Working paper

International Growth Centre

Strengthening the Institutional Framework for Flood and Water Management in Bihar

Developing a Strategy for Reform (Phase I)

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1 Introduction

1.1 Purpose of study

For centuries, great civilizations of the world have been humbled by the devastation of floods. Floods, ever unpredictable in the magnitude of their impacts and frequency, are a recurring phenomenon throughout the globe. Often the very factors that determine the rise and fall of nations are closely tied to the abundance or scarcity of water. Analysis of global data sets also reveals a statistically significant relationship between greater rainfall variability and lower per capita GDP. The civilizations of Asia are no exception as the rivers of the greater Himalayas are the most flood-prone of all. Floods, therefore, are a devastating fact of life in much of South Asia. In India, floods tend to wreak havoc on a recurring basis, particularly in the state of Bihar. Bihar is one of the five most flood prone states in India.

Floods in Bihar result in significant human and financial losses for the state on an annual basis. This also has a direct economic impact as recovering from flood losses takes a toll both on individual households and state agencies. Therefore, the management of floods in Bihar is an area of priority for the state government. Although this topic has been researched and discussed in the context of Bihar for many decades the study, *Strengthening the Institutional Framework for Flood and Water Resources Management in Bihar: Developing a Strategy for Reform,* was designed to investigate an area of flood management in Bihar that has been relatively under studied; the institutional management of floods. Though many scholars have pointed out that institutional dysfunction and governance deficits are the source of major flood disasters in Bihar such as the Kosi floods of 2008, an investigative study on the performance of key institutions that are engaged in flood management activities in the state has rarely been conducted. Thus policy makers in the Government of Bihar have limited understanding about the types of institutional challenges that are undermining the ability of Bihar to cope with annual floods and which policy measures need to be adopted to address them. Therefore, this study attempts to address this gap by investigating the *institutional* challenges hindering optimal performance and aims to identify priority areas of reform for improving the management of floods in Bihar.

This project aims to shape policies related to the institutional framework of flood and water resources in the state of Bihar. Based on the analysis and recommendations made, we aim to reduce the adverse impacts of these events on the population, businesses and industries located in flood-prone areas within the state, thus potentially making a significant contribution to the overall sustainability and growth of the state's economy. Allied to this, the project aims to influence development and investment programs by the Government of Bihar and international and bilateral funding agencies in the flood and water resources management sectors.

1.2 Structure of Report

The*Strengthening the Institutional Framework for Flood and Water Resources Management in Bihar: Developing a Strategy for Reform* study is a scoping study that is divided into two phases. This report is the culmination of *Phase One* of the study which primarily focused on understanding flood and water resources management functions, resources, processes, and procedures as well as identifying key gaps and challenges in the existing institutional arrangements for flood management in Bihar.

This phase one report is divided into several sections. Section one is the introduction while section two provides some background to floods and flood management in Bihar, detailing the history and the impact on growth in Bihar. Section three describes the approach and methodology for this report and section four describes the organizations engaged in flood management, which were analyzed under this study. Section five describes in detail the survey design and survey process utilized to gather data as well as details discussions held with the Government of Bihar (GoB). Section six analyses the key findings

from each of the surveys and illustrates some of the causes and effects of the challenges on flood management in Bihar. Section 7 presents experiences of flood management from international case studies from South Asia, the UK and from flood-related projects. Lastly, section 8 presents the conclusions for phase one and further recommendations for phase two which are made based on phase one findings.

It is important to note that the *Strengthening the Institutional Framework for Flood and Water Resources Management in Bihar: Developing a Strategy for Reform* study is a scoping study that will give policy makers in Bihar a *sense* of some of the major challenges that have emerged from our qualitative surveys, discussions and analysis. The surveys are not statistically significant and due to time constraints this study could not cover all rivers basins in the state. The households, WRD officers, and organizations surveyed provide a qualitative understanding of *some* of the key challenges on the ground in *some* districts of Bihar. However, these findings are not an exhaustive list of all the challenges facing Bihar in flood management. The major gaps highlighted in this report represent an initial step towards understanding some of the complex and challenging issues facing institutions such as the Government of Bihar's Water Resources Department (WRD) today in managing state-wide flood events. Further detailed studies are required to build a more thorough and comprehensive understanding, focusing on all of the basins of Bihar and on all of the various actors engaged in water resources and disaster management in order to develop a more comprehensive understanding of the institutional challenges. Further analysis can deepen the high level understanding that has been developed from phase one of this scoping study.

2 Background

2.1 River Systems in Bihar

Bihar has monsoon type tropical climate with high temperatures and medium to high rainfall. Three-fourths of Bihar's area and population lie in the natural floodplains of the Ganga and its Himalayan tributaries. About 68800 sq. km out of the total geographical area of 94160 sq km comprising 73.06 percent of the state is flood affected and this is about one-sixth (17.2 percent) of the total flood prone area of India. Three-fourths of north Bihar's rivers originate outside India, in Nepal and the Tibetan region of China. About 65% of the catchment area of Bihar's rivers falls in Nepal and Tibet and only 35% of the catchment areas lie in Bihar. Seventy six percent of the population in north Bihar live under the recurring threat of flood devastation. Bihar's physical vulnerability to floods results from its flat topography, high rainfall levels (more than 1200 mm annually), concentration (about 80 percent) of annual rainfall in only three monsoon months and high sediment loads.

The total geographical area of north Bihar is approximately 52313 sq. km encompassing the districts of Muzaffarpur, East Champaran, Sitamarhi, Seohar, Saharsa, Supaul, Darbhanga, Madhubani, Khagaria, Samastipur, Begusarai, Araria, Madhepura, Purnea, Katihar, Kishanganj, Saran, Gopalganj, West Champaran, Vaishali and Siwan. The geographical coverage of South Bihar is approximately 41787 sq. km made up of the districts of Rohtas, Buxar, Kaimur, Bhojpur, Arwal, Patna, Jahanabad, Aurangabad, Gaya, Nalanda, Sheikhpura, Nawada, Lakhisarai, Munger, Jamui, Bhagalpur and Banka.

The Ganga River, which serves as the main drainage system for the state, flows from west to east and stretches 432 km across Bihar, dividing the state into two (see Figure 1). North Bihar, the plains located north of the Ganga, is divided into eight major river basins; the Ghaghra, the Gandak, the Burhi-Gandak, the Bagmati, the Adhwara group of rivers, the Kamala, the Kosi, and the Mahananda. Thus, all the rivers in north Bihar share basins either with another Indian state or with Nepal and Tibet. The southern rivers comprising the Karmanasa, Sone, Punpun, Kiul, Badua and Chandranare mainly rain-fed and have their origins in the Vindhyachal, Chhotanagpur or Rajmahal hills.

Significant portions of the catchment area of the northern rivers lie in the Himalayan glacial region and therefore are snow-fed and perennial in flow. During the monsoon period the flow in these rivers increases 50 to 90 times, leading to flooding in the plains of Bihar. By contrast the southern rivers are purely rain-fed and are either dry or carry little flow during the non-monsoon months. The plains of Bihar, adjoining Nepal, are drained by rivers that carry high discharge and very high sediment loads, which then fan out onto the plains of Bihar. Gradients vary from 22 cm per km near the Indo-Nepal boundary to 7.5 cm per km near the confluence of the rivers with the Ganga main stem. The soil of north Bihar is sandy alluvial, rich in lime and often contains a high proportion of clay. The soils are among the most fertile in India and can support a variety of crops with appropriate land and water management. However, the flat terrain and the major seasonal variations in water volume in the rivers cause extensive flooding in the northern plains. In addition, as the rivers reach the plains and lose momentum, they begin to meander. Rivers like the Kosi are notorious for changing course. The records available suggest that the river was flowing about 160 km east of its present course some 200 years ago. This river was flowing east of Purnea in the late eighteenth century and is now flowing west of Darbhanga (Mishra 2008). The lateral movements of rivers cause erosion and loss of land. At the same time new land is continuously formed. These new *chaur* (low-lying lands), however, remain waterlogged for years before they become productive.

In south Bihar, the bank of the Ganga is naturally formed as a levee obstructing the drainage of the land on the southern side, which extends up to the foot of Chhotanagpur hills. The natural slope of this land is from south to north, from the foothills of the Chhotanagpur hills to the Ganga. There are several rivers in this tract, which drain the rainwater of the tract and accumulate behind the high bank of Ganga. This

has resulted in formation of *Tals* or lakes. The area on the south bank of the Ganga River comprises a group of such Tals including the Fatuha Tal, Bakhtiyarpur Tal, Barh Tal, More Tal, Mokama Tal, Barahiya Tal and Singhaul Tal. These Tals get submerged in water during the monsoon season and are thus deprived from kharif cultivation in most of the area. In fact, a considerable portion of the land in Bihar is waterlogged. This is a phenomenon that has been exacerbated by development as embankments, canals, roads, and railway tracks have impeded the natural drainage of these rivers. Official records suggest that nearly one million hectares of land in Bihar, 85% of north Bihar, is waterlogged. The 835,000 hectares of waterlogged area constitutes about 16% of the total area of north Bihar (GoB 2009).

2.2 History of Flooding in Bihar

Conventionally the typology of flood management is classified based on flood type, source area, warning time, flood duration and recession, and impact on agriculture. In Bihar, the Government of Bihar's Flood Management Information Systems Cell (FMISC) has classified floods into four different categories[1]:

Class I: Flash floods – floods from Nepal rainfall, lead time is short (8 hours) in Kamla-Balan, recession is fast;

Class II: River floods – lead time 24 hours, recession is 1 week or more;

Class III: Drainage congestion in river confluence- lead time > 24 hours, lasting full monsoon season, and no Kharif season agriculture;

Class IV: Permanent water logging - shrinkage in area only in February, local rainfall, micro-relief aspects.

A further classification that has been identified by the FMISC based on the degree of severity of the flood event is the following:

Not affected: <10% area inundated

Low Flood: 11%-30% area inundated

Medium Flood: 31%- 60% area inundated

High Flood :> 60% area inundated

The plains of north Bihar have recorded the highest number of floods during the last 30 to 35years. Since independence, Bihar has had four major flood events, in 1954, 1974, 1987, and 2004. In addition, in the years 1978, 1987, 1998, 2004, 2007, and 2008 Bihar witnessed high magnitudes of floods. The total area affected by floods has also increased during these years. Floods in 2004 demonstrated the severity of the flood challenge when a vast area of the state was badly affected by the floods of the Bagmati, Kamla & Adhwara groups of rivers resulting in 800 lives lost. The 2007 floods were Bihar's worst in 20 years, affecting more than 24 million people, killing nearly 1,000 people, and destroying over 700,000 homes. And these events seem to only be increasing in the amount of damage they cause despite rising government spending on flood protection, which has increased dramatically from Rs. 0.13 million in the First Five Year Plan (1951-1956) to Rs. 106 billion in the Tenth Five Year Plan (2002-2007) and in 2010-2011 the WRD reported expenditure of more than Rs. 159 billion on flood protection works (WRD Annual Report 2010-11).

[1] FMIS Flood Report 2009

The timeline of past floods in Bihar is as follows[2]:

1998: Embankment damage along Burhi-Gandak, Bagmati, Adhwara and Kosi Rivers accounted for 381 deaths, asset damage worth Rs.1 billion and crops damage of Rs.3.67 billion.

1999: Excessive precipitation in the catchments caused flooding of Kamala-Balan and Kosi rivers. Crop damage was estimated at Rs.2.5 billion and property damages another Rs.0.5 billion.

2000: Eastern Kosi Afflux Bund breached due to excessive discharge caused by heavy rainfall. This flooded 12,351 villages. Crop damage was estimated at Rs.0.8 billion.

2001: Breaches in Kosi, Bhutahi-Balan, Bagmati and Burhi-Gandak embankments. Crop and property damages were estimated at Rs.2.6 billion and Rs.1.8 billion respectively.

2002: Kamala Balan left and Khiroi right embankment overtopped. The floods caused 489 deaths. Crop and property damages estimates stood at Rs.5 billion and Rs.4 billion respectively.

2003: Ganga surpassed the 1978 HFL at Bhagalpur and the 1994 HFL at Patna.

2004: Heavy rainfall caused 53 embankment breaches in Bagmati, Burhi-Gandak, Kamala Balan, Bhutahi-Balan and Adhwara rivers. 885 deaths were reported. Crop and property damages were assessed at Rs.5 billion and Rs.10 billion respectively.

2007: Heavy rainfall caused 28 breaches in Burhi-Gandak and Bagmati embankments causing extensive damage to life and property.

2008: Eastern Kosi Afflux Bund breaches upstream in Nepal and Kosi river floods five districts in north Bihar. Three million people affected and approximately 3000 lives lost.

One of the major contributors to floods on an annual basis in Bihar is the Kosi River. The Kosi River rises in the Himalayas in China and drains the foothills to the east of Kathmandu in Nepal into India where it flows across the north Bihar plains to eventually join the Ganges. Its three tributaries within the Himalaya, Sun-Kosi, Arun and Tamur, join together at a point ~ 10 km upstream of Barahkshetra and the combined channel empties into the plains. The Kosi is historically known as the "sorrow of Bihar". This is largely due to the highly erratic nature of the river which has actually changed course in a "westerly direction and laterally moved more than 150 kilometres" in the last two centuries (Dixit et al, 2008). Floods from the Kosi River in the past have caused extreme destruction in the downstream area of Nepal and India leading to loss of lives and property as well as increased human degradation among the poorest segments of India's poorest state. In fact, nearly every year approximately 80,000 Bihar is living adjacent to the Kosi River cope by engaging in distress migration to Punjab and Haryana during the flood season (Dixit et al, 2008).

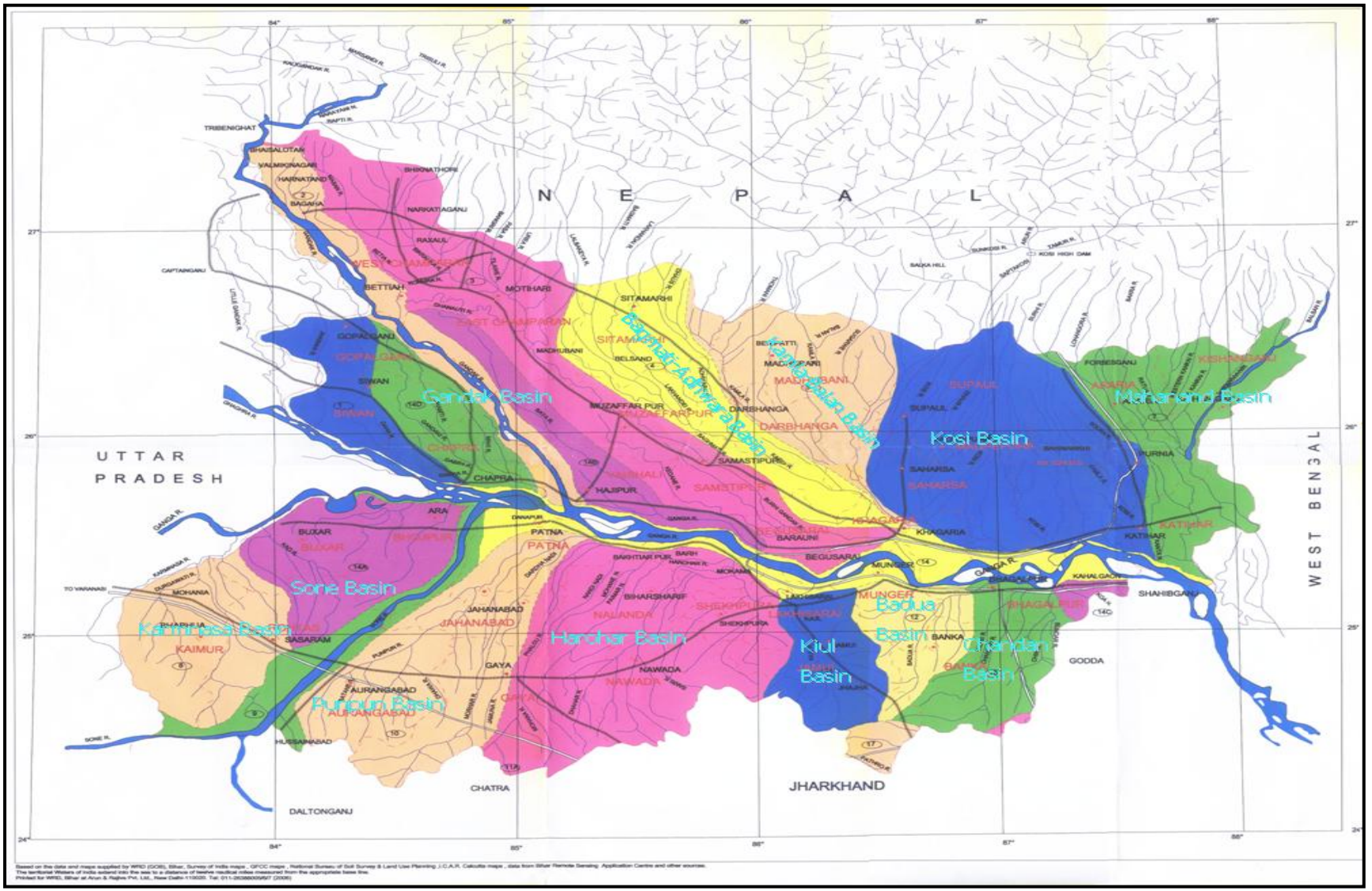
In order to overcome the problem of floods in Bihar, 3629 km of embankments have been constructed out of which 3179 km of embankments lie in north Bihar and 450 km of embankments in south Bihar[3]. This includes 50 km and 10 km of embankments constructed along the Bagmati and the Gandak respectively, which have provided flood protection to districts such as Sitamarhi, Muzaffarpur, and West Champaran. In 1959, embankments were utilized to stop the process of the Kosi shifting its course. The river was jacketed between two embankments following the signing of the Kosi Agreement in 1954 between the Governments of India and Nepal. The treaty set out to build the Kosi barrage, which was

[2] Ibid

[3] Department of Water Resources Annual Report 2010-2011, Government of Bihar

completed in 1962, constructed by the Government of India (GoI) within Nepal. India financed and constructed the project and is responsible for the "general maintenance and operation… after due intimation to" Nepal. Following completion of the Kosi barrage in 1964 the river gradient changed and sediment deposition in the river section upstream of the barrage increased rapidly (Dixit et al, 2008). Over time, this raised the bed level of the river above the surrounding land. Instead of permanently protecting the surrounding area from floods, the embankments have changed the morphology of the river, raising the jacketed channel above the land (Dixit et al, 2008).

Figure 1. River Basins and Drainage Areas in Bihar



2.3 Impact of Flooding on Growth

Bihar's continues to be one of the poorest states in India as its current poverty rate still lags behind the national average. In 2004-2005, 54.5 percent of the population of Bihar lived below the poverty line and rural poverty in Bihar was 55.7 percent and urban poverty 43.7 percent (GoB 2012).In addition, Bihar continues to have one of the lowest Per Capita Income figures in India. In 2006-07, the average Per Capita Income of Rs.10,055 in Bihar was 32.2 percent of the national average of Rs.31,198, this ratio increased to 34.7 percent in 2009-10 with the Bihar Per Capita Income rising to Rs.16,119 and the national figure rising to Rs.46,492 (GoB 2012). The state is also highly rural with 89 percent of the population living in rural areas. There is a North-South dichotomy in Bihar's human development. The southern districts have far larger income profiles than the flood-prone north Bihar districts, which include the flood-affected areas of the Kosi basin.

In August 2010, the International Growth Centre (IGC) held a national level meeting in Patna, Bihar on the topic of '*Floods and Growth in Bihar*' to explore the multiple causal issues around Bihar's floods and the multiple impacts floods have on the economic growth of the state. The workshop report clearly states that there is a connection between the incidence of floods in Bihar and economic growth, particularly with respect to two factors: agriculture and embankments (IGC, 2010). Agriculture is a major factor as more than 80 percent of Bihar's population is engaged in agriculture as their main source of livelihood; however, floods tend to devastate agriculture lands, particularly in river basins where silt deposits from floods leaves the land uncultivable and therefore forces farmers and their families to relocate or seek alternative livelihoods. The second issue is that of costs associated with embankments – building, maintaining, and repairing – once breaches and damages occur to the infrastructure. According to the IGC report, it is estimated that the cost of managing embankments is far higher than building them (IGC, 2010). A Government of Bihar Commission, which analyzed the data on flood damages from 1968 to 1991, concluded that trends in flood damages started rising after 1984. The Planning Commission, in its study on the Kosi embankments in 1991, found that in the flood protected areas of the Kosi crop production had decreased, whereas in un-protected areas, crop production had increased. The IGC report then goes on to point out that the major adverse impacts of floods on Bihar's economic growth can be attributed to:

- Loss of life and property
- Loss of agricultural land due to water logging and soil salinity
- Constant threat to engineering structures and public utilities
- The link between flood and corruption/rent-seeking

A recent example of this adverse economic impact is the 2008 Kosi floods where more than 500 villages were inundated in the districts of Supaul, Madhepura, Purnea, Saharsa, and Araria. According to Government of Bihar figures, 236,632 houses were fully or partially destroyed across the districts of Supaul, Madhepura, Saharsa, Araria, and Purnea. According to the Government of Bihar and the World Bank's Kosi Post Disaster Needs Assessment report of 2010, the estimated damage is Rs.5,935 million (US$ 134.9 million) (GoB 2010). Of these, the first three districts were the worst hit with over 95 percent of the reported damage. About 1800 kilometres of paved and unpaved roads and about 1100 bridges and culverts were destroyed in the floods. Maximum damages were reported in Supaul, Madhepura and Saharsa. Extensive structural damage was caused to irrigation and flood protection infrastructure, including the Kosi barrage. More than 6 km of the main Eastern Kosi Canal was fully damaged, 3 km of the branch, and 1 km partially damaged. Over 150 km of the distributaries and sub-distributaries were fully damaged, as well as 730 km of watercourses, 151 canal bridges, and 138 regulators. Over 380,000 acres of paddy, 15,500 acres of maize and 69,500 of other crops were adversely affected, impacting close to 500,000 farmers.

Approximately 10,000 milk animals, 3000 draught animals, and 2500 small ruminants perished in the disaster (GoB 2010).

In addition to these sectors, major damages were caused to the livelihoods, health, education, social, and environment sectors. Over 90 percent of the flood affected population was dependent on agricultural livelihoods, which were severely affected. Educational infrastructure and scholastic calendars were affected in all five districts, and regular curative and preventative health services disrupted. In addition, 123,932 acres of arable land has been rendered fallow due to sand-casting with long-term implications for the environment, agriculture, and livelihoods. The floods resulted in a significant decline in the agricultural production base due to sediment deposition and loss of livestock, farm working capital and other farm assets (e.g. tube wells, farm implements, etc.). As per official estimates, coarse sediment was deposited on an area of 284,000 ha in 1063 villages in 35 blocks of the five districts (GoB 2010). Generally, the deposits of sediment are deep, continuous and widespread in the northern parts (Supaul District) and relatively shallow and patchy in other districts.

The five districts affected by the flood were among the least developed even before the 2008 flood. Available district-level indicators show that they lagged behind the state as a whole: literacy rates in 2001 were lower than the state average of 47.5 percent, and lower than in neighbouring districts (apart from Katihar and Kishanganj which lie further east) (GoB 2010). Female literacy rates were even lower, less than 20.5 percent on average. The state of infrastructure was poor in these districts. Rural connectivity levels were extremely low, with less than half of the villages in each district having access to a paved road (GoB 2010). Table 1 below provides a summary of the economic costs of the Kosi 2008 floods in terms of damages incurred by sector and the corresponding requirements for reconstruction per sector based on 2010 exchange rates.

Table 1. Summary of the reported damages and needs by sector[4]

Sector	Sub-Sector	Disaster Damages		Reconstruction Needs	
		INR Million	US$ Million[5]	INR Million	US$ Million
Infrastructure					
	Housing	5935	134.9	99000	225
	Roads and bridges	5695	129	13936	317
	Water	-	-	26828	591.4
Productive					
	Agriculture	-	-	-	-
	Livelihoods	-	-	1622.5	36.9
Social sectors					
	Education	-	-	1251	28.4
	Health	-	-	730.2	16.6
	Social	-	-	-	-
Cross-cutting					
	Environment	-	-	-	-

[4] GoB 2010

[5] As the study was conducted in 2010, a standard exchange rate of US$1-Rs. 44 has been used.

Beyond the Kosi Floods, Table 2 below gives an overview of the quantity and types of damages from previous floods in Bihar from 1979 to 2006, however only data from 1988 onwards is visible. It is clear that floods primarily impact households by destroying a large share of crops, cropland, and property. This can have devastating impacts on household income for years after the floodwaters have receded, trapping households in ever worsening cycles of poverty.

Table 2: Total numbers affected and damaged in Bihar due to flooding, 1979-2006[6]

Total Affected and Damaged in Bihar due to flood 1979–2006[1][2]

Year	District	Blocks	Panchayat	Village	Human (in Lakh)	Animal (in Lakh)	Total Area (in Lakh ha)	Cropped area (in Lakh ha)	Crop Damaged (in Lakh INR)	House Affected	Public Property Damaged (in Lakh INR)
2006	14	63	375	959	10.89	0.1	1.81	0.87	706.63	18,637	8,456.17
2005	12	81	562	1,464	21.04	5.35	4.6	1.35	1,164.50	5,538	305
2004	20	211	2,788	9,346	212.99	86.86	27	13.99	52,205.64	9,29,773	1,03,049.60
2003	24	172	1,496	5,077	76.02	11.96	15.08	6.1	6,266.13	45,262	1,035.16
2002	25	6	2,504	8,318	160.18	52.51	19.69	9.4	51,149.61	419,014	40,892.19
2001	22	194	1,992	6,405	90.91	11.7	11.95	6.5	26,721.79	222,074	18,353.78
2000	33	213	2,327	12,351	90.18	8.09	8.05	4.43	8,303.70	343,091	3,780.66
1999	24	150	1,604	5,057	65.66	13.58	8.45	3.04	24,203.88	91,813	5,409.99
1998	28	260	2,739	8,347	134.7	30.93	25.12	12.84	36,696.68	199,611	9,284.04
1997	26	169	1,902	7,043	69.65	10.11	14.71	6.55	5,737.66	174,379	2,038.09
1996	29	195	2,049	6,417	67.33	6.6	11.89	7.34	7,169.29	116,194	1,035.70
1995	26	177	1,901	8,233	66.29	8.15	9.26	4.24	19,514.32	297,765	2,183.57
1994	21	112	1,045	2,755	40.12	15.03	6.32	3.5	5,616.33	33,876	151.66
1993	18	124	1,263	3,422	53.52	6.68	15.64	11.35	13,950.17	219,826	3,040.86
1992	8	19	170	414	5.56	0.75	0.76	0.25	58.09	1,281	0.75
1991	24	137	1,336	4,096	48.23	5.13	9.8	4.05	2,361.03	27,324	139.93
1990	24	162	1,259	4,178	39.57	2.7	8.73	3.21	1,818.88	11,009	182.27
1989	16	74	652	1,821	18.79	0.35	4.71	1.65	704.88	7,746	83.7
1988	23	181	1,616	5,687	62.34	0.21	10.52	3.95	4,986.32	14,759	150.64

It is apparent that Bihar has extensive resources (land, water, and human) as well as tremendous economic potential. However, in order for it to catch up with national level poverty and human development indicators, Bihar needs to manage its flood risk in a holistic and integrated manner. One of the clear lessons learned that emerged from the Kosi 2008 floods for the Government of Bihar is to improve the institutional performance of agencies engaged in flood risk management activities in the state. Shortcomings in decision making, staff skills and inadequate and delays in maintenance were some of the key factors that underpinned the Kosi Afflux Bund breach in 2008 (GoB 2010). Therefore, it is essential that steps be taken to prevent and mitigate the impacts of future floods and to improve the performance of the state's flood management agencies in a holistic and integrated manner. Subsequent sections in this study will detail the types of institutions engaged in flood management related activities in Bihar, with a specific focus on the Bihar WRD and its current functions as well as specific areas where challenges have emerged from our survey findings.

