffers from the problem of surface water congestion and water logging. According to one estimate about 10 lakh hectares of land suffer from the problem of water logging in perpetuity. About 60% of the estimated water logged area still suffers as it remains to be to be drained. The government should think in terms of accelerating the work so as to complete the task in a time bound manner. Further, even the completed works are not yielding the desired results due to their poor maintenance which deserves to be paid due attention.
- 5.9 **Highways & Roads:** Any construction of Highways & roads should take into account the drainage pattern and natural flow of water. Highways & Roads should not obstruct the natural drainage pattern and pose threat to flooding. Further, proper maintenance of roads and commutation routes must be ensured timely before flood season starts. Highways & roads should provide connectivity in floods situations rather than contribute to flooding. Any development of highways and roads should therefore mainstream disaster risk reduction.
- 5.10 **Desiltation Strategies & Dredging Operation:** In the case of Bihar, siltation is a major and prominent cause of flooding of most of the rivers. Since many major river systems in

Bihar are clogged up and over silted, an efficient de-siltation strategy must be adopted. A massive dredging operation needs to be undertaken. The integrated drainage system in Kosi and Gandak formulated in 1986-87 and subsequently reiterated by the Task Force of the Planning Commission has yet to be implemented due to paucity of resources. This may be undertaken in right earnest.

- 5.11 **Afforestation:** There has been loss of forest cover over the years in the catchments areas. Concerted action is required to be taken so as to restore the eroded green cover of the catchments areas of rivers to regulate water flows. In addition, soil conservation and works in catchment areas should be undertaken to help in reducing run off of rain water and the silt content in flood waters.
- 5.12 **Innovative flood and seismic-resistant Housing:** The State government should work for bringing an innovative housing project specially for the poor, whose kuchha houses encounter repetitive destruction by the floods year after year, to ensure that those are replaced by flood and seismic- proof durable homes. It is seen that floods and earthquakes are major disasters in the State. Some of the districts may get affected by flood and earthquake *simultaneously* also. It is therefore considered imperative that the State Government should incorporate innovative flood and seismic-resistant housing in the vulnerable districts.
- 5.13 **Construction of Multi-purpose shelters:** It is observed that lakhs of people are forced to live on the temporary shelters made of polythene sheets either on the roads/highways or embankments for months together. There are absolutely no arrangements for any amenities including that of water, sanitation, health etc. Since floods have become annual event and are likely to continue in the coming years, the State Government may consider to construct multi-purpose shelters at Panchyat level in the most vulnerable areas.
- 5.14 **Planning of human settlements with due consideration of likely future Hazards namely earthquakes and floods:** The State should consider amendment in the Town & Country Planning Act to include consideration of Natural Disasters, amendment and enforcement of Master Plan & Development Area Rules & Regulations to take into account the Hazard Proneness in Land Use Zoning, enacting Land use Zoning Regulations for use in new settlement planning or in the development of existing settlements, marking of high flood level (HFL) in each flood prone settlement using suitable permanent buildings or structures, or through a permanent masonry pillar to guide the population against flood hazard in the settlement, taking action for flood protection and fixing plinth level of new constructions.
- 5.15 **Reconstruction of Houses and other infrastructure:** The reconstruction of fully damaged dwelling units in the flood affected districts shall be undertaken so as to be effective against floods and earthquake. Since many of the districts are both flood affected and in the high seismic zone reconstruction of deserves priority. Similarly the

reconstruction of roads in many areas need to be raised and strengthened with improved design also some other infrastructure both for acting as storage for food-grains as well as designated buildings on High Land or suitably raised which can act as flood/earthquake shelter.

NON-STRUCTURAL MEASURES

There must be a realization that minimizing the risk and damage from floods may be possible by adopting a multi-pronged strategy with a mix of structural and non-structural measures. Following Non-Structural measures are suggested:

- 5.17 **Flood Hazard Zoning:** The regulation of flood hazard areas coupled with enactment and enforcement of flood hazard zoning could prevent damage of life and property from flooding in short term as well as in long term. Flood management and control are necessary not only because floods cause devastation, but the optimal exploitation of the land and proper management and control of water resources are of vital importance for bringing prosperity in the predominantly agricultural based economy of this densely populated State. This cannot become technically feasible without effective flood hazard maps. Flood hazard mapping and flood inundation modeling are the vital components in flood mitigation measures and land use planning and therefore should be taken up without loss of further time.
- 5.18 **The Flood Forecasting Network:** The flood forecasting network of the Central Water Commission comprises of over 170 stations dotted all over the country. The flood bulletins issued by CWC however seems to have failed to reach the target communities and timely alerts are hardly reached to the people for evacuation. The CWC network is supposed to issue both river stage forecasts and water inflow forecasts however the required actionable forecasts do not reach the people in time. The general issue of inter-basin water and flood management strategy needs to be suitably addressed. A network of automatic weather stations should be in place including a widespread satellite based automatic weather station at divisional and district headquarters as well as specially selected sites within the catchments areas of rivers for a better picture on precipitation of water flow rates and water levels. This can be done in co-operation with ISRO for devising a real time flood monitoring system. The Central Water Commission which has the responsibility to make suitable forecasting about quantum of water which could flow in the river, has to develop a more accurate and simulated model of interstate river system with suitable measures in place. The State Government should develop a protocol for dissemination of flood warnings and evacuation.
- 5.19 **Flood Resistant Crops:** Crops have been developed which are flood resistant and therefore, a system should be developed for changing cropping patterns by farness of such flood resistant varieties by adopting agriculture practices so as to minimize losses in

crops during floods. Revival of flood resistant crops and research for appropriate technology should also be encouraged further.

- 5.20 **Self Help Groups/ Micro-finance interventions:** SHG is group of rural poor who volunteer to organize themselves into a small group (10-20 persons) for eradication of poverty of their group members. They agree to save regularly and convert their savings into a common fund known as the Group Corpus. The members of the SHG agree to use this common fund and such other funds that they may receive as a group through a common management. Such SHG group formations must be initiated amongst the flood affected community members with the support of government, voluntary organizations and local authorities. SHGs have been very successful in many States. Micro financing is considered as one of the effective ways in the restoration of livelihood to marginal and vulnerable sections affected frequently by disasters. The State Government should promote SHG / Micro – finance interventions.
- 5.21 **Water Based Industries:** Reservoirs can be developed with a good maintenance system where water can be stored in the flood prone areas. This will promote alternative livelihood in the rural areas. For example, areas where the farm lands are damaged, fishing can be promoted, therefore, encouraging fisheries and related water resource cultivation. Livelihood diversification should be promoted at large scale in the vulnerable communities.
- 5.22 **Promotion of Indigenous Knowledge and Early Warning System:** The mechanism to reach to the vulnerable communities / villages by way of early warning is required to be revamped. Local wisdom and indigenous knowledge for early warning should be merged with modern technology.
- 5.23 **Risk Mapping at Village Level:** Hazard identification, vulnerability analysis, and risk mapping should be carried out at village level to determine the hazards likely to affect a community. The capacities of local community to withstand disaster conditions should also be determined along with assessing gaps and additional capacity development requirements in terms of emergency responders, medical personnel / paramedics, communication systems, resources and equipments etc. The aim should be to build capacity at village levels to make them self-reliant for annual flood.
- 5.24 **Setting up of a Flood Management Institute**
- The National Disaster Management Authority has proposed to setup a dedicated institution for flood management. Bihar being one of the most vulnerable States may be considered by NIDM for setting up of this Institute.