[6] GoB 2010

3 Approach & Methodology

3.1 Approach

The data collection and survey stages of the study were structured around the five stages of flood management to which answers to a series of questions were sought (see Table 3). Based on this framework, questionnaires were prepared and administered to four groups (see Section 5):

WRD field level officers (Junior Engineers to Executive Engineers);

WRD leadership (Superintending Engineers and above);

Local communities (households, businesses and village Panchayat Raj officials);

The Flood Management Information System Cell (FMISC).

In addition focus group discussions were held with local communities and discussions and interviews held with WRD, DMD, WALMI and other agencies related with flood management. Further details of the procedures followed for data collection are set out in section 5.

Table 3: Structuring the Study

Flood risk categorisation	• Know what the risk is • Plan for flooding • What knowledge do flood management organisations have? • What technology is employed? • What mapping is available? • Are hazard zones coded/identified?
Flood damage mitigation	• What can be done to mitigate costs/harm done? • What are the costs of the harm/damage done? • What are the costs of mitigation measures (e.g. maintenance, etc.)
Flood warning	• What amount of warning is given? What should be given? • What data collection systems exist? • What communication systems exist? • Is remote sensing used? In real time? • What information is disseminated, at what time, to the affected populations? How is it provided?
Flood events	• What happened? What action taken – by whom, how, when, etc.? • What resources mobilised? • What finances available? • What problems/constraints encountered?
Post-flood actions	• What is done post flood? • What support provided for post-flood situation? • Speed of recovery from flood events? • What lessons learnt? How recorded? How used/passed on?

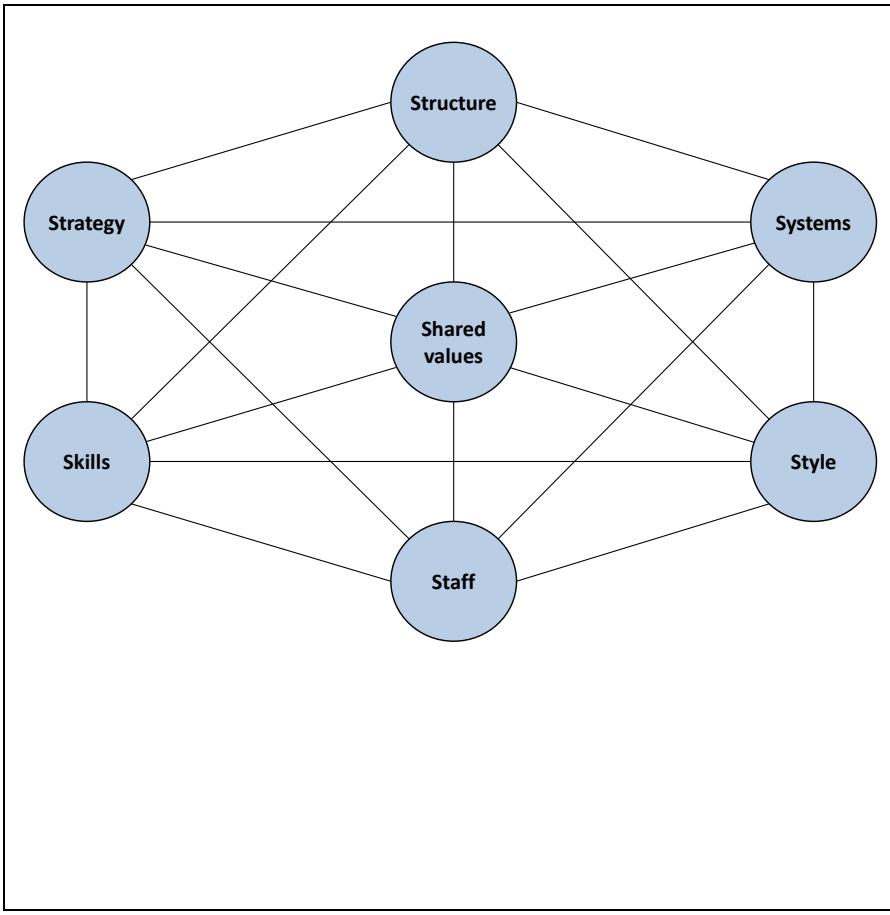
3.2 Methodology

Upon completion of the survey exercises, the data was initially structured into seven categories based on our understanding of the identified gaps. These included:

i) People Gap – Identification of gaps in staffing, leadership.
ii) Process Gap – Issues related to communication, promotion, remuneration.
iii) Technology Gap – Issues related to lack of modern technology (computers, GIS, etc.)

iv) Resources and Funding Gap – Issues related to funding and lack of resources (vehicles, hardware, etc.)
v) Support Systems Gap – Issues related to training and support within the organisation.
vi) Ecosystems Gap – Issues related to level of engagement with local communities.
vii) Coordination Gap – Issues related to engagement with other agencies.

We subsequently refined this initial categorization of our findings by utilizing the 7-S model developed by McKinsey (Peters and Waterman, 1982; DFID, 2003) which formed the basis for a performance assessment framework with which we assessed how well the WRD is carrying out its key functions. This model identifies seven interrelated domains that form the core of an organisation's effectiveness (Figure 2). The model is useful in that it looks at the formal structure and processes of the organisation as well as its culture (the management style and shared values).



Structure: Comprises the organisation chart, job descriptions
Systems: The processes and procedures for getting the work done
Style: The way that management behaves, including showing what is important to the organisation
Staff: The people in the organisation - their capabilities, needs, strengths and weaknesses
Shared values: The culture of the organisation
Skills: The capabilities possessed by the organisation as a whole
Strategy: A coherent set of actions to further the aims and objectives of the organisation

Figure 2: The 7-S Model

As the diagram shows all the seven S's are interconnected, a change in one requires complementary changes in the others. Thus, for example, if the strategy of the organisation is changed then changes need to be made to the other elements. A change in strategy to focus more on customer relations and service delivery changes the organisation's shared values and the management style, and requires new skills and systems allied to staff training. The structure may well change, perhaps with formation of a customer relations department.

Another model that we analyzed that is widely used in relation to organisational change and performance is the Burke-Litwin (1992) model (Figure 3). This model takes greater account of the external environment and the need for an organisation to adapt itself to changes in the external

environment. The model incorporates the seven variables of the 7S model; however, the 7S model was preferred for this study as it is more straightforward and easier to communicate.

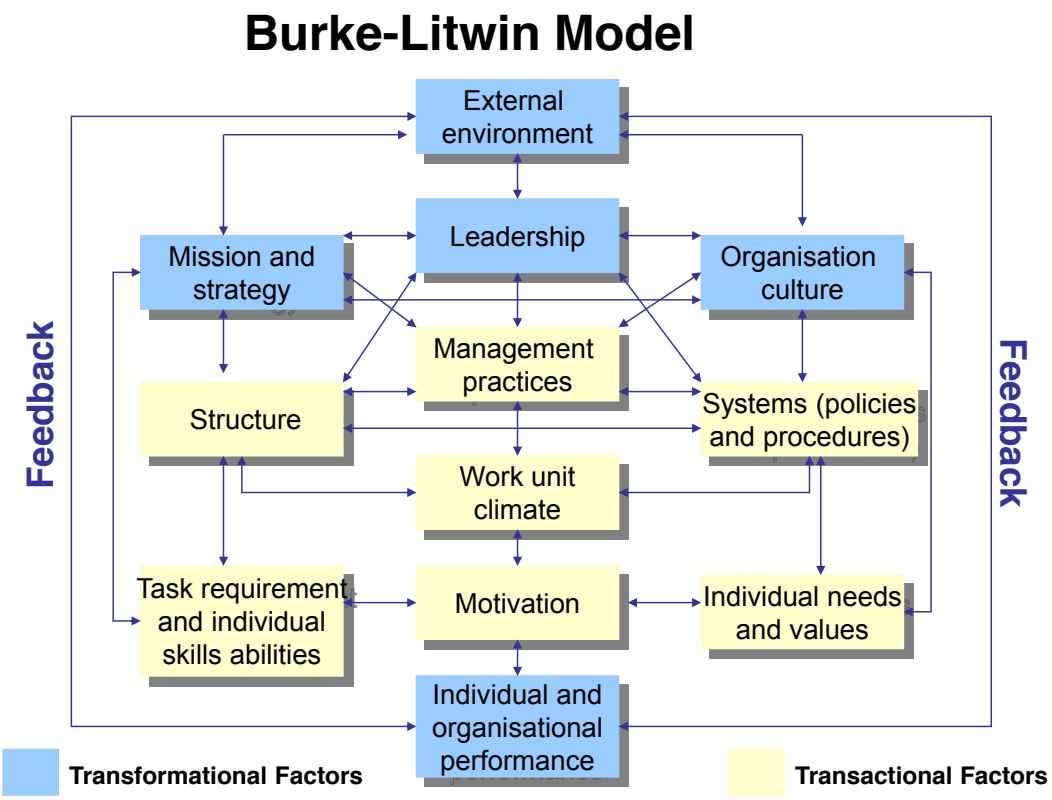


Figure 3: The Burke-Litwin (1992) Model

As will be detailed in section 5 WRD staff at Division and Sub-Division levels were interviewed to ascertain their knowledge, experience and opinions related to flood management. In section 6, their responses based on the surveys we conducted are grouped and analyzed according to both our original categorization of the gaps and also into the seven domains of the 7-S model. In addition, for analysis of the WRD field officer survey responses diagrams known as 'problem trees' (see Figure 4) were prepared for five of the seven domains (there were no issues categorized under the structure and shared values domains).

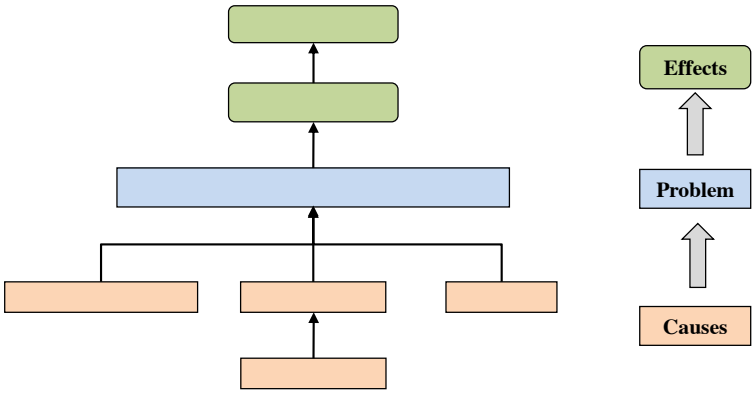


Figure 4: Problem tree analysis linking problem, cause and effect

The problem tree approach was used to try to link the various institutional issues identified through the questionnaires and to identify the causes, the focal problem and the effects or consequences of the problem. The analysis helps to identify the root causes of an institutional problem and its associated effects, thus providing policy makers with an in-depth guide of the types of measures required to alleviate existing challenges. The next section describes the current organizational make-up of the WRD and other related agencies that this study analyzed.

4 Organisations Engaged in Flood Management

The following section provides background details of the some of the key agencies engaged in flood and water resources management in Bihar at the state and district levels. However, as the main focus of phase one of this study was on the internal operations of the Water Resources Department, more in-depth details have been provided for WRD whereas introductory data has been provided for other agencies.

4.1 Water Resources Department

The key functions of the Water Resources Department (WRD) include major and medium irrigation projects, flood management, drainage management, and command area development and water management. WRD undertakes projects in developing major and medium irrigation schemes, constructing reservoirs, interlinking of rivers, participatory irrigation management, construction and management of flood protection structures, anti-erosion works, developing flood management information systems, development of drainage systems, construction of water ways and associated areas. The department headquarters are located in Patna.

Figure 5 below illustrates the organogram of the department. The Chief Engineers (CE)and officers above form the main decision making and strategy team while the Executive Engineers (EE) and officers below form the operational wing of the organization. The Superintending Engineers (SE) are the interlocutors between strategy and operations. Almost all the Chief Engineers in North Bihar and the Chief Engineers of Bhagalpur and Patna are involved in flood management functions. The department divides field level officers into distinct irrigation and flood functions. At the same time, it allows for unconstrained transfers of officers between the two functions.

The department's field apparatus is organized in Circles, Divisions and Sub-Divisions. The Chief Engineer is responsible for the entire apparatus of Circles in his zone. A Superintending Engineer (SE) (also called AC) who reports to the CE heads each Circle and is responsible for the following specific functions: canal, flood, waterways, planning, drainage, and head works, etc. Under the Circle are multiple Divisions. An Executive Engineer (also called Divisional Officers DO) heads each Division. In a Division, typically there are four to five Sub-Divisions each headed by an Assistant Engineer (AE) (also called Sub-Divisional Officer SDO). Each Sub-Division is sanctioned four Junior Engineers (JE) who report to the Assistant Engineer. However, in reality the actual staffing levels deviate from the above guidelines especially at the AE and JE level. This is further detailed in section six.

Under the flood management function, the field office is responsible for visual monitoring of flood protection structures, proposing and monitoring anti-erosion works and guiding experts and decision-makers to inspection of affected areas as well as execution of approved maintenance and anti-erosion works.WRD conducts its flood management operations based on an annual calendar of activities. June 15 to October 15 is designated as the high alert flood-monitoring period known as the 'flood fighting' period in WRD terminology. During this time, the department deputes all of its field strength to monitoring and vigilance of high flood risk areas within each basin. The JEs and AEs conduct regular visual inspections (often multiple times a day) of embankments and other vulnerable sites within their jurisdiction or designated coverage area. In addition, in some basins 'home guards' or night watchmen are deputed at every one kilometre to strengthen the inspection efforts. The EEs and AEs have additional decision-making authority to undertake any flood protection works during this period.

October 16 to December is marked for fresh inspection of post-flood period situation known as flood anti-erosion period. This is a period when flood risk is relatively low and rivers are flowing at their lowest levels. Based on regular inspection, new proposals are sent by the field staff to the head

office in Patna for approval. In addition, anti-erosion work is conducted during this time. From January to June 15, the WRD field officers are mandated to implement major flood protection works that have been approved by the decision-making committees in Patna. Another set of inspections are conducted in June to ensure that major vulnerable points are not left unchecked.

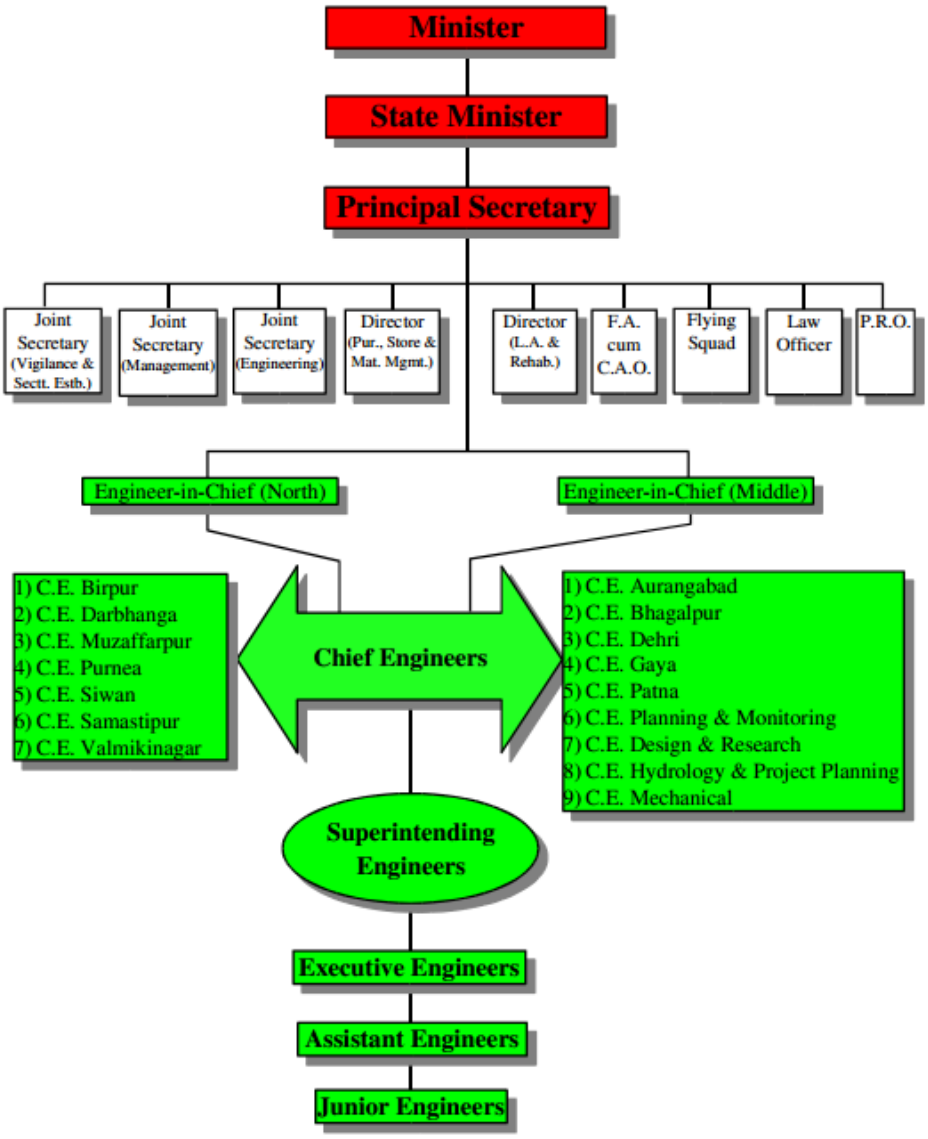


Figure 5: Organizational Chart of the Water Resources Department, Government of Bihar

The process, participants and activities associated with flood management in Bihar are outlined in the "Flood Management Rules" section of in the Bihar Irrigation, Flood Management and Drainage Rules (GoB 2003). The guidebook provides WRD with the following instructions on flood management:

1. Executive Engineer with the help of Assistant Engineer and Junior Engineer is in-charge of maintenance and inspection of embankment.

2. As per guidelines, the Executive Engineer is expected to categorize embankments in risk categories A, B and C and then follow the outlined process for maintenance.
3. Patrolling the embankments is planned and scheduled by the Chief Engineer. He also arranges the resources necessary for patrolling.
4. Process for quick exchange of information from JE level to CE level to Flood Monitoring Cell in Patna must be set up and updated.
5. Central Flood Control Cell under Chief Engineer Planning and Monitoring will function from 15th June to 31st October. Similar flood control cells operate under each Chief Engineers at their respective headquarters.
6. Executive Engineer is responsible for managing the flood fighting material and reviewing the arrangement with Chief Engineer.
7. Every year, field officers will make a list of flood protection works. Anti-Erosion Committee (Concerned CE, Another CE and an SE from headquarter) will inspect various sites and advise the CE for the flood protection works. Field officer will accordingly develop the proposal and send it to State Technical Advisory Committee (listed in Figure 6 below):

Figure 6. List of Members for State Technical Advisory Committee

1.	Chief Engineer, Central Design Organisation, Water Resources Deptt ,Patna	Chairman
2.	Chairman, Ganga Flood Control Commission ,Patna	Member.
3.	Chief Engineer, W.R.D .Darbhanga	Member.
4	Chief Engineer, W.R.D. Siwan.	Member
5.	Chief Engineer, W.R.D. Valmikinagar	Member
6.	Chief Engineer, W R.D. Purnia	Member
7.	Chief Engineer, W.R.D. Samastipur	Member
8.	Chief Engineer, W.R.D. Muzaffarpur	Member
9	Chief Engineer, Hydrology & Project Planning, Patna	Member
10	Chief Engineer, Minor Irrigation, Patna	Member
11	Chief Engineer, Public Works Department, Patna	Member
12.	Director, Agriculture Department, Patna	Member,
13.	Chief Forest Conservator, P.O- Hinu, Ranchi,	Member.
14.	Member (River Management) CWC-R.K.Puram, New Delhi	Member.
15.	Chief Engineer (Bridges), N.E.Railway,Gorakhpur, U.P.	Member.
16.	Chief Engineer, Eastern Railway, 17, Netaji Subhash Road, Calcutta-700 001	Member.
17	Chief Engineer(Bridges) N.E. F. Railway, Maligaon, Gauhati, Assam.	Member.
18.	Chief Engineer, Water Resources Department, Patna.	Member.
19.	Chief Engineer(Research), Water Resources Deptt., Khagaul, Patna.	Member
20.	Superintending Engineer, Flood Control Planning & Monitoring Circle, Patna	Member
21.	Superintending Engineer, Flood Control Design Circle, Patna	Member-Secretary

According to the guidebook an expert committee of retired Chief Engineer level officers can be constituted by the Department to visit the vulnerable sites and offer recommendations to the State Technical Advisory Committee. The guidebook advises that the Kosi River and Pipra-Piprasi embankment of the Gandak River shall constitute two separate Technical Advisory Sub-Committees, which shall after inspecting the sites give their recommendation to the respective field Chief Engineers. These sub-committees shall have the following members:

Chief Engineer, Central Design Organization, WRD (Chairman)

One nominated officer from the Ganga Flood Control Commission (Member)

Chief Engineer, Planning & Monitoring, WRD (Member)

Chief Engineer, WRD, in-charge of Kosi embankment/Gandak Pipra Piprasi embankment (Member-Secretary)

Based on the recommendations of this sub-committee, the field officers make proposals and estimates that are presented to the Kosi and Gandak High Level Committee. This committee is required to conduct inspections of the sites after which revised proposals are submitted by the field officers to the Departmental Scheme Review Committee.

The Scheme Review Committee prioritizes the schemes and rewards appropriate funds. First priority is given to proposals for protection of embankments and retired embankments. The next priority is given to schemes that protect industrial units, large assets such as highways, towns. Finally, if there are any remaining funds, priority is given to schemes that are old and protect thickly populated segments. Last and *the least*, the guidebook claims, "for want of fund, neither the protection works of cultivable land along the rivers nor any protection works for diara area shall be taken up." The guidebook states that all efforts need to be made by the WRD to complete all schemes before 31st May every year.

The Scheme Review Committee consists of the following members:

Engineer-in-Chief (Flood Sector), WRD (Chairman)

One member from Ganga Flood Control Commission (Member)

Chief Engineer, Planning & Monitoring, WRD (Member)

Chief Engineer, IRI, Khagaul, Patna (Member)

Chief Engineer, Central Design Organization (Member)

WRD Patna-cum-Chairman State Technical Advisory Committee (Member)

As will be analyzed in section 6, the reality of how these procedures are actually implemented is quite different from the rules and guidelines laid out here.

4.2 Flood Management Information Systems Cell

The Flood Management Information System Cell (FMISC) was established in January 2007 following the GoB administrative order establishing the Flood Management Information System (FMIS). The FMIS was set up as a result of an agreement at a meeting between the GoB and the World Bank in January 2006 at which a water sector partnership matrix and action plan was agreed. A component of the short-term action was to improve the technical and institutional capacity of the state in flood management, in particular the introduction of modern information technologies.

The FMISC comprises a total of 23 staff currently in office against sanctioned posts of 34 officers. The Cell is comprised of one Joint Director, two Deputy Directors with an additional Director on deputation, six Assistant Directors and four Engineers on deputation, one JE on deputation, and seven contract staff that have technical specialization remote sensing, GIS, web and IT management, disaster management, among others. In addition, the FMISC also has 14 support staff.

The overall aim of the FMIS is to generate and disseminate timely and customized information in order to assist flood management agencies to move from disaster response to disaster preparedness and to effectively support flood control and management in the flood prone areas of Bihar. It was recognised that there was a compelling role and benefit for modern technology to improve decision-making processes before, during and after flood events.

The development of the FMIS was planned in four stages:

i) Flood hazard characterization and emergency response;
ii) Improved flood preparedness and community preparedness;
iii) Flood hazard mitigation; and
iv) Integrated flood management.

The initial Phase I (August 2006-June 2008) activities focussed on flood hazard characterization and operation of flood management products, supplemented by improved flood forecasts, a flood management website, updated flood control manuals, preparation of plans for upgrading hydrological measurements and telemetry and training of government agency personnel.

Subsequent stages of FMIS development seek to encompass enhanced functions and products, supported by improved hydrologic observations and telemetry, more reliable and longer-term rainfall forecasts, enhanced flood forecasting and prediction of inundation using more powerful models, real-time inundation mapping during floods (using Synthetic Aperture Radar, ASAR surveys), real-time flood data dissemination, mapping of floodplain geomorphology using close-contour surveys, establishment of an embankment asset management database, enhanced information flow and communication links together with community outreach and participation programmes providing flood risk assessments and flood warning.

The FMISC is supported by the World Bank with training for the staff and for selected WRD personnel. This has included training by the US Army Corps of Engineers on asset management plans for embankments, specialised training on flood forecasting and water resources management. Once a year the FMISC also hosts a training session for the WRD Technical Advisory Committee. Training is required for WRD engineers, particularly those working in the Flood Management Cell, in mathematical modelling, hydrology, meteorology and flood management. This training is provided by the Water and Land Management Institute (WALMI) and does not, surprisingly, involve staff of the FMISC who could cover the mathematical modelling and hydrological aspects.

The FMIS website provides the following information:

Daily hydro-meteorological status in north Bihar with danger level, water level and rainfall data provided during the flood season (15 June to 15 October);

Daily flood bulletin with summarized information on observed rainfall, water levels and 3-day basin-wide rainfall forecasts;

Inundation maps showing the aerial extent of flooding. These data are obtained from RADASAT layers and images provided by National Remote Sensing Authority (NRSA);

Monthly e-bulletins detailing the work done by the FMISC;

End-of-season flood report;

District level 5-day rainfall forecasts for Bihar and Jharkhand. These data are provided by the Indian Meteorological Department (IMD) during the flood season.

Currently FMIS is in the process of executing Phase II of the FMIS programme, which consists of several components. Component A of Phase II focuses on institutional strengthening of flood management, Component B focuses on development of FMIS including flood forecast and inundation modelling as well as development of an embankment asset management system and lastly Component C focuses on community-based flood risk management in targeted areas.

The FMISC is also the nodal unit in charge of implementing the flood management component of the World Bank aided Bihar Kosi Flood Recovery Project (see section 7). In addition, the FMISC is supporting the WRD in finalizing anti-erosion works utilizing up-to-date satellite images to aid decision-making as well as during flood fighting periods; the FMISC assists the WRD in actively monitoring critical locations in north Bihar. The FMISC supports the Disaster Management Department by providing some inundation maps, which assist the department in undertaking relief and rescue operations.

4.3 Water and Land Management Institute

The Bihar Water and Land Management Institute (WALMI) was founded in 1983 in Patna under the purview of the Water Resources Department. In 1999, WALMI became an autonomous institution. The institute campus is located less than five kilometres from the WRD headquarters in Patna. The main objectives of the institute are:

- Multi-disciplinary training for engineers from Water Resources and Agriculture departments
- Study and develop solutions to improve the water and land management around existing irrigation systems
- Establish linkages with other institutions involved in water management and collaborate with similar foreign institutions on research subjects.
- Act as a knowledge dissemination centre in the field of water and land management.
- WALMI strives to offer training in computers and water management. Further, farmers are also given training in water management for agriculture.

The institute is run mainly by annual grants (95%) provided by the Water Resources Department. Further, revenues generated through fees charged for training facilities and other assets also aid the institute. The overall budget estimate for 2011-12 was Rs.96.71million. This included a maintenance estimate of Rs.51.5 million.

The Director is the overall head of WALMI. Professors (SE rank officers), Readers (AE rank officers), and Assistant Professors (EE rank officers) are deputed from WRD for teaching and research stints at WALMI and report to the Director within their respective hierarchies. In addition, an Estate Officer is in-charge of managing and maintaining the overall assets of the institute. Table 4 below provides a list of staff within WALMI that are currently deputed to WALMI versus the numbers of staff that are sanctioned. The overall figures clearly indicate that there is nearly a 50% shortage of staff in WALMI at all levels. There is specifically a 50% shortage in the number of training staff, which has a more significant impact of the quality and quantity of trainings that WALMI can provide to WRD staff.

At present, the Engineer-in-Chief North (E-in-C) who is head of flood management activities in the WRD is also the acting Director. The Professors, Readers and Assistant Professors are given specific subject matter designations based on who gets deputed by WRD. The process and tenure of deputation depends on the discretion of the WRD decision-makers. Overall, based on our initial discussions it seems that the support staff of WALMI is much bigger and has a stable tenure while the training apparatus is subject to ad hoc mechanisms and frequent transfers of staff.

Table 4. Staff Strength of WALMI

Posts	Sanctioned	Actual	Remarks
Director	1	0	Engineer-in-Chief is acting Director
Professor	6	1	SE rank on deputation from WRD
Reader	16	10	EE rank on deputation from WRD
Assistant Professor	21	11	AE rank on deputation from WRD
Support System			
• **Estate Officer** • **AE** • **JE**	1 2 8	1 1 6	Permanent term position WRD Officer WRD Officer
• **PA to Director** • **Assistant**	1 2	0 2	Permanent term position
• **Lab Assistant** • **Steno-typist** • **Typist** • **Data-entry**	3 8 4 4	0 0 2 1	Permanent term positions
• **Admin Officer** • **Account Officer** • **Account Clerk** • **Cashier**	1 1 3 1	0 0 2 1	Permanent term positions
• **Photographer** • **Photocopier** • **Peon** • **Driver** • **Treasury Guard** • **Cook**	1 1 12 4 1 1	0 1 10 1 1 1	Permanent term positions
Total	44 + 59 = 103	22 + 30 = 52	

WALMI's role in flood management is both strategic and operational. At the strategic level, WALMI is responsible for developing institutional linkages for research and disseminating information within the WRD. At the operational level, WALMI is responsible for offering training to AE and JE level staff on aspects of flood management.

At present, WALMI does not offer any training to officers above the rank of AE. In addition, there is no significant evidence of institutional linkages created or strengthened by WALMI. On the operational front, the focus on flood management is limited to three trainings as listed in the 2012-13 training calendar. These are

Flood Forecasting and Management (limited to 30 AEs)

Refresher Course for AEs

Refresher Course for JEs

Induction Course for AEs

Induction Course for JEs

The budgetary sub-headings of the institute show that there are no special provisions for research and institutional partnerships. Finally, a comparison of the training calendars for the last three years (2010 – 11, 2011 - 12 and 2012 – 13) reveals that no new trainings were added to the list. Therefore,

even on the operational front, WALMI does not seem to be significantly engaged in increasing the technical knowledge of WRD field officers in flood management.

4.4 Bihar State Disaster Management Authority & Disaster Management Department

The Bihar State Disaster Management Authority (SDMA) is a strategic body created under the framework of the National Disaster Management Authority (NDMA) at the state level. SDMA at one level translates NDMA guidelines and policies for appropriate implementation in the state and at another level, develops Bihar specific strategies and new initiatives in the space of disaster management. The Chief Minister is the Chairman of the SDMA. Operationally, the Vice-Chairman is responsible for the day-to-day activities of the organization.

As a strategic policy level body covering all types of disasters, SDMA does not specialize just in flood-related disasters but encompasses all forms of disasters. However, it supports publishing and dissemination of disaster preparedness information with respect to floods. Similarly, they undertake policy level initiatives in preparing the community for flood related hazards by disseminating the do's and don'ts for flood prepared to community members, developing a volunteer task force to be activated during flood events, and training people in swimming and other rescue activities.

The Disaster Management Department (DMD) is the nodal agency within the Government of Bihar that provides disaster-related information and provides disaster rescue, relief and rehabilitation functions to affected areas throughout the state. The agency is responsible for coordinating with various departments to ensure preparedness and immediate action towards rescue and relief when a disaster occurs. A state-of-the art disaster control room in Patna and similar centres at district level are part of the overall DMD apparatus.

For flood specific disasters, DMD has developed a standard operation manual that offers guidelines about the pre-flood season preparations, coordination mechanisms, and an operating book for the relief and rescue operations during and after the flood event. As part of the study, the operation manual was reviewed and its field level implementation was tested through survey questions. As section 6 will detail, it became clear to the study team that the operation manual is not fully implemented. A detailed study of the gaps between the DMD operation manual and the field implementation needs to be conducted to reveal the specific discrepancies. This was considered to be out of the scope of the current phase of the study. In addition, section six will illustrate that the coordination between WRD and DMD at the field level remains invisible to the community and to the WRD officers who were surveyed. A detailed study of the coordination mechanisms between WRD and DMD would reveal the actual gaps that exist. This again was not a part of the present phase ones a detailed study of DMD and its linkages in the flood apparatus was not conducted in this study.

4.5 State Administration (District Magistrates Office)

The state administration at the District Magistrate (DM) level and Block Development Officers (BDO) level are engaged in flood management activities mainly on the functions of communicating with the community, interacting with the media, staying prepared and alert for rescue in the event of a flood and administering the relief and rehabilitation process. In addition, the wide array of developmental projects overseen by the DM and BDO gradually develops the preparedness level of the flood prone areas. For example, they play an instrumental role in constructing physical structures of schools, primary health centres, installation of hand-pumps, and construction of village roads, which together account for both the post-flood reconstruction activities and to ensure flood preparedness of the community. The DMs office is in direct contact with the Circle and Division offices of the WRD on information related to vulnerabilities, rainfall and water levels. The flood management rules section of the Bihar Irrigation, Flood Management and Drainage Rules 2003 (GoB 2003) states three roles for the District Magistrate's Office: a) protecting the embankment from miscreants; b) staying prepared

during floods and helping fill any gaps in patrolling and/or administration; and c) removing all encroachments by April every year to facilitate scheduled embankment maintenance works.

Although there are further insights to be gained about these linkages, this study did not focus on the intricate functions of the DM's office with respect to flood management.

4.6 State Administration (Police)

The police stations are involved in ensuring that miscreants do not damage flood protection structures. They also play the primary role in maintaining law and order during flood events, rescue and relief activities. This study did not focus on the intricate linkages and functions of the police administration with respect to flood management.

4.7 Panchayat Raj Institutions and Elected Representatives

Panchayat Raj Institutions (PRIs) and elected representatives such as Members of Legislative Assembly (MLA) and Members of Parliament (MP) do not have a formal role in the flood management setup. However, there are several informal functions that they undertake. First, they act as pressure agents in influencing the department on anti-erosion works that needs to be taken. Second, MLAs and MPs have a role in presenting new ideas to the department with respect to flood management structures especially embankments and ensuring connectivity by constructing new roads ensuring repairs that are required are done in a timely manner. Finally, they act as key conduits of information during the flood season particularly during flood event rescue and relief operations. With recent announcements of some flood management works to be conducted through National Rural Employment Guarantee Act (NREGA), the role of PRI members is bound to increase. Insights into the perspective of how PRIs view WRD flood management activities are detailed in section 6.

5 Surveys & Interviews

The overarching objective of the surveys and interviews we conducted was to holistically understand the functional capabilities of the WRD to manage floods in Bihar at the state, district and village levels. This exercise included multiple sets of surveys ranging from surveys of officers to surveys of local farmers, PRI representatives and members of Self Help Groups (SHG).The surveys aimed to develop a benchmarking system that will measure institutional progress that the WRD may make in the coming years. The surveys also aimed to gather and collate direct insight from local communities and affected citizens of Bihar in order to provide a grassroots understanding of the reality of floods for Bihar's people.

In addition, we ensured that the surveys did not present WRD as a weakly functioning department. We also ensured that no one department or person was represented in a poor light over another. And finally we aimed not to prescribe instant solutions to any of the challenges and concerns that are highlighted in this study. There are some essential stakeholders whose survey would have offered further insights about the flood management setup. These include the Disaster Management Department and District Magistrate's Office. However, these were not included in the scope of the study due to lack of time and the greater focus given to the internal operations of WRD over external linkages with other departments.

5.1 Selection of Target Basins

During the design phase for the survey, the study team held detailed discussions with the WRD, especially the head of the Flood Monitoring Cell in Patna, who worked with the study team to select the appropriate river basins based on the needs of the surveys. Due to the time limitations for conducting the field surveys, the team agreed to target a total of three basins in the state. The study team then developed a set of criteria for the selection of target basins, which included indicators such as:

Geographical diversity within the state (e.g. in disparate locations),
Vulnerability to flood risk and hazard,
Presence of flood infrastructure,
Diversity of basin morphology in terms of river behavior and type of silt loads carried,
Occurrence of flood events within the last ten years

Based on these criteria, the three basins that were selected to conduct all surveys are: 1) the Bagmati-Adhwara basin in central north Bihar, 2) the Mahananda basin in north Bihar and 3) the Kosi basin in northeast Bihar.

Bagmati Basin Characteristics

The Bagmati is a perennial river of north Bihar. The river originates in the Mahabharat hills (the middle range of the Himalaya below those areas fed by snow or glaciers). Its headwaters are in the Shivapuri range about 16 km northeast of Kathmandu at an elevation of 2,800 meters. The river merges with the Kosi River at Badlaghat in Bihar after travelling a distance of 195 km in Nepal and 402 km in India. Its total catchment area is about 13,400 sq. km of which about 7,000 sq. km are in Nepal.

Flood hazards in the Bagmati River and its tributaries are heavily influenced by both the monsoon, which lasts from June to September, as well as by events in upstream tributaries. In particular,

cloudbursts, mudflows, debris flows, flash floods and bishyari (major floods caused when landslides that dam rivers breach) are common in the mountains. The lower Bagmati region receives a substantial amount of rainfall during the monsoon season and it is this precipitation that serves as a primary trigger for most flood events. After the monsoon, in contrast, conditions are often drought-like. The characteristic alternation of flood-drought in the region is a natural outcome of the region's climate. Moderate flood events in the Bagmati basin tend to benefit agriculture but can result in three types of hazards: inundation, the erosion of banks and loss of land, and the deposition of sediment on land. There are several structural measures present in the Bagamati basin including the eastern and western embankments, ring bunds, afflux bunds. The Bagmati left embankment is 24.45 km long, however, an extension project is under way that will eventually extend the Bagamati embankment to 35.92 km. The Bagmati right embankment is 26.89 km and will also be extended to about 34.71 embankments once extension is completed.

Floods in the Bagmati basin carry micro-nutrients, fine silt and loam and, after waters recede are deposited on fields, where they tend to improve soil fertility and productivity. During major floods events, however, these benefits vanish. In some major floods, so much sand on agricultural land is deposited that the entire paddy crop for the season was destroyed resulting in severe food shortages and loss of livelihoods for local farmers as the land could not cultivated for years after the event (Dixit et al, 2008b).

Mahananda Basin Characteristics

The Mahananda is one of the major rivers of north Bihar, which originates 6 km north of Kurseong in the Darjeeling district of West Bengal in the Himalayan range. It is here that this river starts its 376 km long journey to the Ganga. The total catchment of the river is stated to be 24,753 sq. km of which 5,293 sq.km is located in Nepal, 6,677 sq. km is located in West Bengal and only 7,957 sq. km is located in Bihar. The rest of the catchment is located in Bangladesh where the river ultimately falls into the Ganga (Padma). The Mahananda also brings with it a high amount of silt, as it debouches into the plains, from the Himalayan range of mountains. The river is known to have changed its course in the past. The Mahananda catchment has an average rainfall of about 1.563 mm in its Bihar portion, which rises to a maximum of about 6000 mm in the higher catchment (Mishra, 1999). The Mahananda is now embanked with embankments stretching on the eastern and western sides of the river, with an additional 1200 km of embankments, which have been sanctioned within the new plan period. Currently the Mahananda embankment is 90 km long with eleven spurs and sixteen anti-flood sluices built on the side of the embankment.

Kosi Basin Characteristics

The Kosi starts its journey at a height of about 7,000 meters above sea level in the Himalayas; its upper catchment is located in Nepal and Tibet The river is also called the SaptaKoshi in Nepal as it is comprised of the waters of the Indravati, the Sun Koshi or BhoteKoshi, the Tama Koshi, the LikhuKoshi, the DudhKoshi, the ArunKoshi, and the Tamar Koshi. The first five rivers listed form the Sun Koshi that flows from west to east. After reaching the plains, the bed of the Kosi widens drastically and it spreads over six to ten km. After traversing a distance of about 50 km in Nepal, the river enters India near Bhimnagar (Supaul district) in Bihar. From Bhimnagar, the river flows in a southwesterly direction for about 100 km until it reaches Mahishi in Saharsa district of Bihar. The total catchment area of the Kosi is 74,030 sq.km and this does not include the catchment areas of two of its important tributaries, the Kamla (7,232 sq.km) and the Bagmati (14,384 sq.km). Out of the

total catchment of the Kosi, 11,410 sq.km are located in India and the remaining 62,620 sq.km lie in Nepal or Tibet. The average rainfall in the upper catchment of the Kosi is 1,589 mm while in the lower reaches it is 1,323 mm (Singh et al, 2009).

Since the Kosi River changes its course regularly the areas affected by floods on the river have three distinct features. First the areas which form the bed of the Kosi that are directly hit by its floods, not only face the direct onslaught of the floods but also suffer from land erosion, sand casting, waterlogging, scarcity of drinking water, total collapse of health services, disruption of roads and communication systems, engulfing of villages, smallpox, cholera, Kala-Azar, snakebites, large-scale deaths of livestock because of lack of fodder, and much more. Therefore, the Kosi River presents a challenge in terms of long and recurring flood hazards. The Kosi 'project' has a barrage at Bhimnagar (Nepal) with canals with irrigation potential of millions of hectares, afflux bunds up to 12 km on western and 32 km on eastern side upstream of the barrage, and downstream flood embankments up to 100 km on the western and 124.5 km on eastern side.

The project was designed to protect approximately 2800 sq. km of land in north Bihar and Nepal. Despite this intervention and a long history of flood control management in the basin for more than 5 decades, the river continues to cause extensive flooding due to breaches.

The following list provides an overview of previous flood breaches on the Kosi embankments[7]:

- **1963**: The first breach on the western embankment in Nepal
- **1968**: Five breaches in north Bihar
- **1971**: Collapse of the 1969-built Bhatania Approach Bund
- **1980**: Eastern embankment breach
- **1984**: Eastern embankment breach
- **1991**: Breach in the western embankment near Joginia in Nepal
- **2008**: Breach in eastern afflux bund in Nepal

The 2008 floods caused substantial siltation of the main canal and distributaries, breaches in and siltation of smaller canals and watercourses, as well as destruction of hydraulic and other structures. These damages have rendered the Eastern Kosi Canal system mostly dysfunctional to the present day resulting in a devastating impact on agriculture and livelihoods. The Kosi Cultivable Command Area (CCA) is 612,000 hectares in the five districts.

5.2 Scoping Visit

Prior to beginning the field visits to the three selected basins, the study team undertook a one day preliminary field visit to pre-test the WRD field level questionnaire and conduct preliminary discussions with local community members. The study team traveled to the district of Samastipur in the Ghandak River basin. During the field visit, the study team held discussions in the village of Dhanoun, which is located in one of the sub-divisions of the WRD Samastipur Division. The team met with the former Mukhia or the Panchayat Raj leader of the village, 1 WRD Assistant Engineer, 1 WRD Junior Engineer, and six local community householders. In addition, the team also held discussions at the WRD Section Divisional office and met with 1 Executive Engineer in charge of the Division, 1 WRD Assistant Engineer, and 1 WRD Junior Engineer. Details of the findings of the scoping visit are described in section 6.

[7] GoB 2010

5.3 WRD Surveys

Once the target basins were selected by the study team, a set of surveys were designed to assess the capabilities of the key staff engaged in flood management for the WRD. The surveys aimed to target officers of the WRD who are actively engaged in flood management activities at all levels from junior-level engineers to senior officers such as the Engineer-in-Chief. In order to accurately assess all officers, the study team designed two types of surveys for WRD staff; one set of questions that were addressed specifically for field level officers (e.g. Junior Engineers to Executive Engineers) within the three target basins and another set of questions prepared in an online survey format for senior officers of the rank of Superintending Engineer (SE) and above (e.g. Chief Engineer, Engineer-in-Chief, Director, etc.) for officers located in Patna at the headquarters of the WRD as well as senior field level officers who work on floods throughout the state. Both sets of surveys sought to:

1. Identify the level of knowledge held about the flood risk;
2. Identify the level and quality of interactions within the WRD on flooding issues;
3. Identify the extent and timeliness of flood warnings;
4. Identify the quality of embankment maintenance and management;
5. Identify quality of staff skills, training, and technical knowledge;
6. Identify and map processes and quality of decision making;
7. Identify types of technology, hardware and software available for flood management.

The WRD field level officers survey included questions that obtained information from field level officers on the background data of each Division and/or Sub-Division such as availability of technology, staffing, resources available to staff, trainings given and/or received on flood activities. Specific questions were also raised around a)the topic of flood location and flood risk within the area of responsibility for the interviewees within the basin, b) questions pertaining to flood forecasting and flood early warnings within the target areas, c) others on flood preparedness and mitigation measures particularly questions focusing on the procedures, processes and quality of embankment maintenance activities as well as annual flood anti-erosion works, and d) questions on financial resources and availability of funds to perform regular maintenance activities. Questions around specific flood events and how officers coped with past floods were also raised in the survey as well as open-ended questions that asked officers specifically if they faced challenges in performing their duties adequately as well as opportunities for them to provide feedback and gives suggestions as to how they think these challenges can be overcome. The WRD field officer survey format is provided in Annex A. The survey questions and survey format was discussed in detail with WRD officers in Patna prior to travel to the field in order to obtain their feedback and suggestions for the survey questions. Their inputs were then incorporated into the survey and the questions modified accordingly.

The WRD field officers survey targeted the districts of Muzaffarpur and Sitamarhiin the Bagmati basin, the district of Katihar in the Mahananda basin and the district of Supaul in the Kosi river basin. Prior to travel to each of the districts, the survey team engaged closely with officers in Patna as well as officers at the head of the Divisions within each basin in order to brief them on the purpose of the study, the surveys to be carried out and the officers to be targeted. Within each district, one WRD flood division and two sub-divisions in each Division were selected as target groups to receive the surveys Therefore, a total of three Divisions and six Sub-Divisions of the WRD were targeted for this survey.

The WRD field level surveys were conducted in conjunction with the WRD senior surveys and the community surveys. The fieldwork was conducted over the course of a month starting at the end of March 2012 and completed in April 2012 when the WRD officers. During this period, the WRD officers are mainly engaged in embankment maintenance, inspection and anti-erosion work

activities rather than actual flood fighting activities. In all three river basins, the survey team spent at least one to two days within each basin.

The WRD leadership survey focused on the complete set of functional capabilities required in the WRD in Bihar. The questions probed the present institutional strength of WRD. The survey sought answers based on a leader's experience, technical skills and exposure to best practices beyond WRD in Bihar. We administered the leadership survey to Joint Secretaries, Engineer-in-Chief North, Chief Engineers and Superintending Engineers associated with flood management activities. The WRD senior officers' questionnaire format is available in Annex B.

A total of 31 officers were surveyed in the WRD scoping, field level and leadership surveys in the Ghandak, Bagmati, Mahananda, and Kosi basins and in Patna. In addition to the staff interviewed during the scoping visit, this included 1 Engineer-in-Chief, 1 Under Secretary, 4 Chief Engineers, 3 Superintending Engineers, 5 Executive Engineers, 7 Assistant Engineers, and 5 Junior Engineers. Findings from the WRD leadership and field officer surveys are described in section 6.

5.4 Community Surveys

In conjunction to surveys of WRD staff, the study also focused on interviews, surveys, and focus group discussions with communities, businesses, and Panchayat Raj members in the three target basins. The household qualitative surveys were conducted in selected villages that were directly and indirectly affected by floods within each of the target basins. Surveys of households, local businesses, and local PRI officials were conducted to gauge the response of community members to the WRD, the level of awareness among citizens of flood issues, quality of early warning mechanisms in place, and perspectives on the role and functions of the WRD.

This second set of surveys was conducted to provide the study team with a sense of the types and quality of the interactions at the local level between community members and officers of the WRD. A small survey team from the Asian Development Research Institute (ADRI) was hired to conduct community surveys across the three basins in Bihar. The purpose of the village level surveys was mainly to assess the experience and knowledge held by flood-affected communities. The survey seeks to:

a) Understand the impact on flood affected households, businesses and industries in flood affected districts in Bihar;
b) Identify the level of knowledge held about the flood risk;
c) Identify the level and quality of interactions with the WRD on flooding issues;
d) Identify the extent and timeliness of flood warnings;
e) Identify the level of knowledge held about embankment maintenance and management.

The community level survey questionnaire included both individual household questions and a set of questions for Focus Group Discussions (FGDs). The community, business and local leaders questionnaire, raised questions that pertained to background data and socio-economic characteristics of the householder or business individual being interviewed, questions that pertained to experiences with specific past flood events and perception of flood risk, interactions of the community with the WRD on flood forecasting and flood warnings, perceptions of the community on how flood preparedness and flood mitigation activities are carried out by the WRD and what channels the community has to engage in this process, if any. Questions pertaining to perceptions of the community on how well the WRD performed and quality of flood maintenance works were also raised as well as questions around specific losses that were incurred by individuals during past flood events as well as quality of services provided by government agencies in relief and recovery from

flood events. The community household and business owner survey form is provided in Annex C. The focus group and one-to-one discussions in local communities aimed to obtain a field-level picture of flood hazards and WRD responses to them. The discussions focused specifically on the nature, condition and location of the flood mitigation measures the government had implemented as well as on systematically identifying what people do during floods and what measures they take to meet their key needs, including how they protect their lives, livelihoods and assets. Study team members asked individuals and group what they thought the major issues and challenges with respect to the performance of the WRD in the present as well as for the future in the event where flood impacts become more intense and more frequent.

Within each target basin, the community survey team targeted four villages across the target districts. Villages were selected to provide a mix of communities living within, above, near, and at a distance from embankments to the survey sample**.** The field team visited the study sites and interacted with community groups and individuals through focus group discussions and semi-structured interviews. Initial discussions with the villagers were followed by more in-depth key informant interviews to arrive at a detailed understanding of the interactions of the WRD and the communities that reside within these flood affected areas. Community elders and leaders of community institutions were also interviewed.

Within each basin, four villages were targeted for a total of twelve villages. Within each village, the community survey targeted approximately twelve householders and four local businesses. The types of households selected included the following mix: some suggested by the local WRD Junior Engineer (JE) and some randomly selected by the survey firm. Within each village, the study aimed to target actors such as the Mukhiya (head of local PRI), and at least 2-3 householders that are members of women SHGs, and local leaders were also targeted as part of the selection of the twelve villagers. Secondary data, mostly official district, block, and village-level information related to demography and social and economic statistics, were also collected for each village. Village level profiles of the selected twelve villages are provided in Annexes D, E, and F. However, due to non-availability of business managers in selected villages, only one business manager was eventually interviewed. Similarly, for PRI members, it was not always possible to find three of them in a village on the date of the interview and, consequently, the number of PRI members interviewed varied from 1 to 3 in the final sample within each village. Selection of households was done on the basis of purposive random sample. The total list of households surveyed in each basin and village is given in Table 5 below.

5.5 Community Focus Group Discussions

Focus Group Discussions were held in each of the twelve villages surveyed across all three basins. Each of the FGDs was conducted once all the individual household surveys were completed. The FGDs consisted of a range of eight to fifteen members from the selected village with an average of ten members. The composition of the FGDs included farmers, male householders, PRI members and the Mukhia (head of PRI within each village). 25 percent women householders also participated in the FGDs. The analysis of the FGD results is provided in section 6 and the complete list of FGD questions is in Annex G.

Table 5: Total Number of Households Surveyed in Community Survey

Village	River Basin			Total
	Bagmati	Mahananda	Kosi	
Kuin	**10**			**10**
Rampur Kanth	**12**			**12**
Benipur	**13**			**13**
Janardh	**12**			**12**
Lalganj		**13**		**13**
Kath Ghar Durgapur		**12**		**12**
Lakhi Tola		**12**		**12**
Bhola Marhi		**12**		**12**
Kalyanpur			**12**	**12**
Kodhli			**13**	**13**
Lokha			**12**	**12**
Mansi Piprahi			**12**	**12**
Total	**47**	**49**	**49**	**145**

5.6 Additional Consultations

The team met with a group of senior members of the FMISC team, including the Director to obtain insights into the operational functions and future areas of growth for the FMISC in Bihar. The team was given insights into the role, responsibilities and challenges that FMISC currently faces. Details of the discussions and analysis of the findings are highlighted in section 6. The FMISC questionnaire template is provided in Annex H.

Throughout the process of the design and execution of the surveys, the team also held multiple consultations with officials in Patna from the key agencies including DMD, SDMA and WALMI. Specifically, multiple one-on-one and group discussions were also held with the WRD to ensure that officials of the WRD were clear on the objectives of the study, the main focus of the project, and how results of the surveys would be utilized and eventually benefit the organization.

The team held a workshop at the start of the project with key members of the WRD flood management wing, including officials from the leadership such as the SE Flood Monitoring Cell, EEs, and AEs from the Flood Control Planning and Monitoring Divisions of the WRD to develop ownership of the project, obtain their buy-in, and ensure their integral participation in all aspects of the project. See Annex I for a list of participants that attended the workshop. In addition, the team continued to liaise with the top decision makers of the WRD, often meeting them one-on-one every two to three weeks. The team discovered that the WRD senior decision-makers were positive and supportive throughout the several months of the study. The Principal Secretary stated that this was the first time that a study of this kind had been undertaken for the WRD in a meeting with the project team in February 2012. He also underscored the need for reforms in the institutional management structure of the WRD in order to achieve optimal flood management standards for the Department.

6 Results & Analysis

6.1 Community Survey Results

The community survey gave three levels of insights. One, at an aggregate level, it educated the team about the level of information, interaction, and engagement that community in flood affected villages have around the subject of flood management. Two, it also highlighted the commonality and variations that exist depending on the basin. Finally, we gained similar insights dependant on whether a village is inside or outside the embankment. Individual surveys went into detail exploring the various aspects of flood management and its impact at the household level where as focus group discussions enabled us to draw commonality in these individual experiences. Focus group discussions also highlighted the group thinking on flood management and Water Resources Department.

6.1.1 Individual Surveys (Households, PRIs and Businesses)

The following tables summarise the findings of the community survey:

Table 6. Attitude towards flood and flood management (n=145)

Response	River Basins			Location		Total
	Bagmati	Mahananda	Kosi	Within Embankment	Outside Embankment	
Do you think floods can be prevented No.,(% yes)	19 (40.4)	16 (32.7)	16 (32.7)	26 (35.1)	25 (35.2)	51 (35.2)
Flood protection can be better ` No.,(yes)	25 (53.2)	18 (36.7)	20 (40.8)	30 (40.5)	33 (46.5)	63 (43.4)

In Table 6 (above), we note that one in three community members believe that floods can be prevented while the rest consider floods to be part of their life in flood prone areas. However, a much higher percentage believe that flood protection can be done better. In Table 7 (below), we note that flood information is seriously lacking. Only one in 14 households know the agency responsible for information on floods. Table 8 (below) shows the missing link between WRD and the communities it aspires to protect against floods. More than half of the households do not know that WRD is responsible for flood protection. Only one in 6 households in the flood prone village know any staff from WRD. Table 9(below) shows that almost everyone faces the financial burden of flooding. However, only 1 in 6 gets any financial assistance to offset the losses.