Disaster Preparedness Measures:

Community Based Initiatives:

- 5.25 **Community Training:** Community based disaster preparedness measures should be given priority. Community should be mobilized for taking up micro level initiatives to reduce their vulnerability to floods which is increasing year by year. The community members should be trained to develop their village disaster management plans, constitute task forces for early warning, evacuation, search and rescue, first aid, etc. and provide them with training. Also, reviving local traditions of flood management and coping with floods must be promoted.
- 5.26 **Involvement of Panchayats:** Panchayati Raj Institutions should be actively involved in preparedness and mitigation trainings, awareness, contingency planning, mock drills, etc. It is observed that equipments and resources like boats, medical kits, shelter kits, relief supplies etc. which are of utmost importance to save lives in flood situations are non – existent at Panchayat level. Only after a major flood situation, efforts are made to channelize relief supplies through panchayats. This system of ex-post involvement of panchayats does not serve much purpose. Rather, a system to pre – position essential items at the level of Panchayats would go a long way in cutting response time. Life saving items like boats, lifebuoys, life jackets, anti – venom serum, water purifying tablets etc. should be stocked at Panchayat level before onset of floods seasons.
- 5.27 **Village Grain Banks:** The system of establishment of Village Grain Banks should be initiated, as a food security measure in the districts where floods are an annual phenomenon. This would promote community participation thereby making them self-sufficient in terms of food during critical phase when government machinery is unable to reach with relief supplies.
- 5.28 **Capacity Building**

Given, the vulnerability of the State, the capacity for disaster response, both at the State and the district level is grossly inadequate. Whatever limited human resources are available, they are poorly trained and inexperienced. Capacity needs to be developed across all sectors at all levels.

For capacity development on management of floods, followings are recommended:

- 5.28.1 **Awareness Generation:** Mass Awareness campaigns focusing on actions required to be taken for safety of the people, their property and infrastructure etc. in pre – floods, during floods and after floods should be undertaken. National Disaster Response Force (NDRF) has initiated community capacity building initiatives and the State Government should also utilize their services.

- 5.28.2 **Training of officials:** Training of officials at cutting edge levels on various aspects of flood management should be done. District collectors and his / her team should be oriented / trained before on – set of flood season.
- 5.28.3 **Positioning of Critical Resources:** Adequate number of boats of various kinds including flat bottom boats useful in shallow waters, as well as V bottom boats which can navigate in high current needs to be purchased and positioned at District and Panchayat levels. Similarly, adequate number of dewatering pumps of varying capacity ranging from 10 horse power to high speed 150 horse power need to be kept in reserve to be utilized on short notice.
- 5.28.4 **Capacity for Rapid Damage Assessment:** It should be considered to develop a system for rapid damage assessment as it was observed that almost after 2 months after the first round of flooding, damage assessment was being made and photos of damaged houses were taken. Most people would not wait for so long to repair their houses. If they undertake repair jobs, they do not receive adequate grants for the same.
- 5.28.5 **Development of Water Based Transportation:** It was observed that most villages were so badly devastated and marooned that it was next to impossible for voluntary organizations to reach relief materials. In such cases, only water based transportation could be utilized. Therefore, development of such facilities should be looked at and initiated at Panchayat levels. Similarly, setting relief centers away from the marooned villages also becomes an issue for many affected families as they are not able to go and collect their share of relief for want of adequate transport.
- 5.28.6 **Positioning one battalion of National Disaster Response Force**
- Given the vulnerability to floods, and also many parts of Bihar falling in highly sensitive seismic zones 4 and 5, the State Government has requested NDMA to position one battalion of National Disaster Response Force in Bihar, which will go a long way in making quick and effective response to emergency situations arising from especially recurring flood and also in case of other disasters. This must receive priority consideration.

Measures for improving Response and Relief

Relief Distribution

- 5.29 **Development of Database:** A database of demographic details at village / panchayat level should be prepared and updated periodically as this will facilitate proper and fair distribution of relief materials to the affected people.

- 5.30 **Food Items:** It was observed during the 2007 floods that wheat was distributed as a part of food package which could not be used by a large number of affected people for want of flour mills. Most people affected who were staying in temporary shelters on Roads/Highways/ Embankments did not have wherewithal to use wheat. They preferred rice as it was easy to cook. Therefore only such food item should be selected for distribution which could be readily used and are part of the local dietary habits.
- 5.31 **Quantity and Type of Relief Items :** Some people during the visit of study team complained of inadequate food supply, distributed by State as part of relief material. There were cases of exclusion if the village list did not have the name of the affected persons/families. For example widowed daughter does not constitute part of the family/village and was not to be included for relief. Therefore, these aspects should be considered while relief distribution works are on. The relief distribution system should be changed to make it more transparent and easily accessible to affected people. There were instances where the villagers had to walk / travel through long distances and incur expenditure on transporting the relief material. In such cases, many of them preferred to sell out the relief material rather than transporting them. Air dropping of food material should be avoided as far as possible and should be used a last resort only. There were instances of considerable loss of air dropped materials and also clashes among public and even death of a person is reported by media. Pre - positioning of relief materials and establishment of grain banks should be undertaken.
- 5.32 **Clothing:** Generally it was observed that each relief kit contained only one pair of clothing for the male and female member of each family and children's were mostly neglected in this regard, though, on the contrary they are the ones who need more number of clothing's as they have a tendency to play in the open and during rains may need extra dry clothes. This issue should also be taken into consideration while preparing the relief kits.
- 5.33 **Equity Issues-** Bihar has still a strong caste / sub-caste system. There were reports of discrimination against dalits and others socially and economically backward classes in relief distribution. In fact, these people are more in need of relief as non – availability of food for sustenance may lead to more number of deaths due to malnutrition. Further, a prevalent custom is that the married daughters of families are not considered as family members and not named in the relief lists. Many times when these girls turn widow and head back to their native villages they are not eligible for getting any relief benefits. This kind of entitlement issue should be addressed by the government and necessary policy interventions be made.

Other Issues

- 5.34 **Health Issues:** Medical Kits must be prepared and stocked at the Panchayat level. Community Members / villages should know how to use them for protecting themselves

against post flood preventable diseases like diarrhea, snake bites etc. Awareness on health and sanitation aspects would save many lives particularly in post flood situations when water recedes and water borne and vector borne diseases assume epidemic proportions and cause deaths.

- 5.35 **Sanitation:** It was observed that sanitation facilities especially for women was an issue of concern especially when the entire stretch of land get flooded. They have to travel long distances, sometimes through the water for defecation. Thus, adequate provision of sanitation facilities should be made. Further open defecation become a major cause of contamination of water sources.
- 5.36 **Drinking Water:** This was again a major issue of concern. During floods and in the post - flood scenario, contamination of drinking water sources takes place. Hand pumps at raised platforms for drinking water, distribution of water purification tablets as a part of the Medical kits, making the communities aware about the necessity of use of safe drinking water should be undertaken.
- 5.37 **Compensation for Farm Labourers:** Under the existing scheme, compensations are paid only to the land owners for their agricultural losses. There is no provision to compensate loss of livelihood for farm laborer /daily wage workers who do not get jobs till the next farming season is restored as there are hardly any alternative means of livelihood.
- 5.38 **Protection of Animals:** Livestock are an important source of livelihood and income for most of the poor families living in villages. A large number of animals perish in floods in the State every year thus causing loss of livelihood and source of income for survival of families. Further, during floods, managing adequate fodder for their animals becomes a major issue. Many times the people have to walk long distances in order to fetch fodder for their animals. These have been instances where some people have died when traversing through the flood water in search of fodder for their animals. Therefore, provision of not only fodder but animal shelters should be kept in mind in the pre - disaster preparedness.
- 5.39 **Insurance:** Floods cause immense loss to all sections of society. It further leads to the increase in indebtedness of farmers, daily wage laborers at the hands of local money lenders who further exploit them. Therefore, there should be some provision to compensate the losses caused by floods. Insurance schemes for vulnerable groups may be promoted.
- 5.40 **Education:** The severity of flood situation in Bihar during 2007 was so grim that for 2 – 3 months the schools remained closed. Most of the school buildings were under flood water forcing the authorities to keep schools closed. This adversely affected the students and also caused school dropping. The school building should be either relocated to

higher zones so that at least children do not have to compromise on their education or some alternate arrangements should be made even though on temporary basis to address this issue.

- 5.41 **Child Labour and trafficking:** Floods cause loss of lives, livelihood and source of income forcing many children to resort to work as labourer. These children are forced to migrate to cities / urban centres and are also prone to trafficking. Arrangements may be made in collaboration with voluntary organizations to deal with this problem.



I... still am managing.....!!!!!!