Table 7. Information on Flooding(n=145)

Response	River Basins			Location		Total
	Bagmati	Mahananda	Kosi	Within Embankment	Outside Embankment	
Is there any agency that provides information on flood No.,(% yes)	1 (2.1)	4 (8.2)	5 (10.2)	5 (6.8)	5 (7.0)	10 (6.9)

Table 8. Knowledge of Water Resources Department (n=145)

Response	River Basins			Location		Total
	Bagmati	Mahananda	Kosi	Within Embankment	Outside Embankment	
Which department is responsible for Flood protection No.,(% correct)	25 (53.2)	22 (44.9)	16 (32.7)	31 (41.9)	32 (45.1)	63 (43.4)
Do you know any WRD staff No.,(% yes)	3 (6.4)	9 (19.4)	10 (20.4)	10 (13.5)	12 (16.9)	22 (15.2)

Table 9. Impact of Flooding on Income (n=145)

Response	River Basins			Location		Total
	Bagmati	Mahananda	Kosi	Within Embankment	Outside Embankment	
Income effected by floods No.,(% yes)	43 (91.5)	49 (100.0)	48 (98.0)	70 (94.6)	70 (98.6)	140 (96.6)
Did you get assistance during flood No.,(% yes)	3 (6.4)	11 (22.4)	9 (18.4)	10 (13.5)	13 (18.3)	23 (15.9)

Table 10. Community Participation in Flood Management (n=145)

Response	River Basins			Location		Total
	Bagmati	Mahananda	Kosi	Within Embankment	Outside Embankment	
Does community collaborate during flood No.,(% yes)	25 (53.2)	19 (38.8)	14 (28.6)	33 (44.6)	25 (35.2)	58 (40.0)
Does community help in rebuilding No.,(% yes)	8 (17.0)	5 (10.2)	9 (18.4)	11 (14.9)	11 (15.5)	22 (15.2)
Type of work						
Rreconstruction of houses No. (%)	3 (6.4)	5 (10.2)	4 (8.2)	6 (8.1)	6 (8.5)	12 (8.3)
Mobilizing money / materials No.,(%)	2 (4.3)	—	5 (10.2)	5 (6.8)	2 (2.8)	7 (4.8)
Help in each other No.,(%)	3 (6.4)	—	—	—	3 (4.2)	3 (2.1)

Table 10(above) highlights the engagement of community in flood management. More than half the people surveyed say that the community doesn't work together during flood and a much higher percentage say that there is no collaborative behaviour at the time of rebuilding. This suggests that people who serve the community at the time of calamity do it on their initiative rather than on a broader cultural or social pattern. In this context, Table 11 (below) shows that community engagement and ownership on flood management is a mixed bag. The lack of collaboration seen above does not prevent the community from sharing ideas on flood management which are based on their decades of life experience in flood zone and simple logic arising from day to day activities.

Table 11. Suggestions for Flood Management (n=145)

Response No.,(% yes)	River Basins			Location		Total
	Bagmati	Mahananda	Kosi	Within Embankment	Outside Embankment	
Prevention of erosion with boulder and cement bags	6 (12.8)	6 (12.2)	11 (22.4)	16 (21.6)	7 (9.9)	23 (15.9)
Bamboo tree should be planted on embankment	—	—	1 (2.0)	—	1 (1.4)	1 (0.7)
Construction of security embankment around the village	3 (6.4)	2 (4.1)	2 (4.1)	3 (4.1)	4 (5.6)	7 (4.8)
Arrangement for Drainage of water	1 (2.1)	1 (2.1)	8 (16.3)	3 (4.1)	7 (9.9)	10 (6.9)
Strengthening the embankment and construction of sluis gate	1 (2.1)	1 (2.0)	2 (4.1)	2 (2.7)	2 (2.8)	4 (2.8)
More Channels	—	4 (8.2)	1 (2.0)	1 (1.4)	4 (5.6)	5 (3.4)
Construction of dams for generation of hydroelectricity	—	1 (2.0)	—	—	1 (1.4)	1 (0.7)
Increases in height of embankment	—	1 (2.0)	—	1 (1.4)	—	1 (0.7)
Interlinking of river	2 (4.3)	2 (4.1)	—	2 (2.7)	2 (2.8)	4 (2.8)
Diverting the flow of Kosi on old route	—	—	4 (8.2)	—	4 (5.6)	4 (2.8)
Widening of East and West canal	—	—	1 (2.0)	—	1 (1.4)	1 (0.7)
Excavation of river	—	2 (4.1)	—	2 (2.7)	—	2 (1.4)
Dialogue with Nepal	—	2 (4.1)	—	2 (2.7)	—	2 (1.4)
Arrangement of Boats by block level	1 (2.1)	—	—	—	1 (1.4)	1 (0.7)
Arrangement of drinking water, food and medical help etc.	3 (6.4)	7 (14.3)	11 (22.4)	17 (23.0)	4 (5.6)	21 (14.5)
Distribution of land on other side of river	—	1 (2.0)	1 (2.0)	1 (1.4)	1 (1.4)	2 (1.4)

6.1.2 Focus Group Discussions

In the present study, for getting wider feedback on the flood related issues, focus group discussions were conducted in sample villages of all the three river basins. Everywhere about 20-30 people had attended such discussions. Apart from the villagers, PRI ward members were also present in the discussion, including the Sarpanch or the Mukhiya in some villages. In one of the villages in Mahananda basin, a JE of the WRD was also present. Major issues covered in the focus group discussions were:

1 Experience of flood (Reasons of flood, Frequency of flood, If warning of flood was given, and community groups who suffer most)
2 Community Experience (Maintenance of Embankment, Change in behaviour of the river in recent time)
3 Rating the work of WRD (Whether the work was planned or being carried out after public pressure, and opinion about quality of protection work, Regularity of WRD officials visit before during and after the floods and coordination with the community.
4 Community participation in flood management (Preparedness, self-initiative, and any sign of impending floods)

Key findings of the focus group discussions

1 Experience of Flood

1.1 Although the FGDs were conducted in three river basin areas of Bagmati, Mahananda and Kosi which are in different regions of Bihar, it emerged from the discussions that the basic problem remained the same in all the basins.

1.2 In our sample, two villages were selected within the embankment of the river and two others away from the embankment. The major reason for flood in the villages inside of the embankment is sudden release of water from the upstream of the catchment area in Nepal after rains and accumulation of silt in the bed of the river. Another reason told mainly by the villagers of Mahananda and Kosi basins is the changes in the courses of the rivers in the recent times. In the villages located outside the embankment, there is a phenomenon of water logging, which is the result of seepage of water from embankment and absence of a drainage system. In Mahananda and Bagmati basins, the villagers complained that embankments, damaged no less than two-three years back, have not been repaired as a result of which flood water enters in their village every year.

1.3 The intensity of the flood problem is increasing every year. Earlier, the flood water used to stay for only a few days, but now the villages remain water logged for as long as two-three months. Although the problem is faced by the entire village, the major sufferers belong to poor people of SC and ST, as they generally have their dwellings in lower lands.

1.4 People shift to higher places and sometimes on embankments at the time of flood. For meeting the emergency, they often arrange food and fodder for cattle, but any arrangement of fire wood is very difficult for cooking during the rains.

1.5 No warning is issued in the present days by the officials. Villagers informed us that earlier they used to receive signals before release of water from Kosi, but now this practice has been nearly abandoned.

2 Community experience about embankment

2.1 In Mahananda and Kosi basin, it is the opinion of the villagers that, after construction of the embankment, flooding has increased

2.2 Kosi river has also changed its route in recent time. In one of the village in Kosi basin, after floods in 2008, the old river is filled with sand, and a new stream from the Kosi river is flowing near the village.

3 Evaluation of the work flood protection

3.1 The general opinion of the villagers is that the Water Resource Department officials visit the damage site and embankments only during the floods.

3.2 Survey respondents claimed that they only put bags filled with sand to close the damaged embankment and erosion site. In the opinion of the villagers this is not helpful for preventing the erosion. They felt; if boulder crates are used, it will remain there for a longer period, and they also cited some successful examples of nearby villages.

3.3 The villagers are generally not satisfied with the maintenance of the embankment.

4 Coordination with villagers

4.1 Discussions highlighted that WRD officials visit only the embankment and meet some selected villagers. They never move across the villages to meet different sections of the population.

4.2 In some villages, there are middle men to undertake flood protection work. People complained that they are generally dishonest and they have denied payments to labourers who had worked last year for flood protection.

4.3 Complaint and suggestions of villagers are not taken into account by the WRD functionaries.

5 Community participation in flood management

5.1 It also emerged from the discussion that planned community efforts for flood management is not done. The people unite only at the time of distress. The villagers sometimes help the WRD in plugging the holes in the embankment

5.2 About 80 percent of adults in the villages know swimming and they also keep hired boats for evacuation purpose. They also prepare temporary boats by tagging logs of banana trees using bamboos.

The villagers usually try to forecast the flood by seeing the current in the river. Sometimes they also inform the government officials at block level.

6.2 WRD Leadership Survey Results

The leadership level survey of the department was conducted through a series of formal and informal mechanisms. This included a formal survey questionnaire circulated online to CEs and SEs in Patna and a hard copy version of the survey distributed to flood zone CEs and SEs (see Annex B for survey format). Out of a total of 20 survey forms distributed to WRD officers, 9 survey forms were collected. In addition, a series of individual and small group discussions were conducted with senior officers in WRD offices in the districts of Patna, Samastipur, Sitamarhi, Purnea and Supaul. The following analysis and findings are based on the results and responses collected from senior WRD officers who completed the leadership survey with substantiations arising from the individual and group discussions.

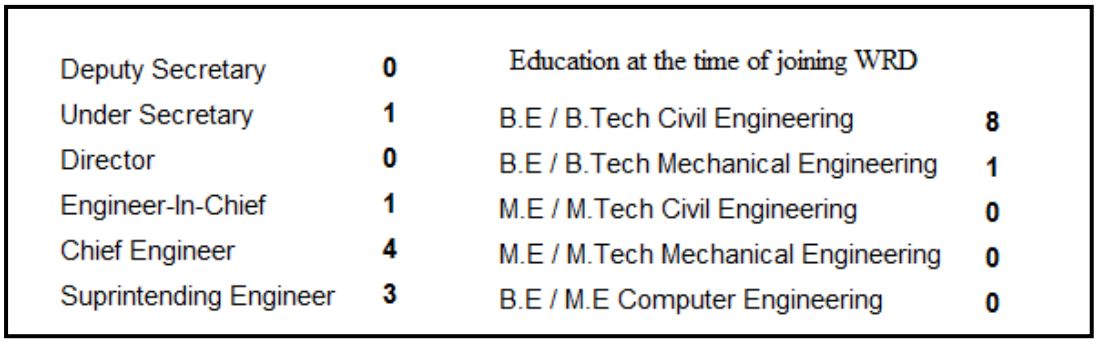
As explained in section 3 on approach and methodology, we began our analysis by utilizing seven aspects of an institution to present and analyze the leadership survey. Not only is this gap analysis framework simple and comprehensive but also it seamlessly integrates into the theoretical framework of the 7-S model that we have utilized to integrate the overall findings of the entire study. Table 6 below provides an overview of the types of classification of the institutional challenges we focused on for the leadership survey, the definitions of each and the potential impact of these challenges.

Table12. Classification of Institutional Gaps

Institutional Gaps	Definition	Potential Effects of Gap (on WRD)
People Gap	Disconnects in the mission and function of organization that arise when key positions remain unoccupied or employed by staff with mismatching capabilities	Inconsistent and non-uniform workload on staff; little to no innovation, old practices repeat; best performing staff remain in fire-fighting mode; ad hoc approach towards entry level hiring takes over systematic approach
Process Gap	Inefficiencies in the functioning and decision-making of the organization that arise from the way staff engage with the hierarchy largely in a top-down manner at peer level and with stakeholders	Centralization of powers; uncertainty of time and priority; new ideas do not propagate; staff disengage from primary activity; accountability is lost; poor transparency of the decision-making processes and functions; lack of established processes results in elite capture of processes
Technology Gap	Existing processes, practices, methods, and tools do not integrate technological systems and tools	Delays in performance which can be critical to reducing vulnerabilities for organizations engaged in disaster management, overburdened field officers; solutions employed do not raise scalability, visibility and efficiency
Resources and Funding Gap	Funding shortages reduce performance of institution	Lowered quality of output due to inadequate funds. Lowered motivation of engineers due to inadequate facilities; poor quality solutions result in poor maintenance and increase in vulnerability to communities
Support System Gap	Inadequate setup to help the department in supplementary (non-core) functions, long-term strategic projects and capacity building	Quality of technical solutions suffers due to inadequate research, little to no training to build capacity of existing staff, culture of seeking conducting research & development does not exist
Ecosystem Gap	Lack of vision and lack of ownership of overall goals of organization by staff and stakeholders	Community is either neutral or negative to perceived performance of Department; Department's role reduced from protecting the community from floods to protecting the structures from floods and miscreants in the community
Coordination Gap	Methods to engage with partner organizations are either weak or missing	Lack of effective long-term solutions; institutional development will be incomplete without partnerships and collaboration

The following members of the WRD's leadership provided responses to the survey: one Engineer-in-Chief, four Chief Engineers, an Under-Secretary and three Superintending Engineers. This is represented in Figure 7 below, which provides details of the educational qualifications of the nine survey respondents at the time of joining the WRD.

Figure 7. Number & Educational Qualifications of WRD Leadership Survey Responses



6.2.1 People Gap

The following sub-section analyzes the responses from senior WRD officers with respect to challenges that emerged under the people gap category.

Table 13. Survey Responses Reflecting People Gap

Indicators	Survey Findings
Field offices are understaffed	• Leaders concur that there is a shortage of field staff • 100% of survey respondents claimed that department has poor dynamic and flexible staff management and little to no planning for staff shortages post-retirement
Uniform level of technical skills **Lack of specialization**	• One in 9 respondents understand remote sensing and GIS • Evidence of high competency in river basin planning (9 of 9) and preparation DPR for water resources projects (8 of 9) • Only 1 in 9 leaders joined the department with a postgraduate degree while the rest were graduates. No one earned any formal academic specialization during tenure of more than 3 decades at WRD (see Figure 7); 8 out of 9 respondents joined as Civil Engineers. • None of respondents have received specialized formal training (barring seminars and introductory trainings) on flood management and associated aspects such as environment, ecology, remote sensing, flood forecasting, etc.
No clear correlation between skills and position	• 8 out of 9 respondents think the promotion policy needs to be revised and reformulated • 3 senior leader respondents have less than 5 years of flood management experience while 3 others have more than 10 years

6.2.2 Process Gap

The following sub-section analyzes the responses from senior WRD officers with respect to challenges that emerged under the process gap category.

Table 14. Survey Responses Reflecting Process Gap

Indicators	Survey Findings
Mismatch in priorities between various levels in hierarchy	• All survey respondents claimed that primary proposals originate at the JE/AE level. However, role of JE/AE is insignificant in the technical review and decision-making process (see section 6.3) • All leaders rate employee satisfaction at JE/AE level as their last priority
Top-down decision-making	• 7 of 9 respondents feel JE/AE shouldn't have decision-making powers in critical maintenance, anti-erosion works • 5 of these think JE/AE should get more decision-making powers
Lack of clarity in decision-making	• Each decision involves JE/AE (making the proposal), EE, SE, CE and experts in Patna conducting the review • Yet in discussions, field staff and leaders have contrasting opinions about the decision-making process (see section 6.3)
Delays in approvals due to time spent chasing proposals through multiple nodes	• All leaders agree that even the small proposals take up to two months to be approved and sanctioned
People gap increases in the organization	• 8 out of 9 leaders think promotion policy needs to be revised • All leaders desire more and more detailed trainings in IT, remote sensing and new developments in flood management
Weak systems of institutional development	• All respondents agree that the department has ordinary or non-existent mechanisms to record best practices • Talking to peers and subordinates is the most common way of acquiring knowledge while accessing internet and other knowledge pools is less common • Clear disagreement amongst leaders on the efficiency of departmental processes for rectifying and correcting errors

6.2.3 Technology Gap

The following sub-section analyzes the responses from senior WRD officers with respect to challenges that emerged under the technology gap category.

Table 15. Survey Responses Reflecting Technology Gap

Indicators	Survey Findings
Top leaders unexposed to new technology; lack of knowledge of innovative practices	• 1 in 9 leader has high expertise in using internet for learning while 4 others have basic or no exposure • Only 1 in 3 basins visited seemed adequately equipped with internet connectivity on the initiative of the SE • Surveys sent online to 5 leaders but no responses obtained
New ideas do not flourish	• Respondents agreed that discussing with colleagues and subordinates is the most practiced way of acquiring knowledge • In the absence of knowledge development infrastructure, very staff can get exposed to new ideas
Manual work increases for field staff	• 8 of 9 leaders considered alertness to be the outstanding attribute of WRD • Central aspect of alertness is visual inspection in field visits. No respondent mentioned the need to leverage technology to enhance visual inspection or maintenance practices
Knowledge infrastructure not maintained	• All respondents have taken short basic courses at WALMI and expressed interest in advanced courses • Three year WALMI calendar shows no provision of advanced courses (see section 4.3) • 8 out of 9 respondents mark that department is not very proactive in engaging with the educational and research institutes • Understanding of flood management information systems is low: 6 out of 9 rate their knowledge on it as basic or none

6.2.4 Resources and Funding Gap

The following sub-section analyzes the responses from senior WRD officers with respect to challenges that emerged under the resource and funding gap category.

Table 16. Survey Responses Reflecting Resources and Funding Gap

Indicators	Survey Findings
Funding shortages reduce performance and quality of institution	• Discussions with senior leaders reveal a project-to-project mindset on funds • Funds are limited for upgrading office setup, facilities to field officers and field equipment • Funds for internal reforms also appeared to be an insignificant issue

6.2.5 Support System Gap

The following sub-section analyzes the responses from senior WRD officers with respect to challenges that emerged under the support system gap category.

Table 17. Survey Responses Reflecting Support System Gap

Indicators	Survey Findings
Training system is inadequate	• All leaders desire basic to advanced training in multiple subjects ranging from IT to Flood Management Systems • No respondents mentioned any advanced trainings taken at local institutes • National Institute of Hydrology (NIH) is only support system for advanced training. Only 1 out 9 respondents took a specialized training at NIH
Insufficient technical research on projects	• 8 out of 9 leaders agree that the department is not very proactive in engaging educational institutions • At a seminar by researchers from IIT Roorkee in March 2012, hunger for research inputs among staff present and inadequacy of such inputs was clearly visible
No independent champions or thought leaders on key subjects	• No respondent identified himself as a champion or high-level expert on any aspects related to flood management • On specific subjects related to flood management, leaders demanded advanced training

6.2.6 Ecosystem Gap

The following sub-section analyzes the responses from senior WRD officers with respect to challenges that emerged under the ecosystem gap category.

Table 18. Survey Responses Reflecting Ecosystem Gap

Indicators	Survey Findings
Lack of community centered approach; community stakeholders not integrated into WRD processes; WRD stakeholders are embankments NOT communities at risk	• All respondents marked that no proposals for flood protection works come from community • 2 of 9 leaders say community involvement is not needed while 8 of 9 say department does not involve community • 9 of 9 leaders say enabling community to take a lead role in flood management is secondary • 7 out of 9 consider community engagement as the last priority

6.2.7 Coordination Gap

The following sub-section analyzes the responses from senior WRD officers with respect to challenges that emerged under the coordination gap category.

Table 19. Survey Responses Reflecting Coordination Gap

Indicators	Survey Findings
Little to no coordination with partner agencies (e.g. WRD and DMD); Narrow focus on building and protecting flood management infrastructure	• While no direct questions focused on coordination issues, several leaders noted in the discussion that flood management is an integrated exercise and the coordination is lacking (e.g. constructing/renovating connecting roads, examining agricultural patterns, managing law and order, interaction during flood events, etc.)

6.3 WRD Field Officer Survey Results

A total of seventeen field level officers working on flood management were surveyed in the Bagmati, Mahananda, and Kosi WRD Division and Sub-Division offices of the WRD. In addition, five officers from the Gandak basin Division and Sub-Division officers were consulted in an initial scoping visit. The following section details the findings based on a compilation of the survey responses and discussions by categorizing the challenges and gaps into the categories as prescribed by the 7-S framework. Just as the findings of the WRD leadership survey were categorized according to seven initial gaps, the analysis of the field officer responses is categorized according to the 7-S challenges. However, as our analysis indicates there are many similarities and synergies between both classifications. The section below divides all of the salient points that emerged from the survey responses as identified by the survey respondents into five of the seven 7-S categories as there are no gaps identified according to *structure* and *shared values*.

6.3.1 Skills

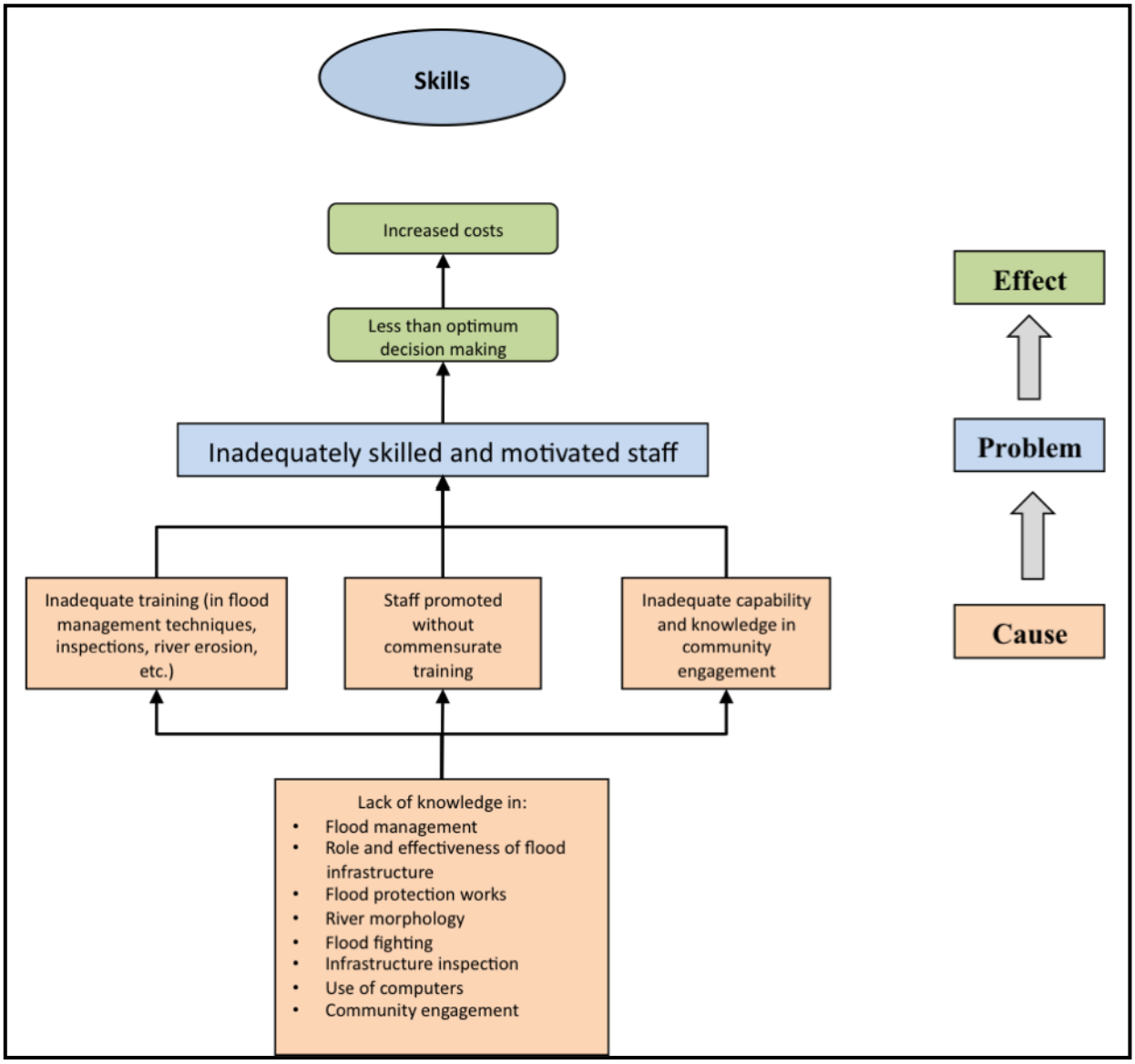
Common themes around issues of training and staff skills emerged as the team travelled from the Ghandak basin for the scoping visit to the Bagmati, Mahananda, and Kosi basins for the three survey visits. Starting with the scoping visit, the officers of the Gandak basin cited the poor provision of up-to-date information and training to staff at the Division and Sub-Division levels on specific technical details of flood management including topics such as river morphology, river behaviour (e.g. how rivers specific to their basin will change course and what its impacts will be), river avulsion, river erosion, safety measures for embankments, specific technical interventions for embankment protection (e.g. Geobags) and their effectiveness. Overall, all surveyed officers from all basins gave us the sense that there is a desire to have *more* and *higher quality* trainings at the field level on a wide range of topics such as the latest global best practices and techniques in flood management, flood forecasting, disaster management, types of modern technologies available, best practices inspections of embankments, and techniques for flood protection and anti-erosion, etc.

A second major issue that emerged concerned the *location* of WRD flood management trainings. Currently, most training is administered at the WALMI offices in Patna; however, AEs and JEs cited that because they often cannot leave their duty stations, a majority of the instances when trainings are conducted they are unable to attend, as they cannot travel to Patna. *Therefore, a clear need was cited to conduct specific flood management related trainings in the classroom as well as on the field within the basin level offices.*

Another area of concern that emerged is the relatively equal technical expertise of senior level staff (e.g. EE, SE, and CE) at the Division level with that of junior level staff (e.g. AE and JE), this concern was also reflected from respondents in the WRD leadership survey (see section 6.2). This challenge emerged with specific officers citing the need for more highly skilled senior level officers that can guide junior officers in the absence of regular on-field trainings. In addition, according to the survey responses, there seems to be no mechanism within the WRD to ensure that training is conducted for staff that is transferred from the irrigation units of the WRD to the flood units or vice versa – therefore this results in an overall poor level of technical expertise of staff when they are transferred between units. Lastly, officers cited issues that WRD Divisions or even Sub-Divisions do not share local experiences and solutions that are utilized for flood management in one basin of the state with other basin offices – no best practices are shared even across basin levels but may filter from one basin to another on an ad hoc basis as a result of transfer of officers or general discussions.

Figure 8 below provides a 'problem tree' analysis of the skills gap and the constraints that were raised by officers around issues of training and staff capacity. This tree provides a graphical illustration of the issues raised as well as goes on to provide some of the potential effects of this gap on the WRD and its overall ability to manage the issue of floods in Bihar in an effective manner. The challenge of inadequately trained staff and poor technical knowhow of senior staff can result in poor decision making, therefore increasing costs of coping effectively with floods.

Figure 8. Problem Tree Analysis of Skills



6.3.2 Staff

During the field-level surveys, the study team learned that within each Division, there is a requirement for one EE to be in charge of the Division and each Division is in charge of four to five Sub-Divisions. At the Sub-Division level there is meant to be one AE in charge and he is meant to have approximately four JEs working under him. Depending on the number of Sub-Divisions, an EE is then in charge of at least four to five AEs and approximately 15 to 16 JEs per Division.

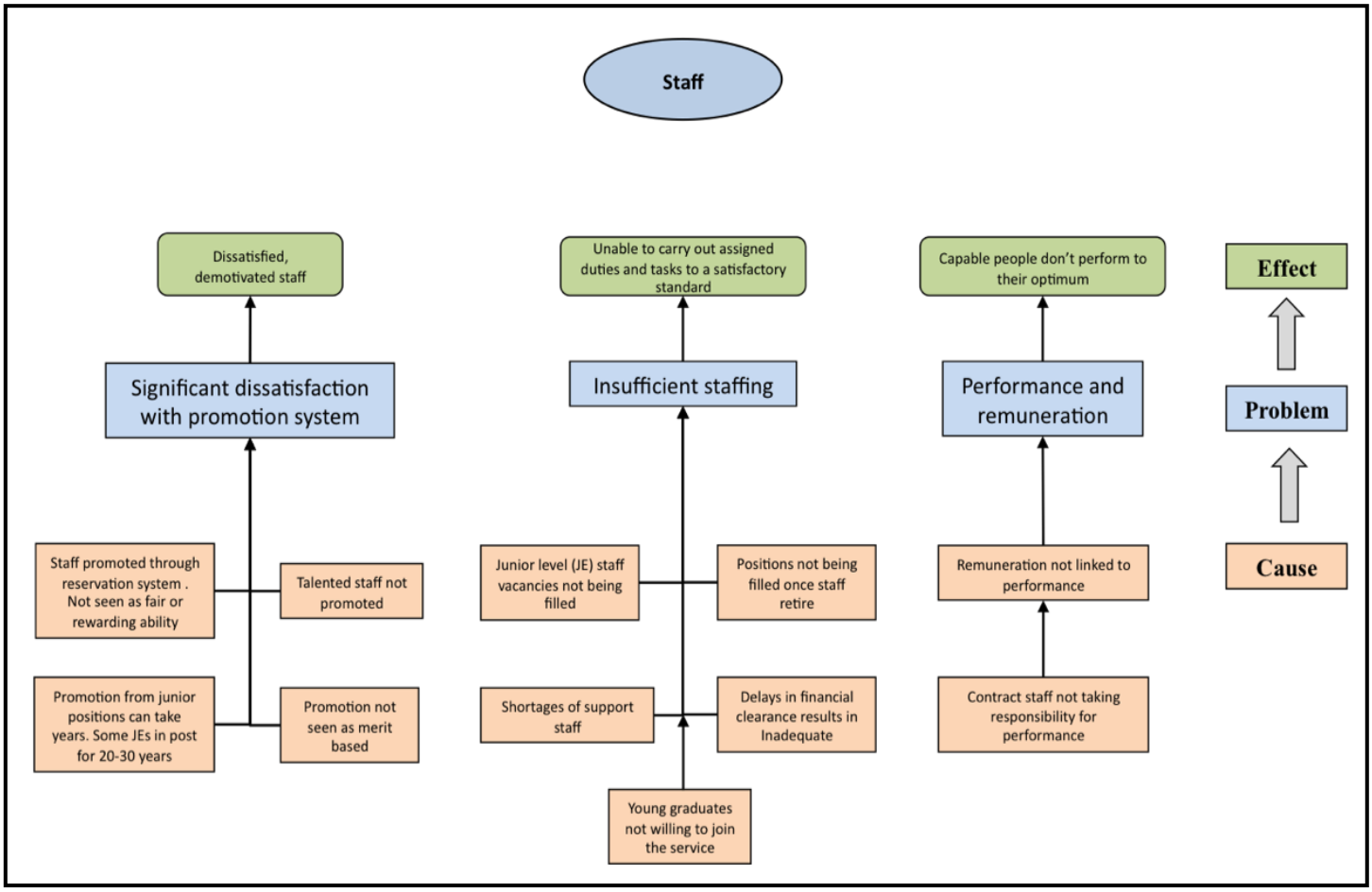
In reality, we discovered that in most of the Divisions and Sub-Divisions we visited, there were rampant staff shortages below the level of the EE. For instance, on our scoping visit to the Gandak basin, we learned that there were only two AEs in the Division and that the vacancies for the remaining two posts had been present for a number of years. Another JE in the Bagmati basin informed us that currently there were 40% vacancies of technical and non-technical staff at the level of the Division within the Bagmati basin. This pattern appeared in all of the basins we visited.

Officers repeatedly stated that there were a number of vacancies within their Division that remain unfilled as well as the posts of retired officers remain vacant indefinitely or for prolonged periods of time. In several cases, officers claimed that support staff posts and JE posts were vacant for up to five years as was reported in the Kosi basin. In the Gandak basin, the study was informed that an AE was promoted to fill a post that had been vacant for a number of years, however, it turned out that the individual that had been deputed to the post was deceased and the WRD had still promoted him to the post of AE without realizing he had passed away. The officers we surveyed reported that this shortage of staff has resulted in severely stretching the officers within the Sub-Divisions who tend to take on the additional responsibilities of the missing staff. One AE in the Mahananda basin informed us that under his jurisdiction he individually has to inspect and maintain 6 km of the embankment, plus he has additional charge to inspect and maintain larger sections of embankments to make up for AEs in other jurisdictions where there are vacancies within the Division. There was a clear perception from the survey responses that there may not be enough officers on the ground to adequately monitor high flood risk areas such as the Gandak and Mahananda basins. In addition, some officers reported that works were not completed in time in some Sub-Divisions due to staff shortages.

A second major area of concern that emerged from the survey responses and scoping visit discussions is the perception among officers that the current WRD officer promotion and transfer system is unsatisfactory just as officers from the WRD leadership survey had reported. Officers repeatedly cited the need for reform in the decision-making and timeliness of staff promotions. In several instances, we met AEs in the Bagmati basin that had been in the post of AE for 19 years, another for 33 years; in the Kosi basin we met JEs who also had been in the post for 33 years without a single promotion to a more senior position. One clear factor that emerged from the survey responses was that the current promotion system is not based on merit or performance nor is it adhering to a time-bound system. Several officers stated that a new merit-based promotion system should be developed within the WRD to reflect the performance of officers. Specifically they suggested promotions based on examinations, community and field-level feedback, and performance assessment. In addition, survey respondents thought that staff members who have been in a specific post for a certain number of years should automatically be considered for promotion. The survey respondents felt that the staff promotion system, which is highly centralized, as all decisions are made in Patna, is conducted without any direct inputs and feedback from field level officers at the Circle or Division levels. Multiple officers also informed us that the current promotion system is not linked to remuneration of staff, and therefore, motivated and high performing officers are rarely monetarily rewarded for their efforts.

Figure 9 below provides a graphical representation of the concerns raised around the challenges of adequate staffing and promotions within the WRD. Our analysis of the effects of these gaps on the WRD indicates that this is leading to dissatisfied and demotivated staff at the Division and Sub-Division levels, staff that do not perform at their optimum level because they are neither rewarded for good performance with promotions nor monetarily incentivized to do so or in some cases they have the responsibility of several officers which results in staff that are unable to carry out the critical tasks of flood management in a satisfactory manner. This can have significant negative consequences for the WRDs ability to inspect, maintain, and respond to high flood risk circumstances.

Figure 9. Problem Tree Analysis of Staff



6.3.3 Style

Issues of 'style' or style of decision-making, coordination, collaboration and style of leadership emerged as persistent challenges identified by officers in numerous surveys. One of the major areas of concern for officers, particularly at the JE level is around issues of decision-making autonomy and the overly centralized nature of decision-making power within the WRD. This gap was also analyzed in the WRD leadership survey respondents (see section 6.3). Overall officers at the JE, AE, and EE levels claimed that there is too much control of decisions, even of decisions that they think can be taken at the Circle or Division level, in the hands of WRD officers in Patna. Specifically, decisions around maintenance and anti-erosion works to be done on the infrastructure stood out as areas where decision-making was too centralized and often too slow. A JE in the Mahananda basin claimed, "I have no decision making power on what works should or should not be undertaken yet all of the accountability if the embankment breaches rests on my shoulders". As a result of this, officers informed us that even though JEs and AEs are at the grassroots level and have first-hand information about conditions at the river, that their recommendations are often disregarded during the final decision-making among officers in Patna. Officers in the Mahananda basin pointed out that there have been instances where their recommendations were ignored and thus resulted in negative consequences for the quality of the embankment. This lack of collaboration among officers in the field with decision makers at the head of the Department can result in poor overall flood preparedness. This point was corroborated by an officer in the Bagmati basin who said "coordination of staff desperately needs to be improved in order to reduce the risk of flooding". An

example of this issue was given by an AE of the Kosi basin, who informed the study team that he was informed by his SE to begin a specific set of maintenance works on his section of the embankment, however, once he began working he was then given contradictory orders by his CE who said to stop all works on that particular section.

Specifically, officers during the survey discussions highlighted existing gaps of coordination both *within* the various divisions of the WRD as well as with external organizations and most importantly with the community members or householders that are meant to benefit from the flood protection measures of the WRD. During the surveys, the study team witnessed very little coordination mechanisms in place between the Water Resources Department and the Disaster Management Department, although this aspect was not studied in detail in phase one. Multiple survey respondents admitted that there was lack of clarity in roles and responsibilities within staff in the Division as well as with other Departments before, during and after a flood event. Therefore, a clear need that emerged from these sets of challenges is that that better coordination and collaboration is required among field staff and senior staff of the WRD, among various GoB Departments who are engaged at the district level to manage floods, and among staff within Circles and Divisions of the WRD as well. The aspect of coordination with Nepal and Government of Nepal agencies in the management of the Kosi basin was not examined in this study.

Overall, this set of challenges clearly points to the lack of integration in flood management among various stakeholders and activities of the WRD. Particularly integration and direct engagement of affected community members seems to be very weak across the three basins we surveyed, as will be revealed in the addendum for section 6.1. Officers in all three basins pointed out that there is a need for greater cooperation of community members to conduct flood fighting works during the heavy monsoon period from June to October as well as there is a need to engage the community in assisting officers with embankment patrolling, inspection, and even carrying out maintenance works. Many officers cited that the community can be a much more useful resource but thus far have not been fully integrated into the WRD processes for flood preparedness and flood fighting. However, there are cases where some officers have been proactive and have taken initiatives for engaging local villagers of their own volition. For instance, a JE in the Mahananda basin informed us that he maintains unofficial mobile communication with local villagers who are regularly available to assist him during the flood period; this system has also served as an ad hoc flood warning system that spreads from word of mouth to other friends and families in the village and surrounding blocks.

Our analysis revealed that communication (within and with external parties) is a crucial element for improving flood management capabilities of the WRD. This is detailed below in Figures 10a and 10b as problem tree graphics. Figure 10a illustrates the problem tree diagram for the style gap and the consequences that can result from ongoing issues of coordination, collaboration, and an overly top-down decision making organization. A natural tendency is for staff to become demotivated, particularly at the junior levels resulting in little or almost no ownership of trying to go beyond standard solutions for tackling complex and often unpredictable challenges of flood risk. Figure 10b illustrates that communication, coordination and cooperation are the key building blocks to developing an integrated flood management structure in the WRD without which, as our graphic illustrates below, can result in inefficient use of existing resources as well as an overall increase in flood risk stemming from poor integration of activities and players across the flood management spectrum.

Figure 10a. Problem Tree Analysis of Style

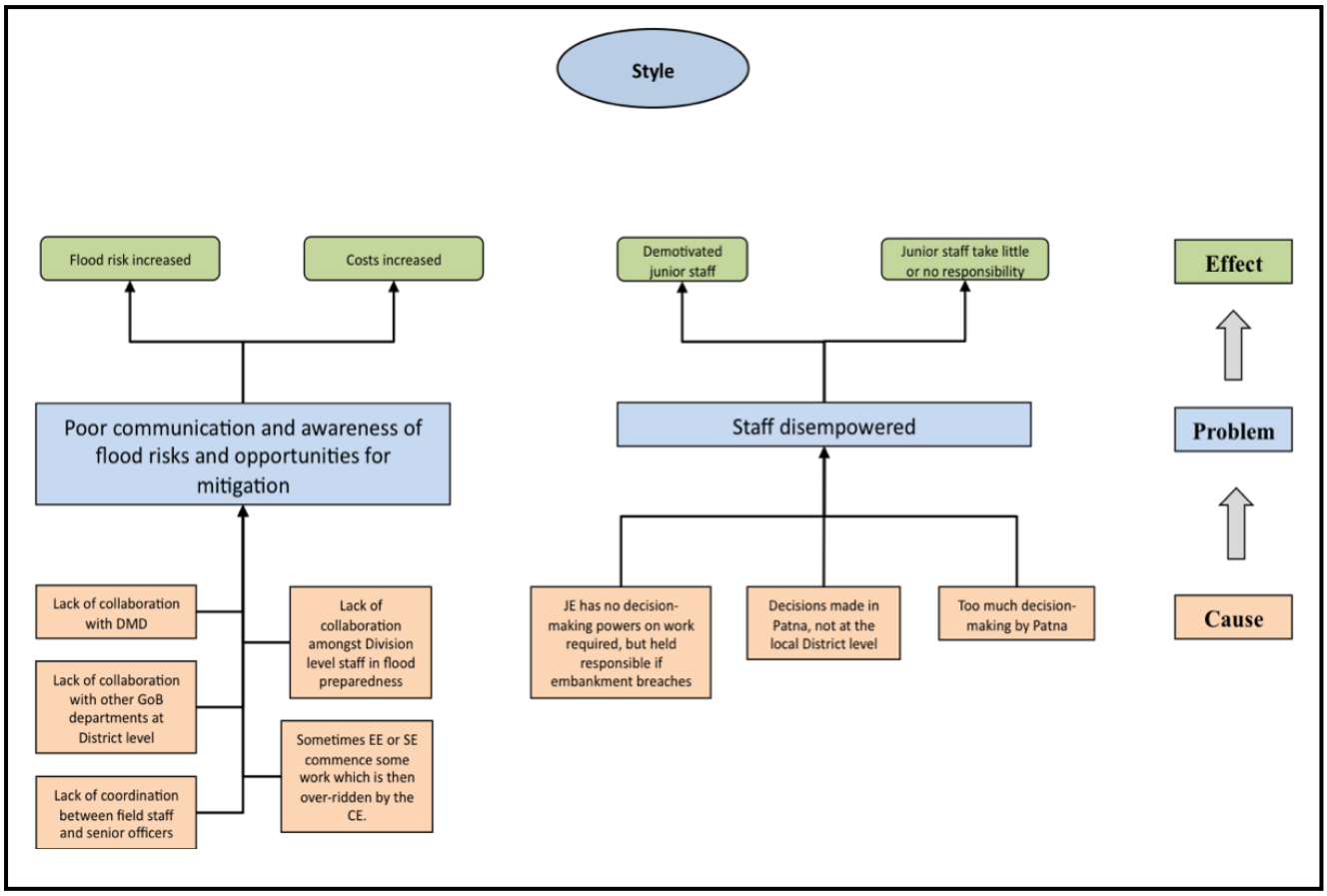
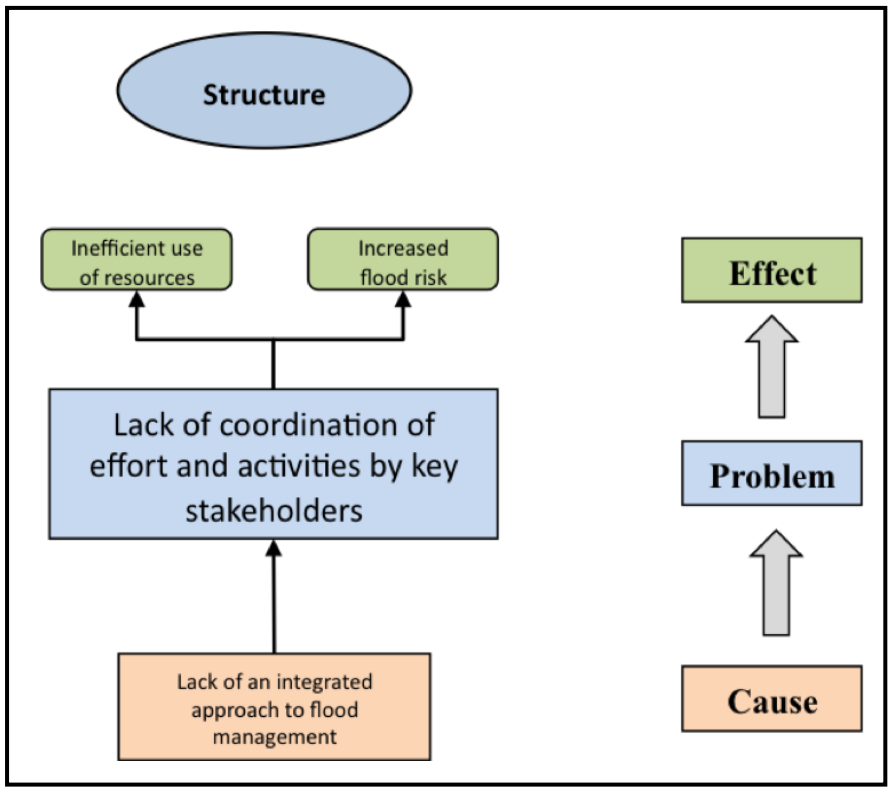


Figure 10b. Problem Tree Analysis of Structure



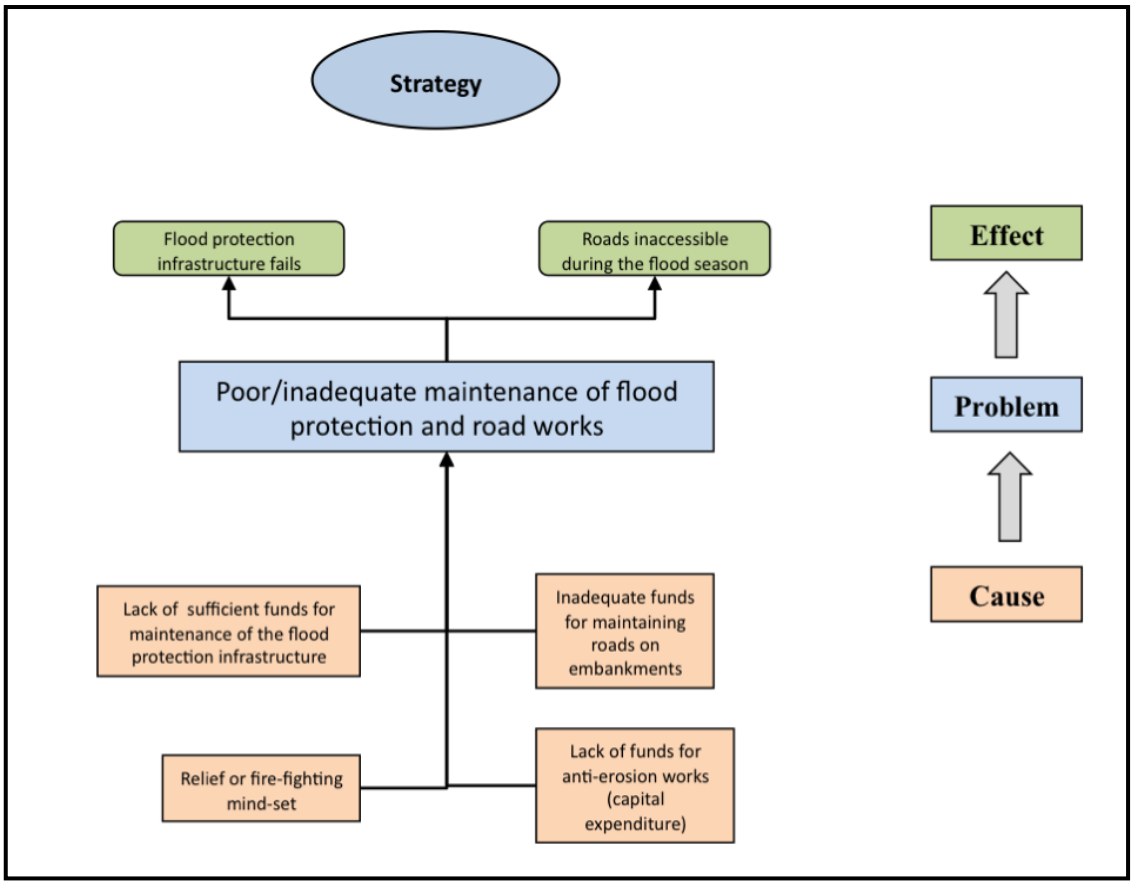
6.3.4 Strategy

A unanimous concern that was raised by all seventeen officers, at all levels within the Divisions and Sub-Divisions and within all basins is the issue of insufficient funding provided to Division level offices to carry out maintenance works on the embankments and roads leading to embankments. All officers from EEs to JEs, repeatedly informed us that the original cost estimates and budgets drawn up by field level officers for executing specific maintenance works were significantly reduced by decision-makers in Patna, often resulting in inadequate funding to Divisions to conduct necessary repair and maintenance works for the flood infrastructure at the basin level resulting in poor maintenance works on the embankments, other flood protection infrastructure, and roads leading to embankments and vulnerable villages.

One of the roads that the study team travelled on to conduct surveys for the Mahananda basin was in such a state of disrepair that it took the team close to four hours just to travel ten kilometres. When we questioned officers as to the quality of the road, which was the only way that several villages in the block could access larger towns and was their only access route to safer and higher ground during flood events, we were informed that field officers had repeatedly put in proposals for repair works on the road, however, these proposals had thus far all been rejected by Patna.

Survey respondents stressed the need for WRD to maintain original budget requests or at least ensure that funding needs to be made available for adequate execution of critical works, this message was provided by all WRD officers surveyed in the Bagmati, Kosi, and Mahananda basins. Even during the scoping visit to the Gandak basin, the team was informed that estimates prepared by the AE at the field level to conduct necessary repair works on breaches were often significantly reduced and only the lowest cost options approved by the final review committee in Patna. Figure 11 below highlights some of the consequences of the gap in strategic decisions around funding of critical works of flood protection infrastructure. The obvious conclusion is that poorly maintained infrastructure or infrastructure repaired with sub-standard materials will inevitably cease to function at an optimal level resulting in ever more embankment failures in critical flood risk areas of the state.

Figure 11. Problem Tree Analysis of Strategy



6.3.5 Systems

The basin field officer surveys identified that systems or processes and procedures are the weakest aspects of flood management at the field level within the WRD. We have divided the systems gaps identified by the survey respondents into multiple themes, each of which is described below.

Lack of adequate resources. 17 out of 17 respondents in the surveys noted that there is inadequate equipment and technical resources in terms of hardware, software, and communication infrastructure in place for officers to be able to conduct flood management activities. Officers repeatedly informed us that they did not have vehicles for conducting site inspections of embankments or if there were vehicles they were either in such a dilapidated state thus rendering them useless or in some cases there is only one vehicle among several officers. Often officers were either using their personal motorcycles to conduct inspections or even their own vehicles. This poses severe constraints for officers to inspect and maintain embankments in an adequate manner as well as poses serious risks for reaching vulnerable locations during peak flood months. In addition to lack of adequate transport equipment, officers cited poor quality offices, little to no communication devices or night vision equipment, and very limited access to equipment such as motorboats. Above all officers in all three basins made a clear request that there is dire need for good quality, all terrain vehicles for officers to patrol and inspect embankments.

Lack of community engagement. As mentioned already under the *style* section 6.3.3, community engagement is a key component of integrated flood management and currently this aspect is highly underutilized in existing flood management practices of the WRD. Clearly this is a missed opportunity, as Figure 12a highlights below, as deeper integration of community and civil

society stakeholders in the process of both flood embankment maintenance and flood fighting can supplement some of the key gaps in the WRD's ability to manage floods.

Poor communication& flood warning systems. Linked to the issue of poor resources and poor community engagement is an underlying weakness of ad hoc communication systems and early warning mechanisms to community and vulnerable groups during times of flood and flood risk. This stems from the initial 'rule' that WRD is not required to communicate flood warnings to local villagers as this task is allocated to the Department of Disaster Management, as one Bagmati EE informed us during the survey discussions. Even though the WRD is primarily the first agency to be 'informed' of impending risks of flooding through various mechanisms such as the Central Water Commission (CWC) and data from rain gauge stations, the WRD is not the first point of contact with communities during floods and weak mechanisms for coordination between the WRD and DMD often result in loss of time in transmitting warnings to communities. Additional aspects of flood warnings that came up as weak points during the surveys include the lack of reliable and timely data to officers at the Division and Sub-Division levels which then translates to very limited lead time, sometimes as little as thirty minutes to one hour, for WRD to provide information to local GoB agencies which then results in further delays in transferring information to communities. This is a fundamental weakness in the flood management system currently in place in Bihar for managing floods, as Figure 12a indicates, these results in increased risk to lives and property of flood affected communities.

Ad hoc promotion systems. This gap as has already been detailed under the *staff* section 6.3.2. However, this gap is also a sign of weaknesses in the way that promotion *systems* have been set up in the state. The results of the survey clearly indicated that rampant delays in promotions for junior level staff, often the staff with the most responsibilities and those that are the first line of defence during flood periods, are the staff that are the most unmotivated and underappreciated in the WRD hierarchy. As Figure 12a illustrates, this results in under performance and has major consequences for the overall robustness of the Department.

Inadequate inspection and maintenance systems. Multiple factors resulting in weaknesses in the inspection, patrolling of embankments as well as systems in place for carrying out maintenance activities emerged from the survey responses. Inspections and patrolling weaknesses are stemming from both lack of physical resources such as equipment, which translates into officers unable to conduct 24/7 patrolling of entire length of embankments and lack of human resources. Simply not enough boots on the ground means that not all weak points along the embankments will be detected. This is coupled with highly top-down systems for decision making around which maintenance works are to be done, with which materials and utilizing which techniques. As there is very little space for junior or mid-level field officers with local knowledge to provide inputs into the decision-making process, other than preparing initial estimates and proposals, anti-erosion and maintenance decisions taken are disconnected from ground realities in the basins we surveyed. Budgets are often reduced and orders given to utilize lower quality materials with little mechanisms available to incorporate feedback from the field before, during, and after these decisions are made. Meanwhile, decision-making teams and individuals rarely seem to travel to conduct site inspections prior to making crucial decisions even though this is clearly stipulated as part of the decision making process (see section 4). Another factor that survey respondents pointed out was the issue of timeliness of execution of anti-erosion works as delays in final approvals also result in increased risk to flood protection infrastructure, sub-optimal performance of embankments and overall increased risk to communities affected by floods.

The diagrams in Figure 12a, b, and c below illustrate the causes and effects of these systemic gaps highlighted here.