ANNEXURE - I

Hazard Vulnerability Profile of Bihar

Devastation of floods has become a recurrent annual feature in India. Within India, the eastern and north eastern regions suffer the most and Bihar being one of these states. Floods cause enormous damage to life, property and disruption to infrastructure along with emotional and psychological instability. Hence, proper management of floods constitutes an important element in India's national development activities. Flood management neither aims at total elimination or control of floods nor can provide total immunity from the effects of all magnitudes of floods. As per statistics of flood damages furnished, it is seen that on an average 7.56 million ha. of area is affected annually out of which 3.55 million ha. is the cropped land. Floods have claimed on an average 1595 lives and 94,772 livestock's. Annually 1.2 million houses are damaged by floods alone.

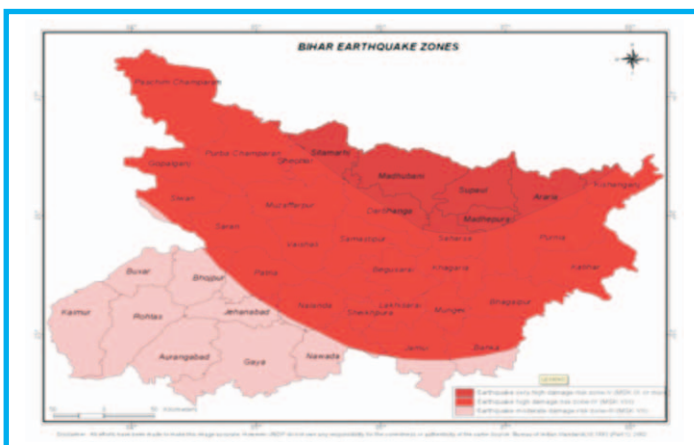
Geographical Situation of the State

- 17 % of the country's flood area lies in Bihar.
- 72 % area of the State is flood area.
- Frequent change of river course eg. Baghmati.
- Frequent Droughts.
- High wind velocity in the most part of the State.
- Quite often hailstorms are experienced.
- Recurrent village fire in hot summer months.
- clod wave
- Earthquake zone-IV and V
- Some district of North Bihar as vulnerable as Bhuj of Gujarat

Location: Bihar is one of the major states of the Indian Union located at 25.11 N Latitude and 85.32 E Longitude. Bounded on the north by Nepal, on east by West Bengal, on west by Uttar Pradesh and on south by Orissa. Bihar has a number of rivers; the most important is Ganga, others are: Sone, Poonpoo, Falgu, Karmanasa, Durgawati, Damodar, Swarnarekha, Baraker, Koal, Kosi,



sediments) is not an even plain, but shows corrugated inequalities and buried ridges (shelf faults). Western Bihar sits on the sub-surface Faizabad ridge while the eastern sections sit on the Munger-Saharsa Ridge. The areas near the border with West Bengal lie on the Kosi Graben (Purnea-Kasganj Graben). The central sections of Bihar lie atop the Gandak depression and East Uttar



Pradesh shelf. The Himalayan Frontal Thrust does not run in Bihar, though, it runs across the border in Nepal. The Patna Fault lies in western Bihar, trending NE-SW. Apart from these there are east-west running tear faults in the region that control the courses of the main rivers. The strongest earthquake shook the state on January 15, 1934. The epicentre was 5.6 kilometers northwest of Laukahi, Bihar, along the Indo-Nepal border. The worst-affected districts were Monghyr, Motihari, Bhatgaon and Kathmandu. Patna, Darbhanga, Sitamarhi, Saharsa, Samastipur, Muzaffarnagar and countless other towns and villages were severely damaged. 10,700 people were killed in this earthquake in both Bihar and Nepal. On August 21, 1988, heavy damage occurred in districts along the Bihar - Nepal border including Darbhanga, Saharsa and Madhubani.

Seismic Hazard: The districts of Sitamarhi, Madhubani, Darbhanga, Araria and Supaul lie in Zone V. The last big quake here was in 1934. According to the GSHAP, this north-western corner of Bihar can expect a maximum peak ground acceleration (PGA) between 0.16g to 0.32g. Purnia, Champaran (East), Champaran (West), Katihar, Bighusarai, Gopalganj, Samastipur, Muzaffarpur, Siwan, Saran, Vaishali, Nalanda, Patna, Monghyr and Bhagalpur Districts lie in Zone IV. The districts of Bhojpur, Rohtas, Gaya, Aurangabad and Nawda lie in Zone III.

Added Seismic Hazard: The earthquake hazard situation in Bihar is very peculiar, whereas the northern parts of the State adjoining Nepal have the highest seismic intensity zone, the southern districts lie in the most stable area with lowest intensity zone. North Bihar was subjected to one of the most violent giant earthquakes in India and Nepal with M 8.3 in 1934 on the open ended Richter Scale, with its epicenter in Nepal close to the Indian border. It caused large scale damage in both countries, including the whole area from Kathmandu in Nepal to Munger in India. More than 7000 persons lost their lives in India and 8500 in Nepal. Bhatgaon in Nepal and Munger in Bihar were ruined completely and large parts of Patan and Kathmandu in Nepal and Motihari, Muzaffarpur and Darbhanga were also destroyed along with innumerable villages in between. In these districts, houses had greatly tilted and sunk into the ground. The highest intensity observed was Modified Mercalli (or MSK) X.

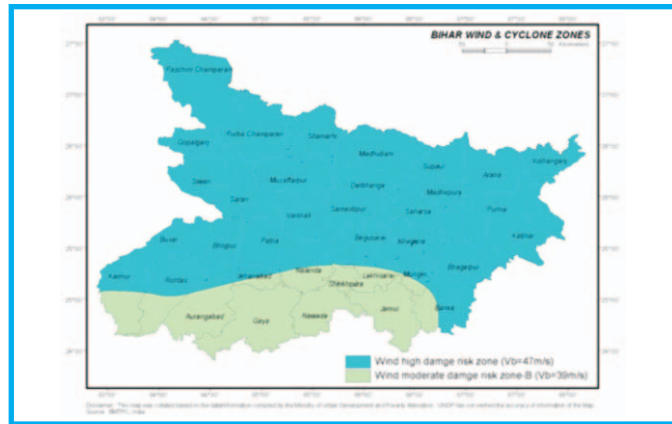
Drought: 33% of the state receives less than 750 mm rainfall, making Bihar chronically drought-prone. Even the 35% of Bihar that receives 750-1125 mm rainfall suffers drought once in four to five years. Thus, 68 per cent of the total sown area is vulnerable to drought conditions. The worst famine in Bihar occurred in 1967. More than 1 million people were affected. Other famines in the state occurred in 1951, 1967 and 1984 in some of the northern districts of the state. Since the 1970s, forest cover has been declining in the state.

State/District-wise List of Identified Drought Prone Districts

District	No. of Talukas	Area of the District (km ²)
MUNGER	4	7884.5
NAWADAH	1	2494
PALAMAU	3	12019.9
ROHTAS	2	7199.7
BHOJPUR	2	3971.1
AURANGABAD	1	3305
GAYA	2	6510.3
TOTAL	15	43384.5

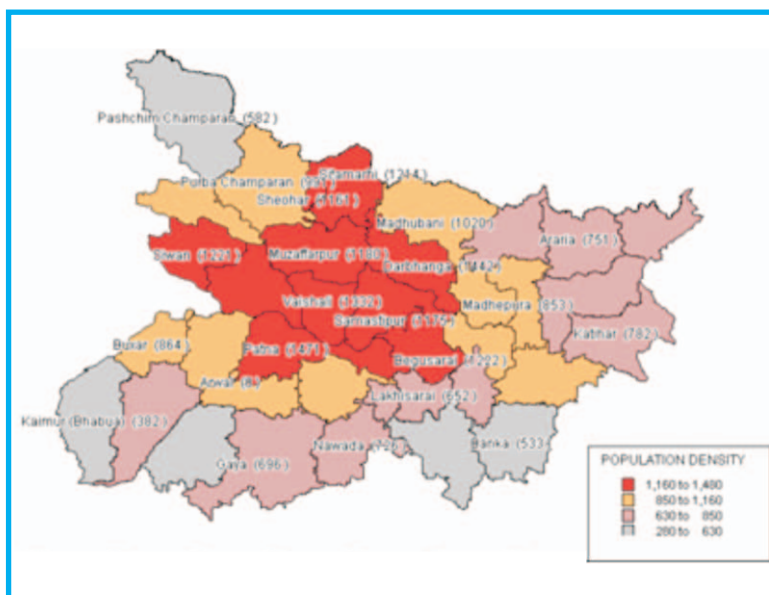
Source : Agricultural Research, Data Book 2002.