Figure 12a. Problem Tree Analysis of Systems I

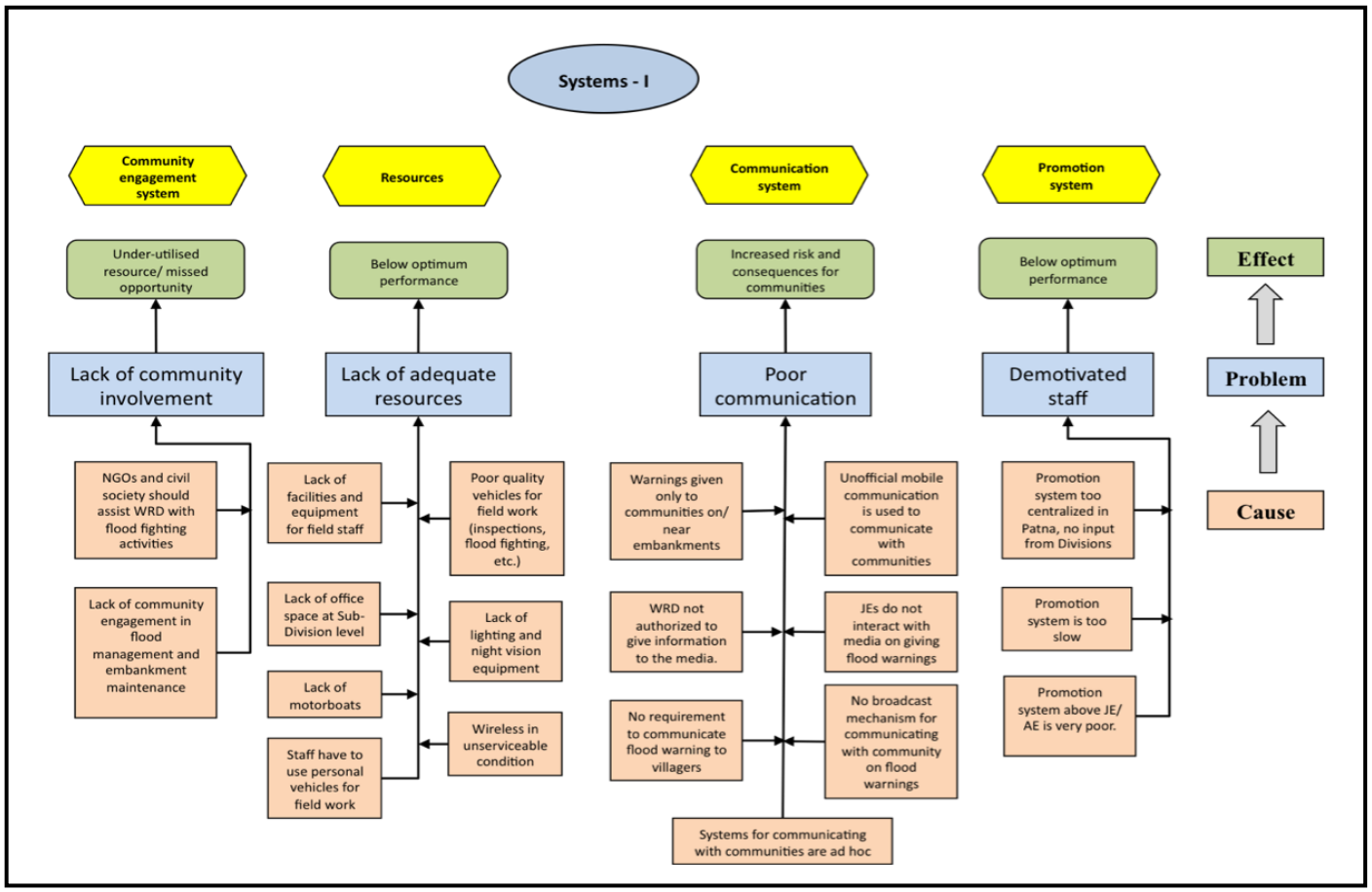


Figure 12b. Problem Tree Analysis of Systems II

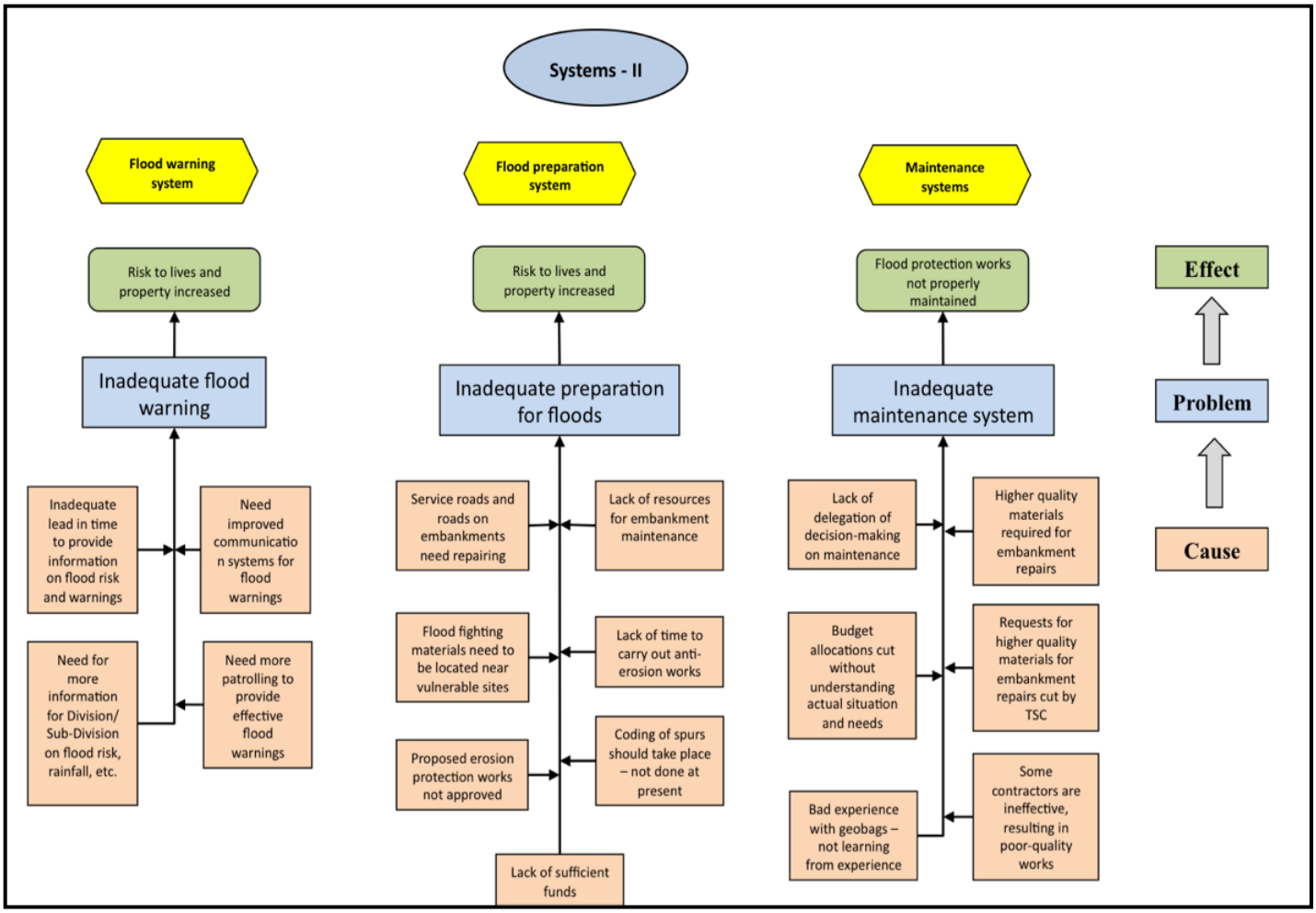
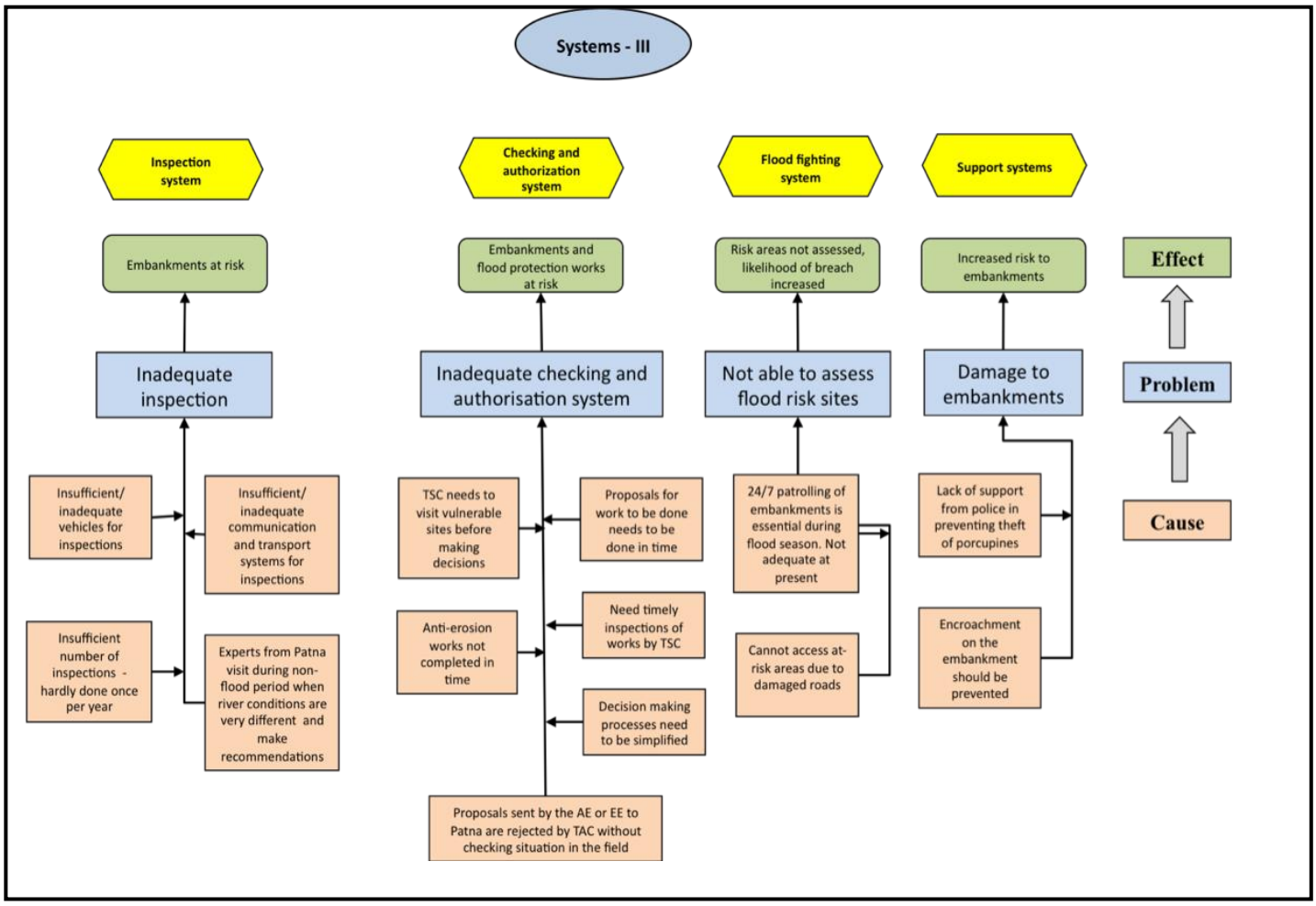


Figure 12c. Problem Tree Analysis of Systems III



6.4 FMISC Focus Discussion Findings

As described in section 4.2 above the Flood Management Information Systems Cell (FMISC) was established as a discrete unit within the WRD in 2007 with funding from DFID and the GoB. Phase I of the planned activities covering 11 Districts in North Bihar and was implemented between August 2006 and June 2008. Phase II covering all 24 Districts in North Bihar commenced in May 2010 and is due to be completed in December 2012.

Under Phase I, the FMISC established a Flood Management Information System, improved flood forecasting, developed a flood information website (http://fmis.bih.nic.in), updated flood control manuals, carried out training and developed plans for upgrading hydrological measurements and telemetry. In this phase the early warning and emergency response needs of the WRD, DMD, the Agriculture Department and District Magistrates were addressed. During this phase little work was carried out on developing improved flood warning systems for local communities. Phase II has been described in detail in section 4.2.

During the flood season, the FMISC works in two shifts from 7am to 9pm.During this period the FMISC liaises with the WRD, DMD, CWC, IMD, and NRSA from whom it receives satellite data. The FMISC monitors flood levels and rainfall levels are monitored on a daily basis and posted in the form of a hydrologic status map on the FMIS website and flood bulletin. These data are also sent daily by

email to Circle level Chief Engineers, who are then to forward this to the Flood Monitoring Cells at the Division levels. No information is yet sent directly to flood affected communities or Panchayats; this is not in FMISCs remit, rather it is the responsibility of the DMD.

At the moment the FMIS can generate satellite imagery of rivers in northern Bihar showing the movement and pathway of a flood. It does not at present, however, have the resources or capability to do real-time modelling. A tender is currently underway to prepare a flood model for a small area within the Bagmati basin. However, the model needs to be scaled up to cover all of the basins in the state as all basins require the data that will be generated from this model. It is intended that this flood model will be able to predict flood water levels and potential areas of inundation up to 72 hours in advance. The FMISC reports annually on its activities through its Annual Report. However, at present there is no database of flood events, other than the reports provided in the Annual Report. It is essential for FMIS to generate such a database so that decision-making in Patna and in the field can be facilitated to cover high-risk areas of embankments and chart future trajectory of river movement.

Some of the outputs from the FMIS are presented in the figures below. Figure 13 shows a flood inundation map showing the extent of the flooding and the block boundaries created by FMISC. This map enables flood risk maps to be prepared for each Block, with further refinements possible within the Block boundary. Figure 14 shows the value of remote sensing for mapping and tracking the movements of rivers and the changing at-risk points on embankments. The figure also shows one of the problems with jacketing the river; in this figure the river is attacking the embankments at 10-11 points, resulting in high maintenance costs to protect these points.

One of the key findings from the field level survey discussions was that not all field offices of the WRD could take advantage of the satellite maps and data provided by the FMISC as they are not connected to the Internet nor do they have computers to access the data and download the maps. A concerted effort has to be made by the WRD to join together the field offices with the excellent work of the FMISC in Patna so that a streamlined and integrated flood data gathering and sharing system can be put in place.

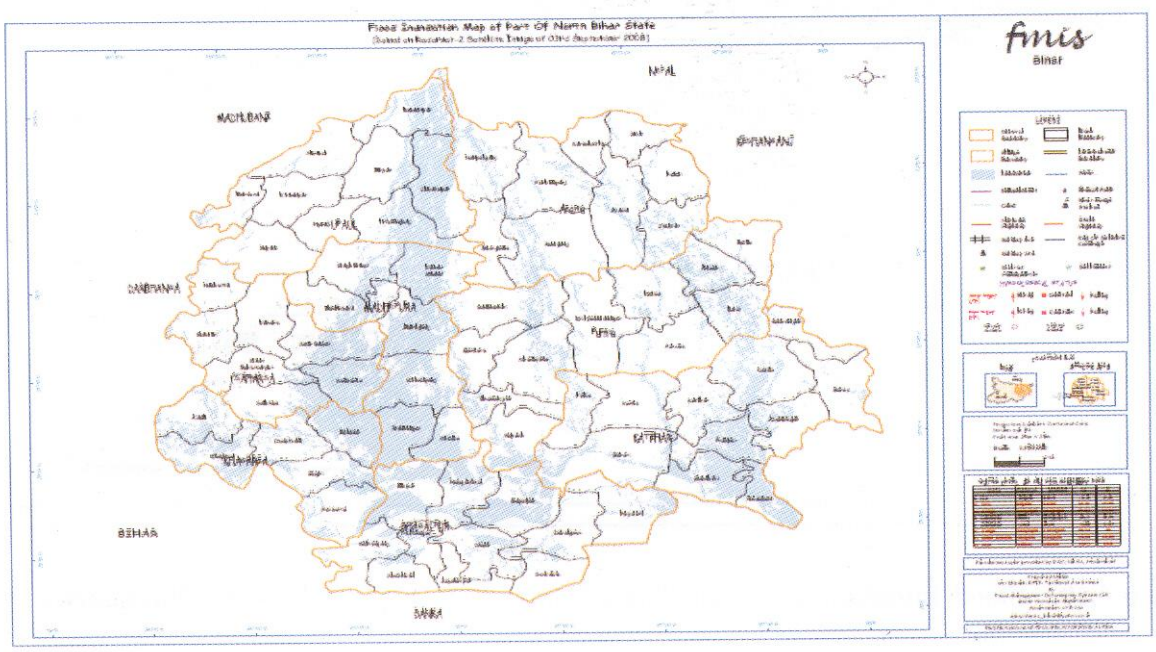


Figure 13: FMIS Flood Inundation Map of North Bihar

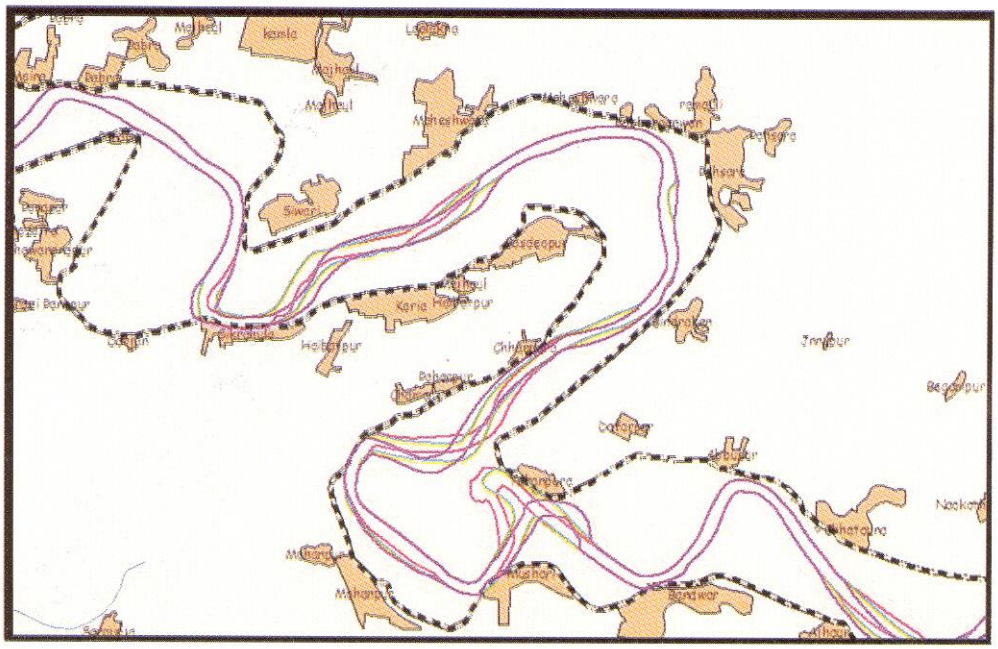


Figure 14: FMIS Mapping of the Changing River Course, Burhi-Gandak River, near Mohanpur (Samastipur).

7 Experience from Other Countries and Projects

This section provides some relevant case studies from flood projects and international experiences with flood management. These serve as some examples of good practices on the institutional management of floods for Bihar, specifically aspects of flood management that are successful in other countries could be adapted to local conditions in Bihar.

7.1 Mapping and assessing flood hazard in Rate Watershed, Nepal

In response to the devastating impacts of floods on Himalayan communities, International Centre for Integrated Mountain Development (ICIMOD) and United Nations Educational Scientific and Cultural Organization (UNESCO) funded a study to investigate the feasibility and mechanisms for flood hazard mapping as a means of helping local communities to develop warning and response systems to floods. The intention was that this would enable these communities to develop flood management plans that would boost their resilience to floods and mitigate damage to property and livelihoods.

The study (Khanal et al, 2007) assesses the flood hazard at national (macro) level, at the watershed (mezzo) and village/municipality (micro) levels. At the national level the impacts from different environmental hazards were assessed. At the watershed level the focus was on hazard, risk and vulnerability mapping. At the watershed level the focus was on enhancing the resilience of local people to cope with and recover from flood events.

In Nepal flood hazards result from five different mechanisms: continuous rainfall and cloudbursts; glacial lake outbursts; landslide dam outbursts; failure of infrastructure and sheet flooding or inundation as a result of excessive rain, and bank overflow or obstruction of flow from development of infrastructure. Nearly 77 percent of the total losses incurred by water-induced disasters occur in the Terai. A rugged landscape, poor socio-economic conditions, mass poverty, a disparity in productive assets and income, inadequate provision of services and lack of political stability, commitment and accountability contribute to communities vulnerability to flood events.

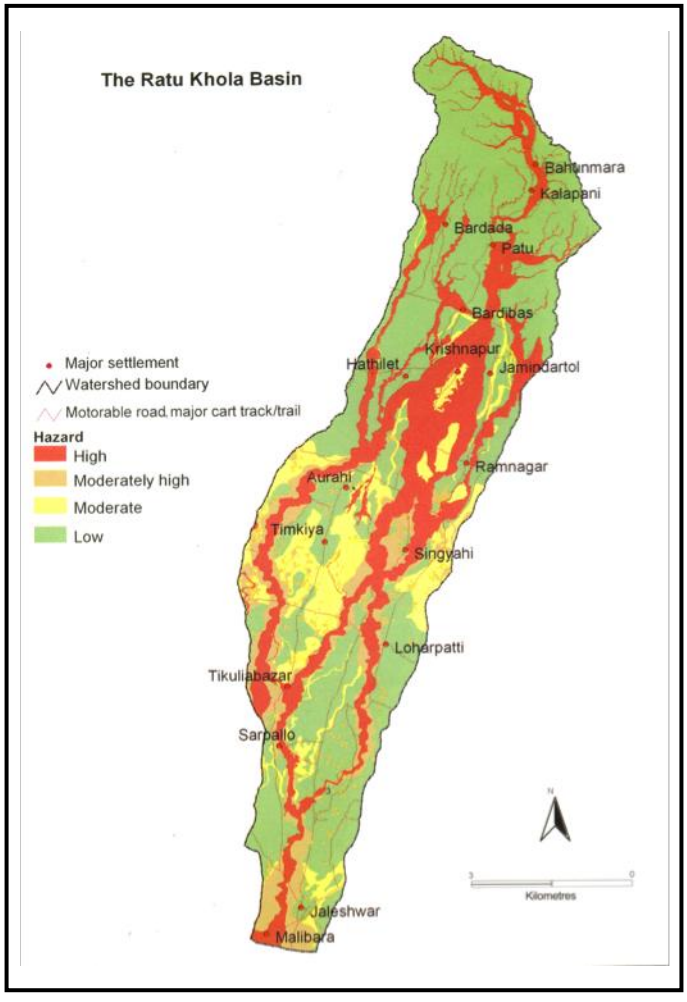


Figure 15: Flood Hazard Map Prepared for the Ratu Khola Basin, Nepal[8]

Flood hazard, risk and vulnerability mapping were carried out in the Ratu watershed through

[8] Khanal et al, 2007

three different approaches: a geomorphic approach using remote sensing (RS) and geographical information system (GIS); measurement of rainfall-runoff using HEC-RAS; and social flood hazard mapping based on local experience. Data and information were provided through maps, aerial photographs, RS imagery, household surveys, group discussions, field surveys and observations, published and unpublished reports. GIS-based software (ArcView, ILWIS) and river system analysis software (HEC-RAS and HEC-GeoRAS) were used to process and analyse the data. A comparison of these three approaches showed that the RS and GIS approach is effective for assessing and mapping flood hazard, risk and vulnerability for a large area.

The flood risk and vulnerability maps showed that nearly 18 percent of the watershed lay in the high-risk category. Inundation maps showed that a large part of the area adjacent to the India border are subject to extensive inundation by floods, some locations with a two-year return probability.

It was found that flooding; cutting of riverbanks and shifting channels were the most frequently occurring hazards in the lowland areas of the watershed. On average 8 percent of total household income was lost as a result of floods, with 61 percent of households in the watershed exposed to flood hazard, with 21 percent being in high-hazard localities. It was found that in addition to the natural processes of rise in the riverbed and shifting channels, inundation has increased in recent years due to man-made infrastructure such as roads and bridges.

There were no activities or programmes found on flood preparedness. The project endeavoured to establish a community-based early warning system and associated flood impact measures such as identification of safe evacuation routes and safe areas. In this context villagers were trained to read and record precipitation and discharge in upstream areas, whilst in downstream areas villagers were taught to read maps and to identify and mark safe evacuation routes and safe areas.

7.2 Community Flood Information System (CFIS), Bangladesh

The overall goal of this project was to reduce vulnerability to damage resulting from flooding in the floodplains of Bangladesh. This objective was accomplished by providing useful, timely and understandable flood information at the community level in a study area. This information was in contrast to the government-issued flood warnings, which were presented in a context and format that was not understood by the rural communities.

The CFIS project took place over a 6-year period from October 2002 to March 2008. Its activities and achievements included:

A needs assessment: Over a 2-year period detailed assessments were carried out to assess the needs of the local communities and local government for flood information, the format in which they required this information and the training and awareness required for effective uptake of the developed flood warning systems.

Floodplain modelling: The project developed a system (WATSURF) for accurate and efficient floodplain modelling, with an automated dissemination module. Flood forecasts were created for the study area as a digital map, allowing for automated distribution of site-specific information to users. The 48-hour forecasts were accurate, with an average error of 15 cm. In addition to the flood warning function the program automatically created inundation and flood-depth maps for use in flood risk and vulnerability assessments.

Dissemination of flood risk warnings: A number of dissemination techniques were investigated and tested. The most successful system was an automated SMS text messaging service with multiple pathways to local governments to key stakeholders– local government, schoolteachers, imams, shopkeepers and vulnerable households. These warnings were incorporated in a network of people who would pass on the information and any flood warning to their neighbours and local community through hoisting coloured flags and posting information on bulletin boards.

Utilisation of cellular telephones: It was recognised early on in the project that there were significant opportunities for using mobile phones as a central component for information dissemination. This technology created an opportunity for low-cost, reliable and deeply penetrating dissemination of flood forecasts to the target group.

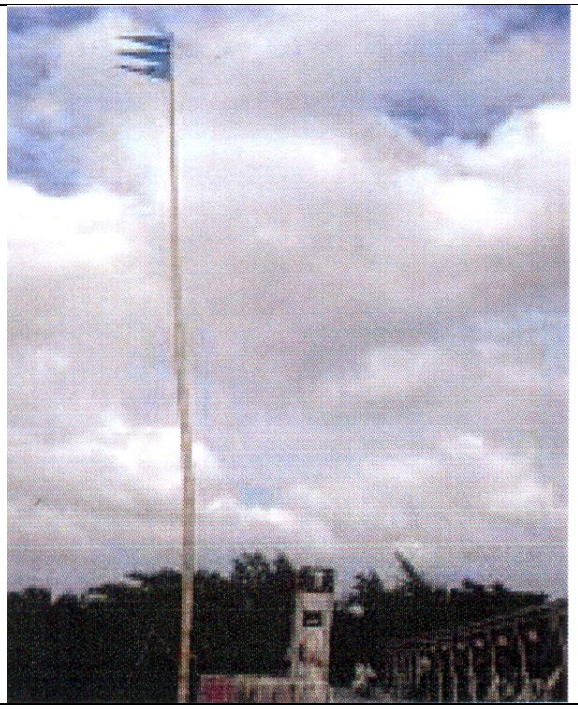


Figure 16: Three Raised Flags Showing a Rise in the Water Level

Public-private partnerships: The project approached three of the largest mobile phone operators to see if they were interested in supporting the dissemination of the flood forecast information. The second largest operator, Banglalink, agreed to transmit the information at no cost during the 2007 and 2008 flood seasons.

Engaging government and other stakeholders: The project was able to provide flood information to localities and users that were not covered by the government run flood warning systems. Through the demonstrated benefits of the approach of direct communication with those most at risk the project raised awareness and understanding amongst government staff and local politicians of the value of providing timely flood warnings.

7.3 United Kingdom Environment Agency, United Kingdom

In the United Kingdom (UK) responsibility for water resources management, including flood management, rests with the Environment Agency. The Agency is responsible for planning, design and construction of flood defences, flood mapping, flood warning and flood management, and has a significant research and development programme into all aspects related to flood occurrence, management and mitigation (see Figure 17).