Wind Hazard: the design wind speed in almost the whole state is 47 m/s (169 km/h) which could only occasionally be reached in what is called 'Aandhi'. In such events, weakly built huts of thatch, sheets etc. and those with sloping roofs such as using thatch and tiles and A.C. sheet and corrugated Galvanized Iron (C.G.I.) sheet roofs which are not fully anchored and integrated will suffer damage. The damages occurring in 'Aandhis' is again of localized nature and does not result in a 'disaster' to the State.

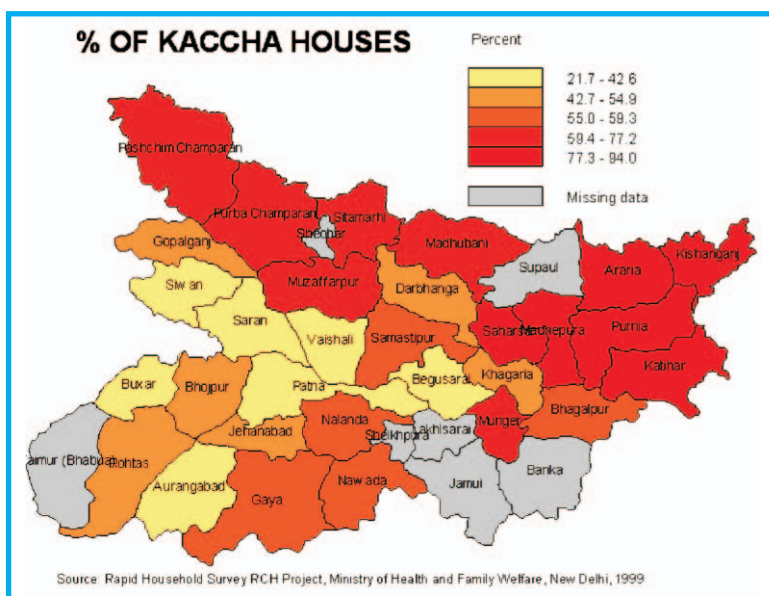


Social & Economic Vulnerability: Societal analyses focus on determining the vulnerability of people of different ages, income levels, education, capabilities, and experiences to a hazard or group of hazards. Vulnerable populations are typically those who are minorities, below poverty level, over age 65, single parents with children, households that require public assistance, renters, and housing units without vehicles etc. High density of population in vulnerable areas increase physical exposure and hence the vulnerability. Income analysis of the community is importance because poverty is one of the most important indicators of vulnerability. Built environment analyses focus on determining the vulnerabilities of non-critical structures and facilities, e.g. Housing types. Social and Economic Vulnerability Indictors district wise are represented in pictorial format below.

Population Density Map: Most of the districts which have high population density are in the flood prone areas like Sitamarhi, Muzaffarpur, Samastipur, Patna, Begusarai etc.

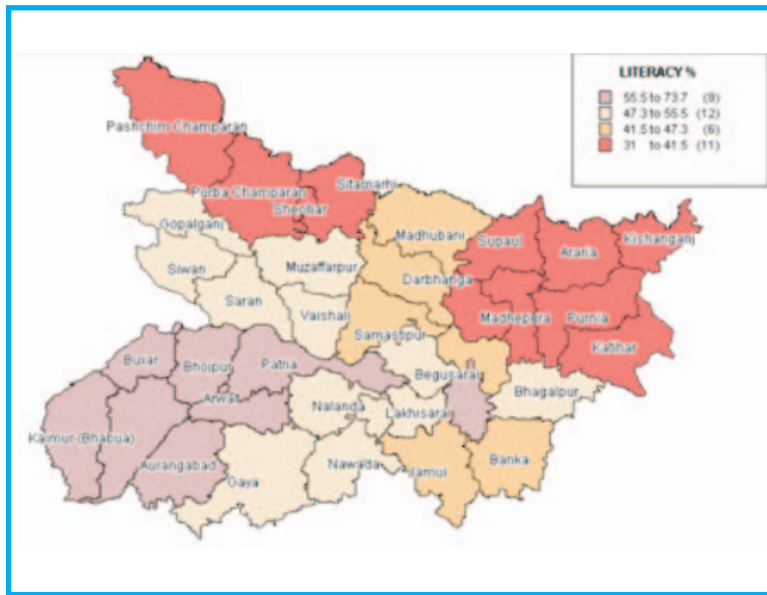


Housing Types: High % of Kaccha houses in the Earthquake and flood prone areas.



Source: Rapid Household Survey RCH Project, Ministry of Health and Family Welfare, New Delhi, 1999

Literacy: Most of the districts in north Bihar have very low literacy and enrollment ratio.



- Increasing Trend in Population Growth
- Low per capita income and GDP
- Higher density of Housing and other buildings
- Qualities of buildings are non disaster resistant in relation to vulnerability index. (floods and earthquakes)
- Settlement and land use planning in the vulnerable areas
- Less investment or no investment in prevention and mitigation in all the sectors
- Inadequate initiatives for disaster risk reduction
- Inadequate Institutional arrangements and systems for risk reduction
- Development and disaster are not integrated and considered as two different identities
- Normal Rainfall: 205 mm
- Avg. Number of rainy days: 52.5 days in a year

Agriculture:

Bihar has a total geographical area of 94.16 lakh hectares on which it houses a population of 83 millions, thereby generating a population density of 881 persons per sq. km. (Census 2001). Gross sown area in the State is 79.46 lakh hectares, while net sown area is 56.03 lakh hectares. There are

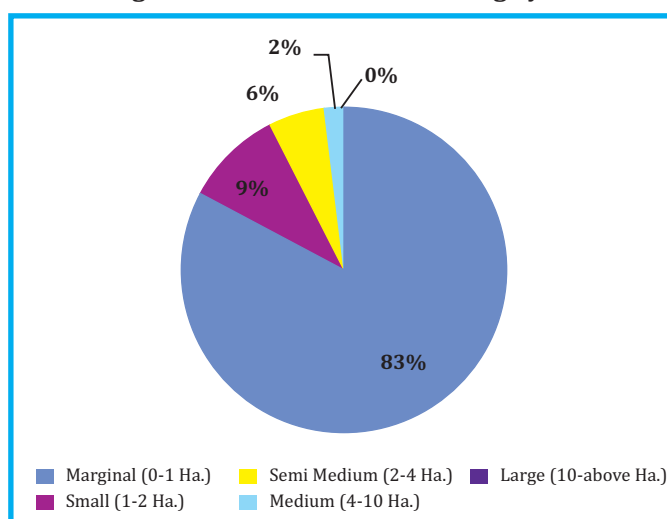
around 1.04 crore landholdings in the State of which around 83 percent are marginal holdings of size less than 1 hectare (Table 2.1). With around 90 percent of the total population living in rural areas, agriculture as the primary feeder of rural economy continues to operate not only on margins of land but also on the margins of human enterprise, its productivity being among the lowest in the country. Without increasing returns to these margins, not much can be done realistically to develop the agricultural sector. Thus, agriculture continues to define both the potentialities and constraints to development in Bihar.

Table 1: Distribution of Holdings by Size Class

Category of farmers	No. of Holdings	Operational holding (In Ha.)
Marginal (0-1Ha.)	86, 45,932 (82.9%)	27, 87,789 (40.8%)
Small (1-2 Ha.)	10, 05,650 (9.6%)	13, 00,667 (19.0%)
Semi medium (2-4 Ha.)	5, 90,970 (5.7%)	15, 82,279 (23.1%)
Medium (4-10 Ha.)	1, 78,295 (1.7%)	9, 75,355 (14.3%)
Large (10-above Ha.)	11,570 (0.1%)	1, 93,760 (2.8%)
Total	1, 04, 32,417 (100%)	68, 39,850 (100%)

Source : Agricultural Census Division, Ministry of Agricultural, New Delhi

Percentage Distribution of Landholding by Size Class



Major Rivers in Bihar

The Main Ganga Stem (Bihar): The Ganga enters Bihar near Buxar in the middle region of its course, nearly 155 km. Downstream from varanasi. The total length of the ganga in Bihar is nearly 445 km. Apart from 110 km. Along the UP-Bihar border. The catchment area of the main Ganga stem in Bihar is about 16900 sq. km. The Ganga stem in Bihar comprises the main river course, trunk and adjoining areas including 'diara' lands. The catchment areas of small rivers falling directly into the main Ganga-stem have also been included as a part of the Ganga stem.

Ganga stem 'A' sub-basin includes the catchment areas of rivers like Kao, Dharamavati and other small channels meeting the main stem of the river Ganga between its confluence with the river Karmnasa near Chausa and that with the river Sone near Maner. The sub-basin is bounded by the river Ganga in the north, the Sone in the east the Karmnasa in the west. Ganga stem 'B' sub-basin includes the catchment area of the river Baya flowing between the Gandak river basin on the right side and the Burhi Gandak basin on the left side with its northern boundary as Burhi Gandak basin and the southern boundary as the main Ganga stem. Ganga stem 'C' sub-basin includes the catchment area of small streams like Bhaena and Koa. This sub-basin is bounded by the Bilasi, Chandan, Chir river basins in the south and the west, the Gumani in the east and the main Ganga stem in the south. While traveling through Bihar, it has a number of tributaries on its left and right banks which are important rivers in themselves. These are described in brief as below:

The Gandak: The Gandak known as the Kali in Nepal, originates near the Nepal-Tibet border at an altitude of 7620 m situated northeast of Dhaulagiri. While flowing in Nepal, it receives a number of tributaries such as the Mayangadi, the Bari and the Trisuli. After traveling nearly 100 km in Nepal, it enters the plains of the West Champaran district of Bihar near Valmikinagar, Just above Valmikinagar, at Triveni on Indo-Nepal border it receives two tributaries, the Panchnad and the Sohna. From Valmikinagar the Gandak flows in southerly direction and forms UP-Bihar border to some distance and then it flows through West Champaran, Saran, Muzaffarpur and Vaishali districts of Bihar before joining the Ganga on its left bank opposite Patna city. The total length of the river is 630 km of which 370 km lies in Nepal and Tibet.

The Burhi Gandak: The Burhi Gandak takes off from Chautarwa 'Chatur' in the West Champaran district. One of its major tributaries, the Masan rises from the springs of the Someshwar hills at an elevation of 300 m. The river is known as Sikarahnna in its upper reach upto the confluence of the river Dhanauti. After flowing for a distance of about 56 km. the river takes a southerly turn where it is joined by Dubhara and Teur. From this point, the river takes a south-easterly direction and flows through the Muzaffarpur district for about 32 km. In this reach, the river spills over its banks and a number of spill channels take off and join it later. Flowing through Darbhanga, Samastipur, Begusarai and Munger districts, it joins the Ganga on the left bank near Khagaria town opposite to the town of Munger. Its total length is 580 km.

The Bagmati: The Bagmati rises in the Shivpuri range of hills in Nepal, 16 km. north-east of Kathmandu at an elevation of 1500 m and flows in westward direction draining the Kathmandu valley. The river cuts through the Mahabharata range of hills in Nepal and enters India in Bihar in the village Shorwatia in the Sitamarhi district. In this reach, three spill channels take off from the Bagmati and region together near village Joriahi at about 2.5 km south of Samastipur-Narkatiyaganj railway line. The river Lalbakeya, an important right bank tributary of the Bagmati joins it near Dewapur just downstream of Khoripakar. The river Bagmati once again tried to avulse into the Purani Dhar below Khoripakar during floods in the year 1983. The Purani Dhar takes off near village Balwa and is also called the Belwa Dhar. The take off point of this Belwa Dhar is very unstable and is getting wider and wider to an extent that even in lean season nearly 40 percent of the Bagmati river water passes through the Belwa Dhar which outfalls into the Burhi Gandak near Minapur in the district of Muzaffarpur. The river Bagmati in its last reach is joined by the Darbhanga-Bagmati river, one of its Major tributaries on the left bank, just above Hayaghat. The Darbhanga-Bhagmati drains the Adhwara group of rivers. After the confluence with the Darbhange-Bagmati, the river Bagmati is known as the Kareh. From here it runs in south-east direction for 191 km and before outfalling into the Kosi near Badlaghat, it receives the Hasanpur-Bagmati near Kudra on its right bank and the old Kamla near Phuhia on its left bank. The total length of Bagmati is about 589 km of which 195 km lies in Nepal and the rest 394 km in Bihar.

The Kamla Balan: The Kamla Balan originates in the inner valleys of the Himalayas in the Mahabharat range of hills in Nepal at an elevation of 1200 m. It is joined by a number of streams on both the banks during its flow in the Mahabharata range in fact, two important streams namely the Kalikhola and the Tawakhola flowing in opposite directions, from west to east and east to west respectively, join together and flow in the name of the river Kamla. The river Kamla after traveling a few kilometers in the west emerges out through a gorge near Tetaria and debouches near the Terai area of Nepal at chisapani about 48 km. north of Indo-Nepal border. In the Terai portion in Nepal, the river is joined by the tributaries like the Jiwa, the Gurmi, the Lohjara, the Mainwati etc. on the left bank. On the tight bank the Bachraja takes off from the Kamla, the mouth of which is now silted up. It is an old abandoned course of river Kamla. Then onwards, the river flows in southern direction and debouches into the plains near Indo-Nepal border and enter Indian territory in the district of Madhubani in Bihar. It flows in southern direction till it joins the river Kareh (Bagmati) near Badlaghat. The rivers Dhauri, Soni, Balan and Sugarave join the river kamala on its left bank in the Indian territory. During the floods of 1954, the river Kamla abandoned its course near Bhakua village and avulsed into the river Balan and since then it is flowing through the course of the river Balan and its hence known as the Kamla – Balan. The total length of the river Kamla Balan is 238 km of which 208 km lies in Nepal and the remaining 120 km in India.

The Kosi: The river Kosi originated at an altitude of over 7000 m above MSL in the

Himalayas. The upper catchment of the river system lies in Nepal and Tibet. The highest peak of the world, the Mount Everest and Kanchanjanga lie in the Kosi catchment. It is one of the ancient rivers of India and has its mention in the old literatures as Kaushika.. It is known as Sapt Kosi in Nepal because its seven tributaries – the Sun Kosi, the Bhoti Kosi, the Tamra Kosi, the Dudh Kosi, the Barun Kosi, the Arun Kosi and the Tamur Kosi meet above Tribeni (about 10 km upstream of Chatra). Below the confluence of Tribeni, the river Kosi flows in a narrow gorge for a length of about 10 km till it debouches into the plains near Chatra, the river enters the Indian territory near Hanuman Nagar in Nepal. The river Kosi has been notorious for its meandering behavior which would be apparent from the fact that it had changed its course across a width of about 250 years. Subsequently it flows in easterly direction and ultimately joins the Ganga near Kursela in Katihar district. The average bed slope of the river in different reaches from its origin to outfall is in the range of 1.4/km to 0.11m/km.