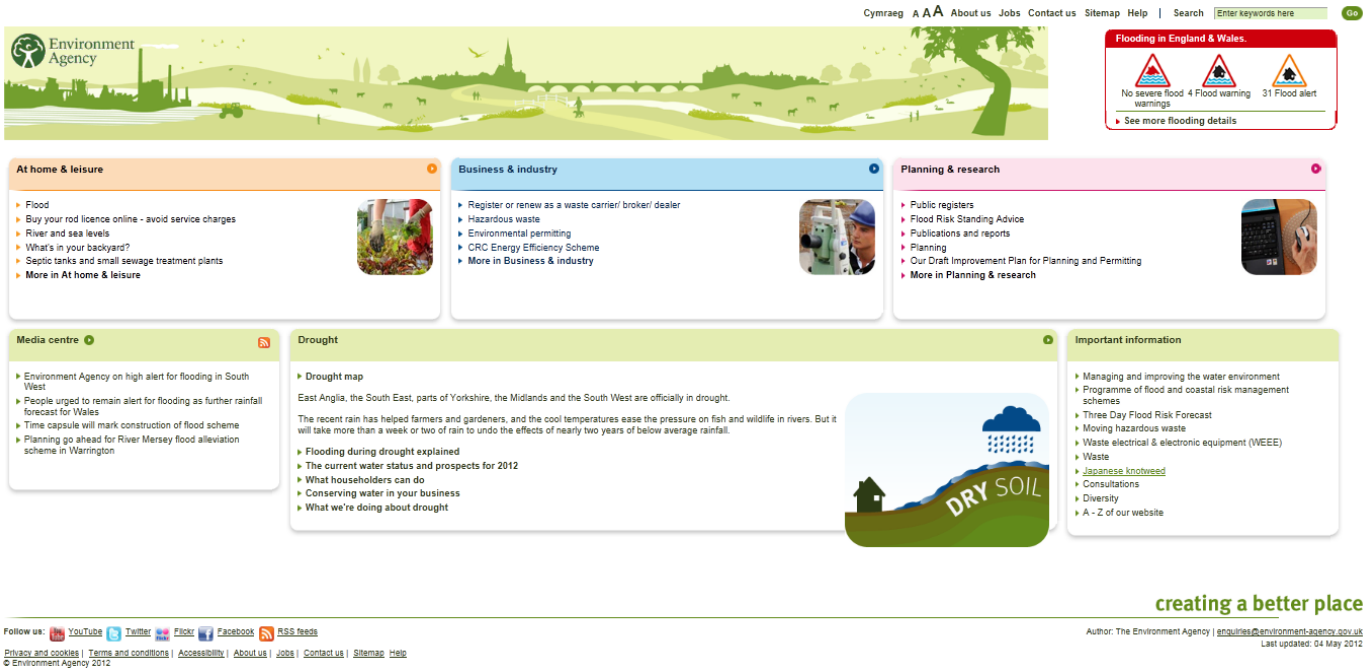


Figure 17: UK Environment Agency Web Site

The Agency provides detailed information related to flooding on its website. The site provides answers to the most frequently asked questions, as shown in Figure 18, with one of the most important features being the flood maps. These maps can be viewed by typing in the postcode or city/town/village name into the search engine (Figure 19), with the facility to then zoom in on a locality using the zoom facility bar in the top left corner of the map (Figures 20 and 21). The flood map shows the main rivers, the extent of possible flooding, flood defences and the areas benefitting from flood defences. In addition, there is a pull-down menu which allows the user to view other information for this locality, including river and sea levels, bathing water quality, land and water pollution levels, air pollution, groundwater levels and river basin management plans. By clicking on the map the user can obtain a further screen (Figure 22), which shows the level of flood risk at this location, together with an explanation of that risk and additional sources of information.

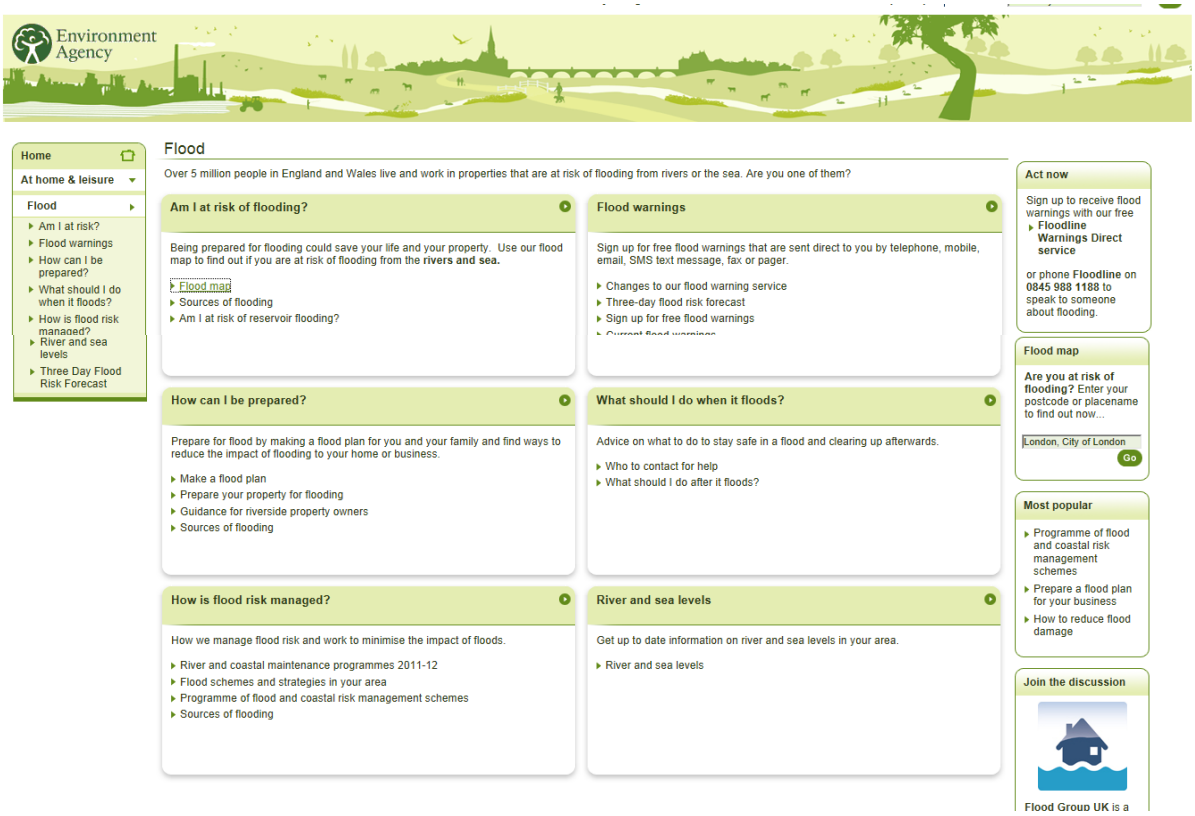


Figure 18: Main page related to flooding with key questions

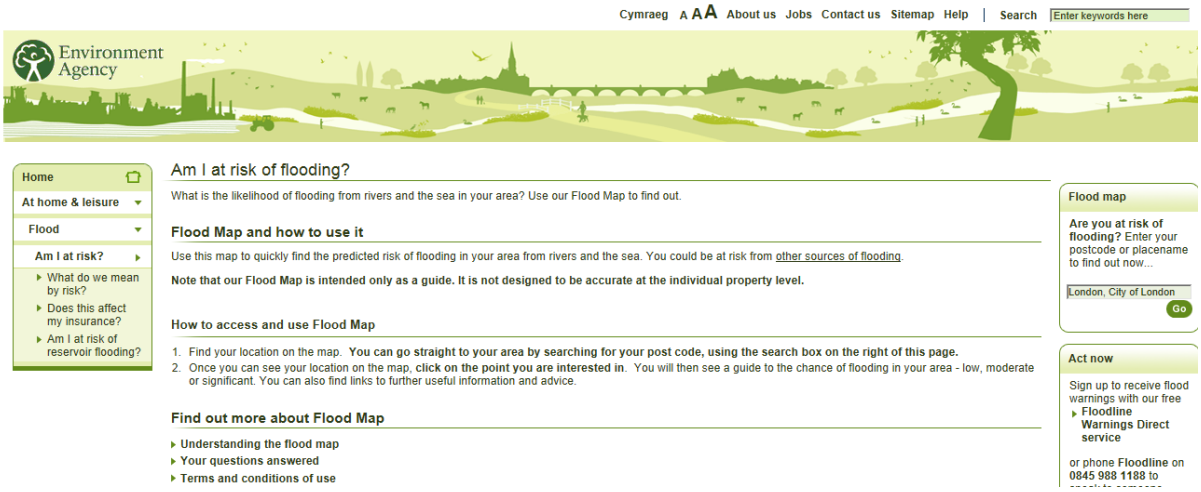


Figure 19: Web page to obtain the flood map

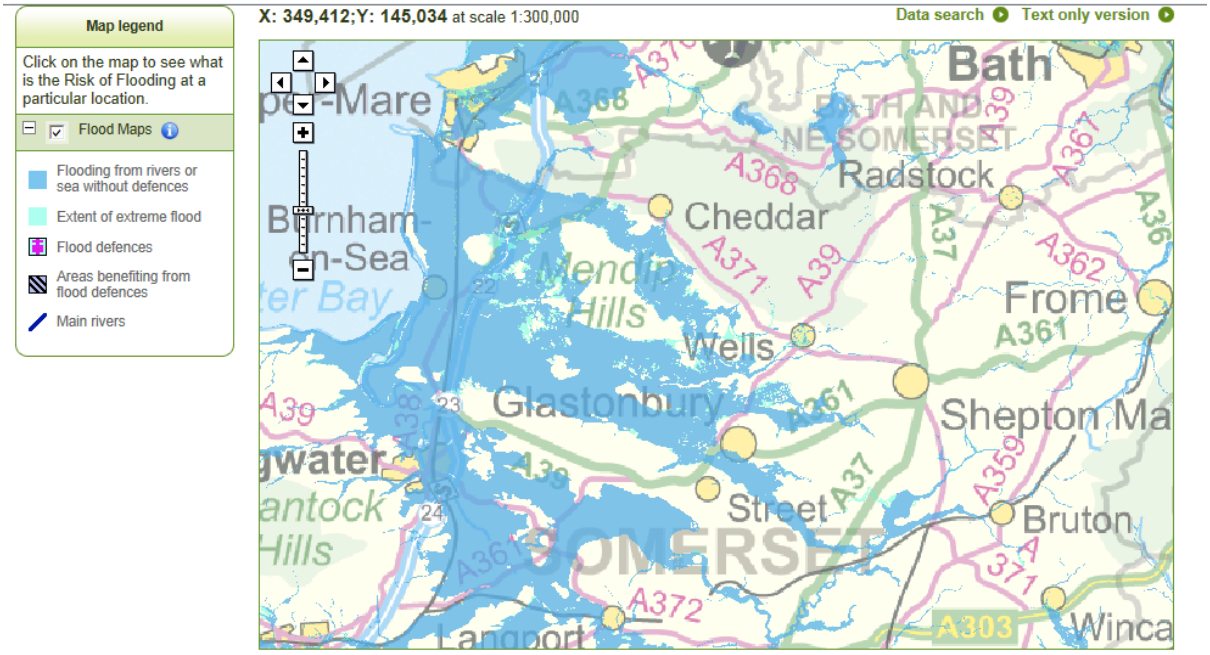


Figure 20: Flood map for Glastonbury in the West of England

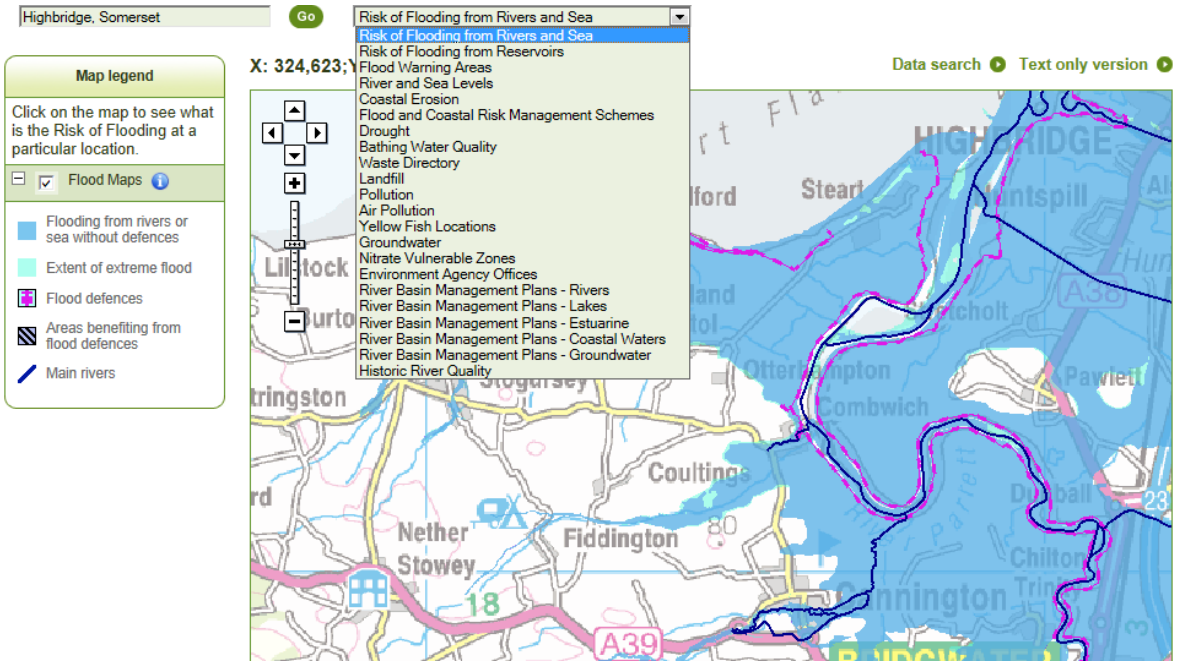


Figure 21: More detailed flood map showing flood defences around Bridgewater and Highbridge

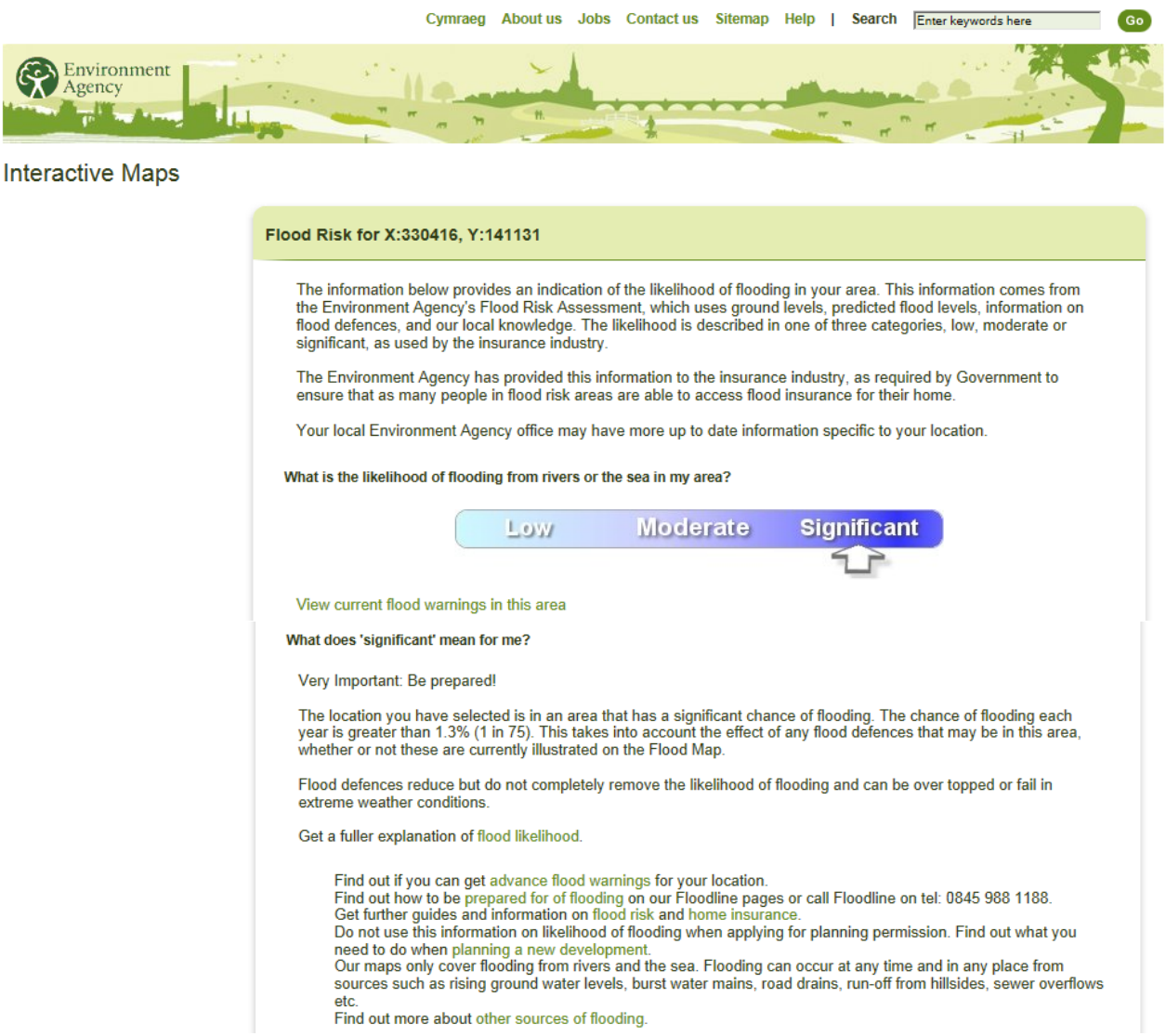


Figure 22: Categorization of the Flood Risk

The site also provides a facility for flood warnings (see Figure 23) with a 3-day forecast with additional information and contact details for whom to contact for more information (see Figure 24). Those in flood prone areas can sign up to a free Flood Warning Direct Service, which will send texts or email messages to a designated address if a potential flood event arises. Further information is provided on additional web pages on flood protection measures and products (such as flood boards, sand bags, etc.)

Sites such as this are user-friendly and can provide communities as well as officers within the WRD or Agency critical information in disparate locations during flood events.

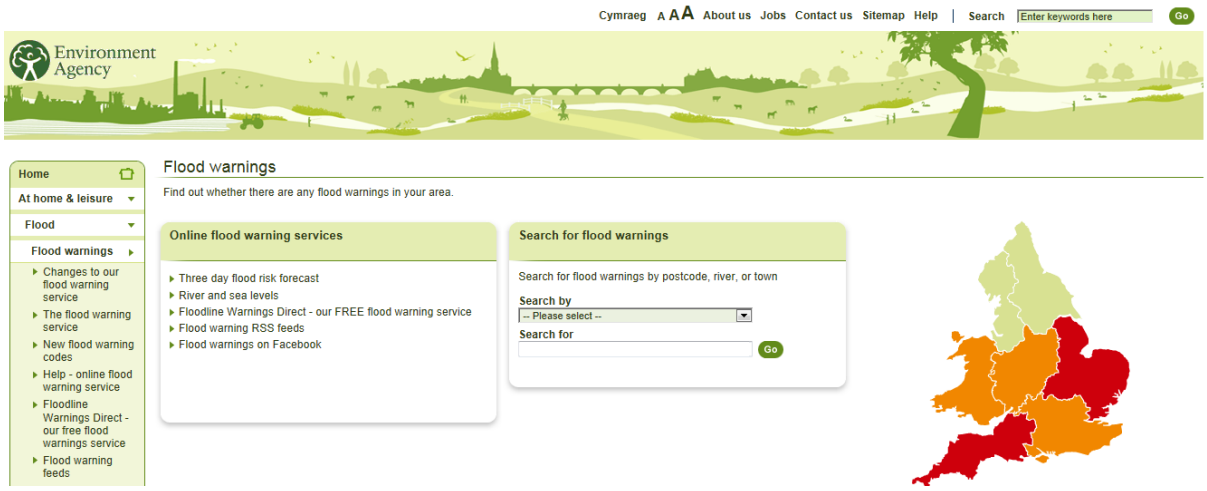


Figure 23: Flood warnings Web Page

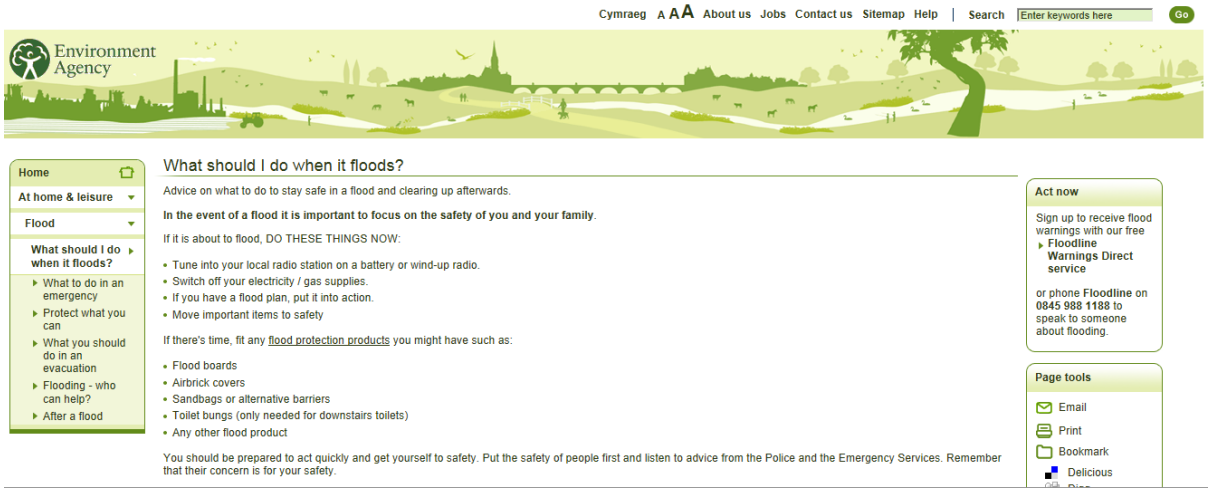


Figure 24: Flood Event Information and Flood Helpline Contact Details

7.4 World Bank Bihar Kosi Flood Recovery Project, Bihar

In August 2010, the World Bank approved a $220 million credit to the Government of Bihar to support the flood recovery as well as future oriented risk reduction efforts of GoB through (i) reconstruction of damaged houses and road infrastructure (ii) strengthening the flood management capacity in the Kosi Basin, (iii) enhancing livelihood opportunities of the affected people, and (iv) improving the emergency response capacity for future disasters. This project has a specific component dedicated to strengthening the flood management capacity of the Kosi basin focusing on building the capacity of flood forecasting and flood erosion management as well as providing limited support on rehabilitating structural measures such as embankments in the Kosi basin.

The objective of this component is to strengthen the overall flood forecasting and flood and sediment management capacity in Bihar by enhancing knowledge, understanding, and capacity of flood and sediment management. This is being achieved by implementing both structural and non-structural measures, mainly focusing on the Kosi River Basin, but with several activities benefiting flood management in the state as a whole. This component has three subcomponents: (i) knowledge management and capacity building; (ii) flood forecasting and early warning; and (iii) structural investments. The main tasks include: (a) conducting a series of technical studies, mathematical and physical modeling, geotechnical and other investigations, and setting up a Center of Excellence for Water Resources and Flood Management Research and Development; (b) establishing an

embankment asset management system, including training on inspection of embankments; (c)development of a flood and sediment management master plan that will provide an overall framework for flood management in the state; (d) enhancing the flood forecasting and early warning capacity for the Kosi basin, including development of a digital elevation model (DEM) for the Kosi River Basin to prepare hazard and risk maps and assessments, development of an automatic hydro-meteorological monitoring system, development of rainfall-runoff models, and development of a flood early warning and emergency system as well as community-based flood preparedness measures; and (e) strengthening of eight km of the Kosi western embankment and piloting of river training, erosion and sediment control, and strengthening of sections of embankments using more adaptable and suitable materials and construction techniques.

Though these interventions are mainly focused on the Kosi basin, this project attempted to pilot crucial flood management solutions in one basin that can eventually be scaled to the rest of the state. As section 6 of this study has illustrated, some of the key challenges that the Water Resources Department faces today indeed result from a lack of world class research institutes focused on flood management, ineffective decision making in terms of asset management of existing embankments resulting in delays and weak infrastructure, and a poor flood early warning system that does not often reach vulnerable communities, among other challenges. These challenges are in line with the interventions that the World Bank's Kosi project is attempting to address, albeit in a single basin.

The Kosi project was initiated in 2010. Two years later the flood management component has been delayed due to a number of factors. Plans for the Center of Excellence were delayed due to difficulties in determining a suitable location, plans for the Flood Master Plan have still not been initiated due to lack of technical expertise within the Department, and requests are still pending to begin to collect data for the DEM model. This project clearly illustrates the need for a champion within the WRD to spear head and take ownership of the various aspects of the project and see them through completion. In the absence of a dedicated individual or group of individuals, implementation of critical reforms in the flood management processes and procedures of the WRD, even within the context of a World Bank project, tend to get overlooked in the day-to-day operations of the Department. Reforming pre-existing practices and procedures and integrating new systems is often a complex and time consuming exercise that needs the right level of engagement from senior decision-makers in traditionally hierarchical organizations such as the WRD. In the absence of dedicated attention to the reform initiatives, delays and inertia sets in leading to low levels of take up. Progress is yet to be achieved in the Bihar Kosi Flood Recovery project; however, as the projects other objectives are achieved, the flood management component will also eventually achieve its results so that improvements are can be made in the flood management apparatus of the state.

8 Conclusions and Next Steps

8.1 Conclusions

As we engaged in the process of trying to understand the WRD and its operations through surveys, interviews, focus discussions with multiple agencies and multiple actors across multiple river basins of Bihar, we came to one inexorable conclusion; that the WRD has the almost unenviable task of managing one of the most complex and volatile river systems in the world. They have the highly perilous responsibility of protecting millions of lives from the constant onslaught of floods. And what we discovered is that thus far the WRD has achieved numerous successes in achieving this goal. Throughout all the basins we visited, we met a plethora of dedicated engineers at all levels that work tirelessly despite not-so-ideal conditions and little resources to aid them in managing the enormity of their tasks. One of the most remarkable aspects of our fieldwork was that all officers that participated in the survey were open and honest about the inherent issues that need to be addressed in the Department, although junior level officers expressed concerns related more to the daily operational activities of the Department whereas the senior officers identified strategic challenges. This knowledge and acceptance was seen at all levels from senior level officers to field staff within the Department. Lastly, we witnessed firsthand a deep desire to reform and improve performance standards of the WRD for future years. Phase one of this study has clearly focused and illustrated that there are a number of challenges that pertain to the actual functioning of the Department that need to be addressed.

Section 6 described in detail the findings that emerged from each of the three sets of surveys we conducted by analyzing each of the three survey responses separately. In this section, we provide an overall summary of the findings. Table 14 below utilizes five of the seven elements of the 7-S framework to represent a summary of our findings from the community, WRD leadership and field officer surveys.