The Mahananda: The river Mahanada is a major northern tributary of the river Ganga passing through Nepal, India (Bihar and West Bengal) and Bangladesh. The Mahananda originates from Mohalidram hill of the Himalayas at Chimali at an altitude of 2060 m and about 6.4 km north-east of Kurseong town in Darjeeling district of west Bengal. After flowing 20 km in the hills of Darjeeling the river enters the plains near Siliguri. River Balason joins this river below Siliguri on its right bank. It then flows in a south-westerly direction forming more or less the boundary between India and Bangladesh. The old Balason river joins Mahananda on its right bank upstream of Sonapukur Hat. Another tributary the Chenge joins the Mahananda on its right bank about 3.2 km upstream at Taibpur railway bridge. Another stream Donk meets on its left bank near Belwa village. The eastern kankai, a major tributary joins the Mahananda on the right bank near Kuttighat at about 0.60 km downstream of its crossing with Kishanganj-Bahadurganj road. The western kankai, another major tributary carrying discharge higher than the Mahananda joins on its right bank about 3.2 km upstream of Dengraghat. The river Mahananda bifurcates into two branches near Bagdob in Bihar. The western course known as Phulhar (Jhaua) carries about 75% of the total discharge and is joined downstream of Bagdob on the right side by Parman, major tributary. The eastern course known as Barsoi branches carries the remaining 25% discharge. The total length of Mahananda from its origin to outfall point in the river Padma near Godaghat is 376 km.

The Karmnasa: The Karmnasa originates near Sarodag on the northern face of the Kaimur range of hills in the Kaimur district of Bihar at an elevation of 560m. It flows in a north-westerly direction through the plains of Mirzapur upto Lalitpur village in U.P. the river flows through the district of Varanasi in U.P. and forms the common boundary between U.P. and Bihar to a length of 76 km and finally joins the Ganga on its right bank near Chausa in Bihar.

The Sone: The Sone originates in Maikala range of hills in MP at an elevation of 640m.

after passing through the Vindhya range of hills in MP; it crosses the Kaimur hills and flows in north east direction. It enters UP in Mirzapur district and flows in east direction. It receives the Rihand and the Kanhar on its right bank and the Ghagra on its left bank before entering Bihar through Palamu district where it receives the north Koel river on its right bank. The river takes a north-east course and enters Rohtas district. It then forms the boundary between Patna and Bhojpur districts for some distance and then flows through Aurangabad and Patna district, it joins the Ganga at about 16 km upstream of Danapur in the Patna district. The river Sone has a total length of 784 km of which about 500 km lie in MP, 82 km in UP and the balance 202 km in Bihar.

The Punpun: The Punpun originates from Chotnagpur hills in Hariharganj block of Palamu district in Bihar at an elevation of 442 m. The Punpun has four major right bank tributaries namely the Morhar, the Dardha, the Madar and the Batane which have significant contributions to its flood flow, whereas its left bank tributaries such as the Khudwa, the Beige, the Siroka and the Panchane etc. are very small rivers and therefore their contribution to the flood flow in the basin is insignificant. It flows for most of its portion in a north, north-east direction and outfalls into the Ganga near Fatuha at about 25 km downstream of Patna. Its total length is about 235 km. As in the case of the main river, the tributaries are also rained and majority of them originate from the same range of hills in Palamu, Aurangabad and Gaya districts of Bihar.

The Kiul-Harohar: The main river Kiul of the Kiul-Harohar system originates from an elevation of 605 m east of Khajuri in Chotanagpur plateau and flows in east direction close to the southern base of Gidheswari hills. After that it flows in north-east direction towards Lakhisari and joins the river Hrohar on its left bank. Then further down the combined river joins the Ganga near Surajgarha in Mughal district. The Kiul-Harohar river system consists of a number of small rivers such as the Lilajan, the Mohane, the Falgu, the Panchane, the Goithwa, the Dhadhar, the Tilaya and the Sakri etc. apart from the Kiul and the Harohar which during the course of flow bifurcate and rejoin meeting each other number of times making it difficult to ascertain their exact length.

The Badua: The river Badua rises in the southern most hills of Munger district, north-east of Chakai at an elevation of nearly 333m. After flowing for a small distance in Munger district it enters Bhagalpur district and flows through it for most part of its course. It flows from south to north and falls into the Ganga through Champa Nala situated west of Bhagalpur town. But during the flood season, its spill mingles with the spills of the Chandan river and other smaller rivers situated south of Bhagalpur. The floodwaters thereafter, flow in the north-east direction and ultimately drain into the Ganga near Nathnagar railway station east of Bhagalpur town.

RECOMMENDATIONS OF IMPORTANT COMMITTEES / WORKING GROUPS/ TASK FORCES ON FLOOD MANAGEMENT APPOINTED BY THE GOVERNMENT OF INDIA

1. Brief particulars of The Policy Statement – 1954 and Supplementary Statement 1956

Following the unprecedented floods of 1954, the Union Minister for Planning, Irrigation and Power, placed before Parliament on 3rd September 1954, two statements namely “floods in India – Problems and remedies” and “The Floods in the country”. The objective, set unequivocally, in the policy statements, was to rid the country of the menace of floods by containing and managing floods. In the supplementary statement placed before the Parliament on the 27th July, 1956, the optimistic note changed a little, stating “we shall, however, be able to curb and confine the floods, more and more and do all that is possible to save ourselves from the harm and the devastation that they bring”. Another statement on the flood situation and flood control programme pointed out that absolute immunity from flood damage was not physically possible even in the distant future.

2. The High Level Committee on Floods – 1957 and policy statement of 1958.

The High level Committee on Floods submitted its report in December 1957, and this was considered by the Central Flood Control Board in its seventh meeting held in May 1958. Some of the important recommendations and this includes were,

- (1) Absolute or permanent immunity from flood damage is not physically attainable by known methods of flood control. Flood plain zoning, flood forecasting and warning, and like measures should, therefore, be given due importance, particularly as these do not require large capital investment.
- (2) Flood control schemes should fit in with other water related plans to the extent feasible.
- (3) Future multi-purpose projects should consider flood control aspects simultaneously.
- (4) Effects of embankments on river regimes need to be considered before approving such proposals.
- (5) In general, embankments are satisfactory means of flood protection when properly designed, executed and maintained, but a suitable combination of this method with other methods such as storage dams, detention basins, etc. is usually more efficient and should be adopted as resources permit.

- (6) Priorities for soil conservation work relating to flood control should be as under:-
 - (a) Catchment areas of multi-purpose dams.
 - (b) Himalayas with their foothills.
 - (c) Indo- Genetics Plain and
 - (d) Deccan plateau.
- (7) Works relating to watershed management prioritized. Work commenced in a catchment should not be left incomplete to take up work in other catchments.
- (8) The following order of priority in general is recommended:-
 - (a) Emergent Schemes
 - (b) Continuing Schemes
 - (c) Schemes for the protection of important urban and industrial communities.
 - (d) Schemes which would help in augmenting flood protection in the country.
 - (e) Schemes which combine other beneficial utilization of waters.

Another policy statement tabled in Parliament in 1958 also emphasizes that while substantial diminution of flood related distress is possible, immunity against flood is impracticable.

3. The Ministers' Committee on Flood Control – 1954

A Minister's Committee on Flood Control was constituted in February 1964, to review the National Flood Control Policy outlined in 1954. The Committee mainly recommended more attention to non-physical measures like flood warning and forecasting, flood plain zoning, flood insurance, studying possibility of multipurpose storage dams for flood prevention and sediment detention in regard to major flood producing catchments, administrative measures for restricting occupancy of flood zones and emphasis on flood zones and frequency studies.

4. The Working Groups on Flood Control for the Five – Yea Plans

The Working Groups on Flood management, comprising of experts and administrators, review the progress and performance of flood management measures undertaken and suggest appropriate strategies to formulate proposals including mobilization of resources for each five year plan and recommend measures, required for effective flood management program in the country.

5. The Rashtriya Barh Ayog- 1980

The National Flood Commission (RBA) submitted its comprehensive report in March, 1980. This contained a total of 207 recommendations covering the entire gamut of flood problem in the country. Some of the important recommendations were.

- Data Collection for providing information on their long-term performance and their impact on various socio-economic factors.
- Legislation and enforcement by States to prevent unauthorized riverbed cultivation and encroachments into drains etc.
- Separate reporting of floods damage for (i) Unprotected areas (ii) Protected areas and (iii) Areas situated between the embankments.
- Legislation for management of flood plains
- A comprehensive dynamic and flexible approach to the problem of floods as a part of a comprehensive approach for the utilization of land and water resources.
- Priority for measures to modify the susceptibility of life and property to flood damage.
- Priorities for the completion of continuing schemes.
- Provision of adequate funds for maintenance.
- States to enact legislation amending section 17 (II) of land acquisition act, to make the existing provisions for emergent situations, as applicable for flood control works.
- Intensifying studies on sedimentation of reservoirs.
- Forming a National Council for mitigating the effect of the disaster.

A review of implementation status of these recommendations made by CWC during 1987 and subsequently during 2003 indicated that there is much to be achieved.

6. **The Pritam Singh Committee Report – 1980**

To examine the problem of erosion in West Bengal on both banks of the river Ganga upstream and downstream of Farakka Barrage, Government of West Bengal set up a committee in August 1978 under the Chairmanship of Shri Pritam Singh, Member (Floods), CWC. The Committee comprised of chairman, GFCC, Director CWPRS, General Management, Farakka Barrage Project, Chief Engineer, Government of Bihar and West Bengal.

The Committee identified the priority reached downstream of Farakka Barrage for taking anti-erosion measures.

7. **The National Water Policy – 1987**

Important recommendations made in the National Water Policy of 1987 on flood control and management were:

- Basin wise master plan for flood management in each flood prone basin.
- Sound watershed management and catchment area treatment.
- Providing adequate flood – cushion in water storage projects wherever feasible.
- Emphasis to be made on measures like flood forecasting and flood plain zoning to minimize flood damage.

8. **The report of the Committee on Flood Management in the North – Eastern States – 1988 (Naresh Chandra Committee)**

During the year 1987, when the failure of the monsoons resulted in an unprecedented drought in most parts of the country, Assam and the neighboring States had the misfortune of experiencing large- scale flooding of the Brahmaputra valley. A Committee was set up under the Chairmanship of the Secretary, Water Resources to look into this problem in some detail, review the efficacy of the current measures being taken and recommend further measures.

The Committee suggested that the recommendations of the Rashtriya Barh Ayog should be implemented by the State Governments, Anti-erosion works are costly and can be justified only when protection is provided to vital installations. The main cause of erosion in tributaries is impinging of high velocity. To overcome this problem, bank revetments, preferably made with boulders, should be used. For drainage improvement the adequacy of existing sluices and drainage channels should be checked in a timely manner.

9. **The Report of the Committee on Flood Management in the States of Bihar, West Bengal, Uttar Pradesh and Orissa – 1988**

After the severe floods of 1987 in Bihar, West Bengal, Uttar Pradesh etc. the Government of India set up a Committee under the Chairmanship of Secretary (Water Resources) to review the efficacy of the current measures and recommend measures for urgent implementation. Some specific recommendations of the Committee include:-

- a. Properly designated, satisfactorily executed and adequately maintained embankments should continue as cost effective and quick measure.
- b. Early completion of partly completed projects.
- c. Construction of raised platforms on Government or acquired land and handing over to local bodies / panchayats.
- d. Ensuring adequate waterways to ease out drainage congestion.
- e. Operation of existing reservoirs keeping flood moderation in mind even if no flood cushion is provided.
- f. Provision of flood benefit/reserve storage in new /future reservoir projects to the extent possible.
- g. Implementation of flood plain zoning.
- h. Settling cost sharing among beneficiaries of anti-erosion works executed.
- i. Setting up of Tal Development Authority and arranging special funding for developmental schemes suitable to Tal/Chaur areas.
- j. Allocation of more funds for early completion of unfinished schemes in Sundarbans of West Bengal.
- k. Evaluation of completed project by states with the assistance of GFCC/CWC.

10. The National Commission for Integrated Water Resources Development Plan

The National Commission for integrated water resources development plan in its report (Sept. 1999) made interalia, the following recommendations regarding flood management.

- a. Since there are no solution for complete protection against floods, the country has to shift its strategy towards efficient management of flood plains, flood proofing, flood forecasting, disaster preparedness and response planning, flood fighting and flood insurance.
- b. Embankments provide reasonable protection against floods. However the performance of embankments have to be evaluated and suitable changes be made in design, construction and maintenance for better results.
- c. The network of flood forecasting and warning is to be extended to remaining flood prone areas.

11. The Recommendations of the Regional Task Forces

During the monsoon of 1996, a large number of States including Rajasthan and Haryana, which were generally not flood prone, experienced floods of severe intensity causing extensive damage to life and property. Certain coastal areas experienced chronic problems of coastal erosion. It was, therefore been considered essential to examine the problem of floods and flood management in the country afresh. Consequent upon this, Government of India had constituted five regional Task Forces namely.

- (i) Eastern Region Task Force
- (ii) Northeastern Region Task Force
- (iii) Northern Region Task Force
- (iv) Northwestern Region Task Force
- (v) Southern Region Task Force

The main thrust areas identified for actions by these task forces were

- a. Implementation of main recommendation of RBA.
- b. Prepare a catalogue of embankments existing in various river systems.
- c. 10% of annual out lay of flood control sector to be earmarked for maintenance of flood control structures.
- d. Studies on some major reservoirs and review of Operation / rule curves.

Other important measures recommended in general are the tackling of encroachment of people into flood plains of the river downstream of the dam and inside embankments, taking up flood plain zoning measure especially the preparation of flood risk maps, scientifically analyzing the happenings of severe rainfall occurrences, very high flood stages and prolonged heavy drainage congestion in specific years, within a reasonable time of occurrence of such events by State Governments etc.

12. The Experts' Committee for Bank Erosion Problem of River Ganga- Padma in the Districts of Maida and Murshidabad in West Bengal – 1996 (G. R. Keskar Committee)

Considering the gravity of the situation of bank erosion problem of river Ganga in the districts of Madia and Murshidabad in West Bengal, the Planning Commission, Government of India, constituted an Experts Committee under the Chairmanship of Shri G. R. Keskar, Member (RM), CWC in September, 1996.

Various measures recommended by the Committee are as under:

(i) Short-Term Measures recommended for immediate execution

Left Bank pstream of Farakka Barrage in the District of Maida

This includes construction of two long spurs at the 29th and 28th km upstream of Farakka Barrage near Manichchak, closing of the gap in left marginal embankment, repair/restoration of existing protection works in the district of Malda and maintenance of Bhutni Diara Embankment.

Right Bank Downstream of Farakka Barrage in the district of Murshidabad.

Repair/ Restoration of existing works, construction of spurs near Bindugram downstream of Farakka Barrage, Afflux bundh with revetment along-with nominal launching apron in Fazilpur reach etc.

(ii) Long – Term Measures

Monitoring of performance of two long spurs upstream of Farakka, restricting flow through Barrage normal to its axis as possible by gate regulation, Extensive river survey before and after flood every year for morphological study and creation of data bank for regular analysis etc.

13. The Expert Group for Flood Management in Uttar Pradesh and Bihar – 1999 (G. N. Murthy Committee)

An Expert Group was set up under the Chairmanship of Shri G. N. Murthy, the then Chairman, GFCC, Patna to examine and suggest action plan of identified specific flood management scheme with interse priority for implementation. The Group emphasized the need for building up realistic data bank on hydrology, topography, geology, morphology, hydraulics, damage etc. As long term solution construction of storage reservoirs and watershed management and as long term measure the priority schemes consisted of schemes on closure of gaps in the embankment/ extension of existing embankments, embankment scheme, anti-erosion works, drainage, schemes in Bihar and Uttar Pradesh.

14. The Working Group on Flood Control Programme for the 10th five Year Plan –2001 (R Rangachari Working Group)

A Working Group on Flood Control Programme was set up by Planning Commission, Government of India in November, 2000 under the Chairmanship of Shri R. Rangachari, whose terms of reference included the review of the performance of the sector during the 9th Plan period and making suggestions on the appropriate strategy for the 10th Plan period etc.

The report submitted in August 2001 had made a review of the flood management works adopted so far and gave suggestions on the future strategy for flood management. It dealt upon many policy issues and examined the international dimension of the flood management. It had made a review of the implementation of the RBA recommendations, too.

15. Report of the Committee on Silting of Rivers in India – 2002 (Dr. B. K. Mittal Committee)

To study and report on the problem of silting in Indian rivers and related aspects including feasibility of desilting, Ministry of Water Resources constitute a committee in October 2001 under the Chairmanship of Dr. B. K. Mittal, Former Chairman, CWC. Its main recommendations were:-

Measures for minimizing Siltation

- a. Catchments afforestation, right practices of land use, catchment area treatment, and others.
- b. In the river itself construction of suitable hydraulic Structures that may trap silt.
- c. Embankments along the aggrading river should be constructed, only after proper studies are made on its behaviour especially due to sedimentation load and resultant morphological changes.

Efficacy of desilting

- d. Desilting in general technically not feasible due to non-sustainability, non – availability of vast land for disposal of dredged material.
- e. Dredging has insignificant effect on flood magnitude.
- f. Selective dredging may be undertaken after a thorough study of each case for desilting of tidal rivers or confluence points and to maintain minimum depth of water for navigation.

16. The Expert Committee to Review the Implementation of the Recommendations of Rashtriya Barh Ayog- 2003 (R- Rangachari Committee)

An Experts Committee under the Chairmanship of Shri R. Rangachari was set up by Ministry of Water Resources, Government of India in October 2001 to review the implementation of recommendation of Rashtriya Barh Ayog.

The Committee summed up its view as follows:-

- a. Flood damage assessment from year to year, is not done realistically or on scientific basis as per surmised but not expressed. This needs corrective steps.
- b. Lack of representative, scientific and credible post- project performance evaluations of past flood management works is a serious handicap.
- c. Unabated and unplanned intrusion into the flood plains and riverbeds, sometimes with the approval of acquiescence of Government has now reached alarming dimensions. If this is not managed, flood losses will continue to mount.
- d. RBA has made a number of recommendations on the future approach and the planning and implementation thereof. Most of these have not been implemented or at the best partially implemented. They will have to be kept in view as part of future approach.
- e. The international dimensions of flood management as an integral part of Water resource development and management must be pro actively addressed.
- f. A number of other issues of importance like adequate funds, legislation, research and people's involvement at all important stages, etc. are very important to effectively manage floods. However, the inter-state issues in multi state river basins is a very important matter waiting to be effectively addressed.

17. The Committee for identification of critical Anti- Erosion Schemes of Ganga Basin States for Inclusion in CSS to be implemented during 10th Plan – 2003 (CB Vashistha Committee)

Keeping in view the seriousness of river erosion and its associated problems, Ministry of Water Resources, Government of India constituted a Committee to identify the Schemes for inclusion in the Centrally Sponsored Scheme “Critical anti-erosion works in Ganga Basin States for 10th Plan” under the leadership of Shri C. B. Vashistha, Chairman, GFCC.

The Committee visited the critical anti-erosion sites of river Ganga in Uttar Pradesh, Bihar and West Bengal for assessment of the problem and gave its recommendations which have largely been implemented.

18. Report of the Technical Group on Flood and Erosion Problems of North Bengal – July 2004 (M. K. Sharma)

The river like Teesta, Jaldhaka, Torsa, Raidak and Mahananda draining the North Bengal along – with their several tributaries cause flood erosion problem in region. To study the flood and erosion problem of the region and suggest suitable measures Ministry of Water Resources constituted a technical group comprising of representatives from concerned Central and State Organisations under the Chairmanship of Shri M. K. Sharma, Member (RM), CWC.

- a. Design flood estimation may be done in accordance with the sub zonal report of CWC.
- b. River training/activation of channel may be attempted on selected reaches where feasible.

- c. Maintenance of embankments during the pre monsoon and the monsoon period may be undertaken in accordance with the these guidelines given in the embankment manual.
- d. Considering the magnitude and severity of flood and erosion problems in North Bengal region it is suggested that comprehensive plan for flood management for north Bengal may be prepared.
- e. Material such as bamboo, branches of trees, river shingle and boulders which are locally available at comparatively lower cost can be utilized for inducing siltation diverting the river flows and preventing the bank erosion.
- f. Implementation of prioritized schemes (listed in the reports) to be taken up during 10th Plan.

19. **National Water Policy 2002**

- Basin-wise water plan for flood control and management.
- Provision of adequate flood cushion in reservoir projects.
- Flood control to be given overriding consideration in reservoir regulation policy.
- More emphasis on non-structural measures.
- Strict regulation of settlements and economic activities in flood plains.
- Flood forecasting activities to be modernized and expanded.

20. **The Task Force on Flood Management and Flood Control**

A Task Force was set up by the Ministry of Water Resources (MoWR) (vide order No. 24/32004-Er/2812 – 48 dated 11 August, 2004) to look into the problem of recurring floods in Assam and neighboring states as well as Bihar, West Bengal and eastern Uttar Pradesh under the chairmanship of Chairman, Central Water Commission (CWC) and Secretary ex-officio to the government of India. The Terms of Reference of the Task Force were.

- (i) To examine the causes of the problem of recurring floods and erosion in Assam and other neighbouring states as well as Bihar, West Bengal and eastern Uttar Pradesh.
- (ii) To review the measures undertaken so far to combat floods and erosion.
- (iii) To suggest short-term and long – term measures for management of floods and erosion control.
- (iv) To examine related international dimensions and suggest future course of action.
- (v) To suggest institutional arrangements for tackling the problem.
- (vi) To suggest sources of funding for the future action plan.
- (vii) To examine any other related matter /issues

RECOMMENDATIONS OF IMPORTANT

The Task Force submitted its report to MoWR on 31st December, 2004. The broad recommendations of the Task Force were

- (i) The role of the Central Government in the Flood control sector be expanded. It has recommended that the flood control schemes should be funded through the Centrally Sponsored Scheme in the ratio of 90% Central and 10% State from the present 75.25. The Task Force has recommended that the corpus for Centrally Sponsored Scheme also needs to be increased substantially to accommodate all critical flood management and critical anti-erosion works.
- (ii) Schemes worth Rs. 316.14 crore be taken before the coming flood season as an immediate measure. The Schemes worth Rs. 2030.15 crore have been recommended under Short Term- I category to be executed during the remaining two years of the X Five Year Plan i.e. during the 2005-06 and 2006-07 and Rs. 2635.81 crore under Short Term –II category to be completed in X Plan.
- (iii) The total investment for plan /flood Management may be increased from the existing half percent of the total Plan outlay to at least 1%
- (iv) Funds in the State sector be earmarked as Additional Central Assistance for maintenance of embankments.
- (v) Eligibility criteria of schemes for Central funding be reduced to Rs.1 crore from the existing limit of Rs. 3 crore per scheme.
- (vi) A revolving fund of Rs. 50 Crore, which may be available annually to the Ministry of Water Resources to take up emergent flood management schemes be created. The normal requirement of 'in principle; approval of the Planning Commission is recommended to be waived in this particular case. The Schemes under this fund could be implemented by the States/Boards after inspection by CWC/ Brahmaputra Board. The Task Force has further recommended that to mobilize resources for this revolving fund, a flood cess of say 1% to 2% could be levied on new infrastructure like roads, buildings, power plants etc. in the flood prone states.
- (vii) The central Government may consider funding the flood control component of the reservoir projects.
- (viii) Under the institutional arrangements, an Authority in the north East region with all the statutory powers be set up. In the meantime the Brahmaputra Board be Strengthened and restructured. The Sikkim and North Bengal.
- (ix) The Ganga Flood Control Commission be strengthened by addition of the post of Member (Works) and appropriate field formation for investigation and execution of critical flood management works be created.
- (x) The jurisdiction of Farakka Barrage Organisation, be extended.

- (xi) In order to have policy formulation and coordination among various agencies, Flood Management Organisation of the Central Water Commission be strengthened by restoring the post of Member (Floods) abolished earlier and redeployment of posts of Chief Engineer, two Directors and other lower level functionaries.
- (xii) The Brahmaputra Board and the proposed Sikkim and North Bengal river Management Board be entrusted the techno-economical examination of the schemes upto Rs 15 Crore for submission to the Planning Commission for investment clearance.
- (xiii) The reservoir projects in the Northeast as well as in Nepal and Bhutan be expedited under the category of long term measures for flood management.

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