Table 20. 7-S Summary Table of WRD Challenges

7-S Diagnosis of WRD Challenges & Opportunities	
Skills • Technical know-how of staff needs to be improved • Need for research & development unit within the WRD that focuses on training and dissemination of latest flood management techniques to WRD staff • Need to make professional human resources development and management a core objective of the WRD	**Style of Leadership** • Too much emphasis on top-down decision-making • Failure in strategic thinking of leadership to transition from construction agency to management agency • Need to set mandate for a more professional agency • Leadership from top needs to help WRD evolve to a "predict and prevent" organization • Provide strategic leadership to transform Department • Need to identify root causes of problems in WRD (e.g. why are junior staffs demotivated?)
Staff • Staff shortages and promotion processes	**Systems** • Ensuring robust systems is important

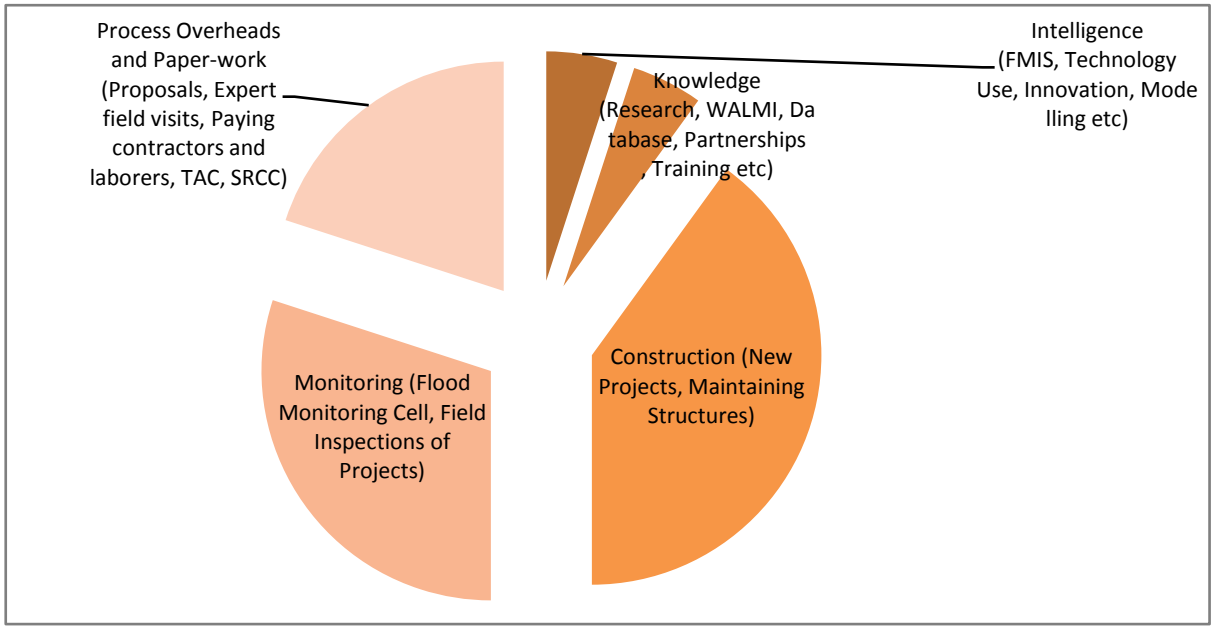
need to be urgently addressed and revised • Need a specialist HRM cell, staffed with experienced HRM people (sociologists, social scientists or similar, not only civil engineers) • Need to identify each individual's skills and post them to positions to match their skills. • Need to identify younger, capable staff and fast track them through the system so that they get to positions at an early age where they still have the energy and enthusiasm to make changes.	• WRD systems appear to be weak and are functioning at sub-optimal levels • The communications systems are poor (passing information down through the organisation to communities) • The human resources management (HRM) system appears to be very weak and outdated in its practices • Liaison/communication with communities appears very poor/ almost non-existent • Mobile technology and modern communication systems can offer WRD significant opportunity to address systems gaps and leap frog
Strategy • WRD needs to define a vision for flood management for the future • Need to focus more on management rather than on construction • Must make strategic shift away from viewing embankment as the client • Need to shift away from "wait and watch" and then react to the crisis mode • The key elements the WRD should focus on for a future vision are: o Engagement with local communities o Providing early flood warnings o Utilizing modern technology o Developing better information portals (e.g. flood risk maps) o Establishing an active research and development unit o Creating a more robust and decentralized FMISC that is funded by WRD o Ensure all hardware and equipment needs are met o Developing robust, timely decentralized decision-making processes	

In flood management, WRD success is defined by just one question: did Bihar escape massive floods this year? As a result, the core strategy is doing more of the same year to year and hoping that weather patterns and river flows do not change and structural measures don't fail dramatically. The result of this one-dimensional strategy is clearly visible in the findings of our survey.

At some levels the WRD functions well; field staff are alert, annual processes are run to identify and fix vulnerable positions, new projects are sanctioned to build embankments and a monitoring and communication setup is operationalized during the flood season. However, this one-pointed strategy also blinds the leadership of the department on several aspects: holistic view of floods and how to address them, environment and ecology, integration of better technology and systems into the flood management, training leaders and field officers on emerging techniques, innovating solutions based on experiences with flood and setting up a powerful vision of for the department. At the same time, this one pointed focus severely burdens WRD field staff. Poor training infrastructure means old practices are perpetuated and innovations in the field do not happen. The overall government machinery creates constraints in timely and need based hiring, merit based promotions, and resources and backing for reforms. The vast experience of WRD in flood management is not flowing back into the system to generate institutional strength and development.

Mechanical activities namely construction, monitoring and process overheads constitute the major portion of WRD's activities and organizational thinking. Intelligence and knowledge development occupy a far lower priority. Figure 25 symbolically represents the scenario today.

Figure 25. Current Scenario of WRD Operational Functions

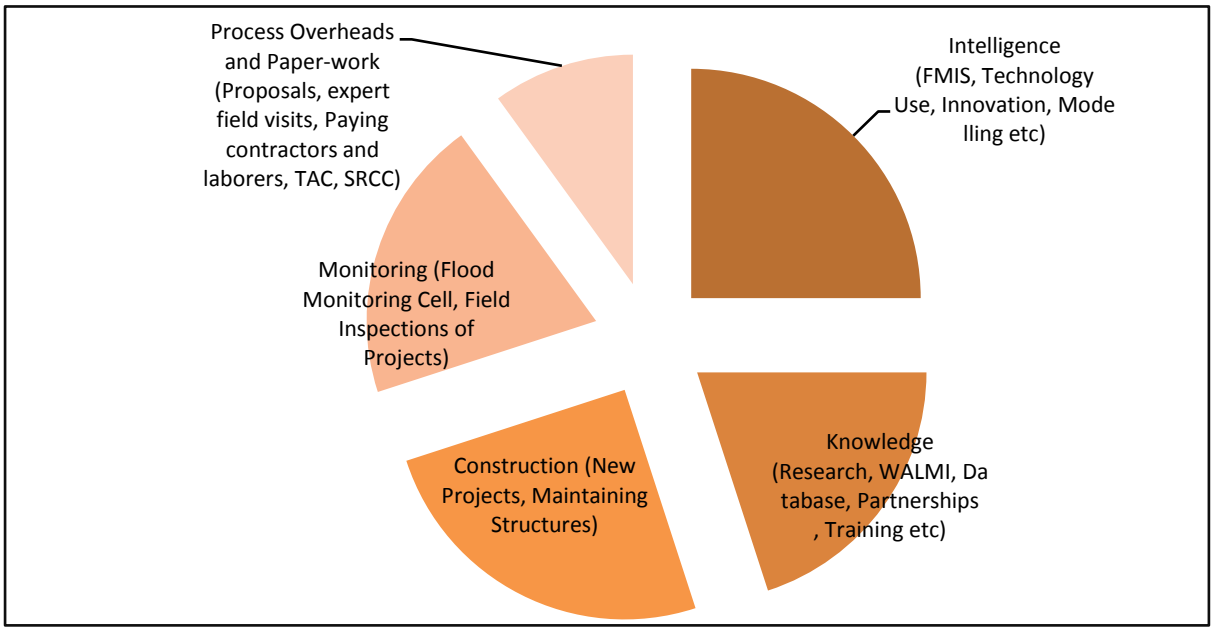


At this point, there is urgent need to "think smart" and think out of the box given such restricted resources. Transport and access remain key problems. One solution is to provide better transport and access, but another solution might be to provide trusted and trained villagers with mobiles and training so that they can monitor the situation in the field and report to their WRD contact officer, who in turn can contact others in the WRD. Modern technology offers the WRD a massive opportunity to resolve some of the current problems. Use of modern technology (remote sensing, mobile phones) with modern institutional approaches (greater community engagement and involvement) can help address some of the more serious problems, and save money, time and resources. We find a very clear message from field experiences, interactions with community and field staff that better liaison with the community is needed and valuable. However, this is in marked contrast to the leadership survey where managers who are further from "the coal face" think there is little need to liaise with the community.

The utmost critical need for the department is a strategic vision for the future with changes in the leadership that can support this vision for the next decade. The focus of the WRD needs to transition from a fire-fighting 'wait and watch' mode to a 'predict and prevent mode' that integrates the elements of robust research and training, technology, communication and decision-making systems, and development of staff strengths. Specifically, there are two dimensions that are integral to this vision: a) technology is rapidly evolving to offer dramatically powerful solutions in flood forecasting, communication infrastructure, monitoring, infrastructure management and integrated approach (structural and non-structural measures) towards flood management, and b) nature, especially climate changes, are constantly changing the game in Bihar with rivers changing course and dynamic sedimentation patterns that are challenging the past solutions. Therefore WRD has to

evolve to counter these dramatic changes. Figure 26 below provides a future scenario of the WRD were it to begin to reform the challenges identified in this report.

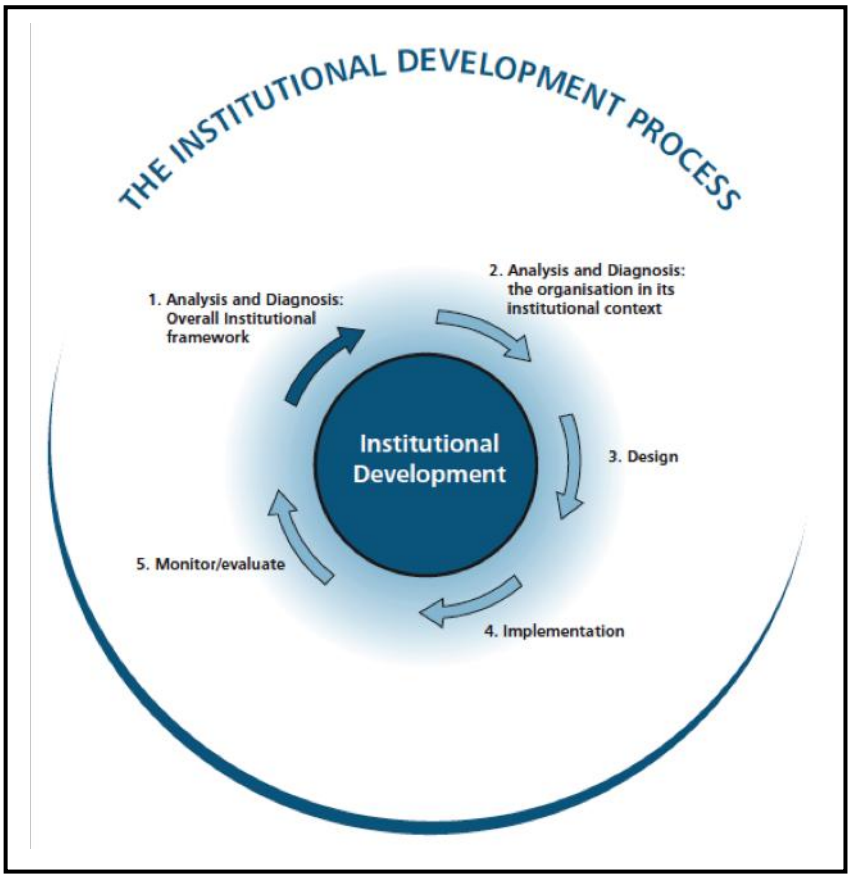
Figure 26. Future Scenario of Reformed WRD



8.2 Next Steps

Figure 27. The Institutional Development Process

The sole purpose of phase one was to identify the most pressing operational challenges that an organization such as the WRD is facing today with respect to flood management. This is in line with the overall institutional development process (see Figure 27), which provides clear steps on how an institution can develop and evolve and the process it needs to take to accomplish this. This graphic is based on the study undertaken by the Department for International Development of the UK (DFID, 2003).Phase one attempted to depict the overall institutional framework of the WRD and set the organization in its current institutional context.



However, simply identifying the challenges is not enough. A follow up phase is necessary to begin to operationalize the reform process that we have begun in phase one. The focus of phase two is to begin to work with key decision-makers in the WRD and identify solutions that can address the challenges described in this report. Phase two will design solutions and provide a road map of how these solutions can be implemented, monitored and evaluated. Figure 28 below provides an illustration of the framework for the next phase of this study based on the change management methodology as prescribed by the DFID report on *Promoting Institutional and Organizational Development*. The next phase of this study will integrate the findings of phase one into a framework that can deliver the organizational changes necessary to enhance the flood management operations of the WRD and ensure the resilience of Bihar against future flood risks.

Figure 28. Change Management Framework[9]

Element	Issue
Change Vision	Why is change necessary? Is there a compelling and inspiring vision that is driving change (such as improved public services)? Has this been communicated?
Change Strategy	What are the enablers & barriers to change? Are people willing to change? What should the approach be? Is there a clear project team leading change?
Commitment	Is there support for change amongst politicians/senior civil servants? Is there local ownership or has reform been imposed? What is being done to build commitment.
Capacity and Leadership	Is there a change sponsor or champion who will lead change? Is there effective leadership throughout the organisation with the capacity to manage change? Do staff have the skills needed to perform in the new organisation? have change agents been identified?
Culture	How does the organisational culture support/hinder reform? Is reform taking place on the basis of internalised principles? Is effort needed to change the culture? What is being done to engage with users and poor people? What resources are being mobilised to sustain change?

The next step of phase two must start with the aspects of capacity, commitment and leadership, change vision, change strategy and culture identified in Figure 28. The potential and desire for changing and reforming the WRD that is currently present in the leadership of the Water Resources Department must be tapped and utilized so that in conjunction with the staff of the WRD we can develop a sustainable and far more robust flood management institution for the future of Bihar.

[9] DFID 2003

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Acronyms & Abbreviations

1. Assistant Engineer (AE)
2. Bihar State Disaster Management Authority (SDMA)
3. Block Development Officer (BDO)
4. Central Water Commission (CWC)
5. Chief Engineer (CE)
6. Cultivable Command Area (CCA)
7. Disaster Management Department (DMD)
8. District Magistrate (DM)
9. Engineer-in-Chief (E-in-C)
10. Executive Engineer (EE)
11. Flood Management Information Systems Cell (FMISC)
12. Geographical Information System (GIS)
13. Government of Bihar (GoB)
14. Government of India (GoI)
15. Indian Meteorological Department (IMD)
16. International Centre for Integrated Mountain Development (ICIMOD)
17. International Growth Centre (IGC)
18. Junior Engineer (JE)
19. Members of Legislative Assembly (MLA)
20. Members of Parliament (MP)
21. National Disaster Management Authority (NDMA)
22. National Remote Sensing Authority (NRSA)
23. National Rural Employment Guarantee Act (NREGA)
24. Panchayat Raj Institutions (PRI)
25. Remote Sensing (RS)

26. Self Help Group (SHG)
27. Superintending Engineer (SE)
28. United Nations Educational Scientific and Cultural Organization (UNESCO)
29. Water and Land Management Institute (WALMI)
30. Water Resources Department (WRD)

Annexes

Annex A: Questionnaire for WRD Division & Sub-Division

The purpose of this survey for WRD Divisions and Sub-Division staff is to:

a) Find out what the actual practices are in the field in relation to flood management
b) Understand the field level processes and procedures
c) Identify problems and constraints for field staff
d) Discuss issues and gather suggestions and recommendations for improvement

Survey for Division or Sub-Division? _____

District _____

Block _____

Division _____

Sub-Division _____

Name(s) of the nearest rivers/embankment:

Name of river/embankment	Distance from office
1 _____	_____ km
2 _____	_____ km
3 _____	_____ km

Name of respondent(s) to this questionnaire

Name **Position**

Date _____

Interviewer's Name (Print clearly) _____

Interviewer's Signature _____

NOTES: _____

Survey No. **Code** [ ]

A. Background data on Division/Sub-Division

1 Is this a Division or Sub-Division office?

Division	Sub-Division

2 What is the total staffing for this Division/Sub-Division (all categories):

Executive Engineer (EE)	
Assist.Eng (AE)	
Sub-Engineer (SE)	
Surveyors	
Drivers	
etc.	

3 What is the total staffing in the office (i.e. excluding staff based in the field or other

offices)

Executive Engineer (EE)	
Assist.Eng (AE)	
Sub-Engineer (SE)	
Surveyors	
Drivers	
etc.	

4 Please provide general data for this Division/Sub-Division:

Total population		persons
Number of villages		No.
Number of towns		No.
Total land area		km
Total cultivated area		ha
Total irrigated area		ha

5 Please provide data on flood infrastructure

Length of embankments		km
etc, etc		

6 Please provide information on your offices and resources:

	Quantity	Condition	Notes
Rooms in office			
4WD vehicles			
Other vehicles			
Motorbikes			
Computers			
Telephone			
Internet (Yes/No)			
Availability of electricity (hours/day)			
Walkie-talkies			
Other (specify)			

7 Finances. What is your annual budget?

Office		Rs
Operation		Rs
Maintenance		Rs
etc, etc.		Rs

8 Questions to individual staff

	Staff member 1	2	3	4
a) What is your position (EE, AE, SDE, etc.)				
b) How many years have you been in this position in this office?				
c) Have you always worked in the flood division (Yes/No)?				
d) How many years in the WRD (total)?				
d) How many years in the flood division (total)?				
e) How many years in the irrigation division (total)?				
f) Have you received any training on flood management?				
g) If Yes, when (year)?				

h) From whom?

i) What additional training, if any, do you think you require in flood management?

9 Technology

a) What kind of technology do you utilize in your work in flood management? (Please tick all boxes that apply)

Remote Sensing	
GIS	
MIS	
Computers	
PC Tablets	
Other (please specify)	

10 Staffing

a) How many flood specialists are in the WRD?

b) How many hydrologists are in the WRD?

11 How many current vacancies are in your Division? Or Sub-Division?

a) How many years have those positions been vacant?

b) What do you think are the causes of delays in filling vacancies?

13 What is promotion system within the flood division of the WRD? I

a) Is it the same throughout the state?

b) In your opinion, do you think there some drawbacks to the existing promotion system?

c) Can or should the existing system be improved? If so, what are some of your suggestions?

Survey Code No.

B. Flood location and flood risk

1 a) What are the names of the rivers in your area of responsibility?

b) What are the approximate distances to these rivers from the office?

c) What are the flood risks from these rivers?

d) How often do they cause flooding (perception)?

e) How often have they caused flooding in the last 10 years?

2

a) Name of river	b) Distance (km)	c) Flood risk	d) Flood frequency (perception)	e) Flooding on last 10 years

1 = High
2 = Medium
3 = Low
4 = None
5 = Other (specify)

1 = Every year
2 = Most years
3 = Some years
4 =Never
9 = Don't know

3 What is the nature of flooding in this locality (tick those applicable)?

Direct from rainfall	
Embankment breached due to erosion	
Embankment breached due high water level in river (overtopped)	
Flood flow from upstream location	
Other cause (please give details)	
Don't know	

Details: _____

4 Do you think the flooding:

Can be prevented?	
Is something to be lived with?	
Something you can do something about?	
Don't think anything can be done	
Other (please give details)	

How, any suggestions? _____

If so, what can you do? _____

Other details: _____

5 Do you have any suggestions on how to reduce the risk of flooding in this locality?

_____

_____

_____

6 In your experience, have you encountered any cases of deliberate breaching of embankments?

a) What is the reason for this?

b) By whom was this done?

c) What can/should be done to reduce the incidence of deliberate breaching ?

Education	
Training	
Community Engagement	
Other	

Survey Code No. ____

D. Flood preparedness and mitigation

1 What is your estimate of the general condition of the key items of infrastructure?

Percentage in each condition grading

	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Overall
Embankments						
Groynes						
Etc, etc.						

Grade 1 - Excellent, Grade 2 - Good, Grade 3 - Moderate, Grade 4 - Poor, Grade 5 - Very poor

3 What measures do you take to prepare for floods each year?

a) Who is involved within the Division or Sub-Division

b) What are each the EE, the AE and JE doing during this time? What is each of their roles?

4 a) How well prepared were you for the flooding in 2011? ☐
(or the last flood event - state the year)

1=very well prepared, 2= well prepared
3 = moderately well prepared, 4 = not well prepared,
5 = poorly prepared, 9 = don't know

b) If you were not well prepared, why not?

c) What would help you be better prepared?

5 What measures did you adopt last year (or in previous years) to mitigate the flood risk or the impact of flooding?

6 Do you have any suggestions for being better prepared for floods or for mitigation measures?

7 What is the process for maintaining flood embankments? How often is this done?
a) What equipment and facilities are available for maintenance?

8 What is the process of inspecting embankments? How often is this done?

9 Do you think that this system is adequate ? If not, what suggestions do you have for improvement?

10 Does the community participate in maintenance of the embankments?

11 Are there sufficient funds and/or resources to conduct maintenance of the flood embankments in your Division or Sub-Division?

E. Flood events

1 How many times have you had to manage floods in the last 10 years?

Once	
Twice	
More than twice	
More than twice (give number)	
Every year	

2 Please summarise the flood event (up to 4 events):

	Year	How severe?	Duration (days)	Type of flood	Name of river
1.					
2.					
3.					
4.					

1=very bad, 2=bad,
3 = moderate impact, 4 = little impact
5 = no impact, 9 = don't know

1=Heavy rainfall
2 = embankment breach
3 = overland flow
9 = don't know

4 Please describe one typical flood event and the work you had to do:

a) Year of flood		
b) How severe was the flood?		
c) What duration?		
d) Type of flood?		
e) Were you given any warning (Yes/No)?		By whom? _____
f) Did you warn the villagers (Yes/No)?		

g) What happened? _____

h) What role did you play during the flood event?

i) What would you like to have done, or have been able to do, better? What resources would you have needed?

5 Does the community assist you during flood events?

Yes	No

9 = Don't know

a) If Yes, please describe how/in what way:

b) If No, please describe why not:

6 Do you have specific people in the community that you liaise/work with on flood management? Please describe who and the role they play.

7 Does any other government organisation help during the flood? Please detail the organisation(s) and the help provided.

8 Do you expect to get flooded again in the future?

Yes	No

9 = Don't know

- If Yes, what can you do about it?

9 Other comments or suggestions:

10 Is there a Flood Control Cell or Centre at the Division level?
a) How is this set up?

b) What kind of equipment does it have?

c) What kind of staffing does it have?

d) What resources do they have?

e) In your opinion, do you think the flood fighting task force or cell is effective during past flood events?
If not, what can be done to improve its effectiveness?

How does the WRD work with the Disaster Management Department (DMD) during floods?

11 Are there training days by the DMD for the WRD staff?

F. Flood relief and recovery

1 a) Does the WRD give help with flood relief?

Yes	No
	No

9 = Don't know

2 a) Does the community work together to rebuild the damage following a flood event?

Yes	No

9 = Don't know

b) If Yes, describe work done/help provided:

c) If No, why does the community not work together?

Annex B: WRD Leadership Survey Questionnaire

जल संसाधन विभाग का संगठनात्मक सर्वे (Organizational Survey of Water Resources Dept, Government of Bihar)

Senior Management Survey : WRD
This survey will focus on ideas to develop the complete set of functional capabilities required in WRD in an ideal scenario. In addition, questions will probe the present institutional strength of WRD. The survey will seek answers based on a senior manager's experience, technical skills and exposure to best practices beyond WRD in Bihar. The survey will be administered to the Joint Secretaries, Engineer-in-Chief, Chief Engineers and Superintending Engineers associated with flood management activities.

इस सर्वे का उद्देश्य है (The objective of this survey is) :

1. बिहार सरकार के जल संसाधन विभाग के अंतर्गत बाढ़ से निपटने के लिए उपयोगी सम्पूर्ण कार्य-कौशल का ब्यौरा तैयार करना
   (To holistically construct the complete set of functional capabilities necessary to face the flood situation in Bihar)
2. जल संसाधन विभाग के संस्थागत मजबूती के सभी पहलुओं को तलाशना
   (To probe the institutional strength of present capabilities of WRD)
3. जल संसाधन विभाग के समग्र विकास के लिए एक दूरदर्शितापूर्ण और व्यापक मापदंड तैयार करना
   (To develop benchmarking system that will measure institutional progress that WRD will make in the coming years)
4. विभाग के मानव संसाधन सम्बन्धी प्रक्रियाओं का आंकलन कर उन से उत्पन्न होने वाली संभावनाओं पर प्रकाश डालना
   (To highlight the scenarios that emerge from the human resource procedures of the department)

इस सर्वे का उद्देश्य बिलकुल नहीं है कि (The objective of this survey is NOT) :

1. जल संसाधन विभाग को किसी भी रूप से एक कमज़ोर पृष्ठभूमि में प्रस्तुत किया जाये
   (To present WRD as a weakly functioning department)
2. विभाग के किसी भी अंग अथवा अधिकारी को किसी अन्य अंग अथवा अधिकारी से बेहतर बनाकर प्रस्तुत किया जाये
   (To make one department or person look better than the other)
3. सर्वे के माध्यम से ज्ञात होने वाली समस्याओं का त्वरित उपाय सुझाया जाये (उपाय सम्बन्धी सुझाव देने से पूर्व प्रत्येक पहलू पर ढांचागत रूप से विस्तृत चर्चा की जायेगी)
   (And finally, to provide instant solutions to any of the problems highlighted above (Solutions need to be developed once the key issues are fully framed and discussed))

पृष्ठभूमि सम्बन्धी जानकारी (Background Information)

आप किस पद पर कार्यरत हैं (What is your designation) *

- ◯ Deputy Secretary
- ◯ Under Secretary
- ◯ Director
- ◯ Engineer-In-Chief
- ◯ Chief Engineer
- ◯ Suprintending Engineer
- ◯ Other: _____

आप किस शिक्षा के साथ विभाग से जुड़े थे (What was your qualification at the time of joining the department)? *

(अन्य डिग्री को "Other" में लिखें)

- ◯ Diploma in Civil Engineering
- ◯ Diploma in Mechanical Engineering
- ◯ B.E / B.Tech Civil Engineering
- ◯ B.E / B.Tech Mechanical Engineering
- ◯ M.E / M.Tech Civil Engineering
- ◯ M.E / M.Tech Mechanical Engineering
- ◯ B.E / M.E Computer Engineering
- ◯ Other: _____

विभाग में आने के बाद आपने क्या शिक्षा ग्रहण की (What qualifications did you earn after joining the department)? *

(अन्य डिग्री को "Other" में लिखें)

- ☐ Higher Degree / Specialization in Civil Engineering
- ☐ Higher Degree / Specialization in Mechanical Engineering
- ☐ Higher Degree / Specialization in Hydrology
- ☐ Higher Degree / Specialization in Flood Management Information Systems
- ☐ Higher Degree / Specialization in Financial Management
- ☐ Higher Degree / Specialization in Supply Chain Management
- ☐ Higher Degree / Specialization in GIS / Remote Sensing
- ☐ Higher Degree / Specialization in Irrigation Engineering
- ☐ Other: _____

कौन से विषयों पर मिले प्रशिक्षण / ट्रेनिंग ने आपको विभागीय कार्यों में मदद दी (Which training has helped you in you work WRD)?

कृपया ट्रेनिंग का नाम और ट्रेनिंग देने वाली संस्था का नाम इंग्लिश में नीचे लिखें (please write the training and the name of the agency that gave you training)

अपने कौशल में विकास के लिए आप किन माध्यमों का प्रयोग करते हैं (Which sources do you use to develop your skills?) * *

- [ ] Discuss ideas / information with colleagues
- [ ] Discuss ideas / information with subordinates
- [ ] Interact with people from development agencies
- [ ] Interact with training institutes
- [ ] Regularly attend trainings
- [ ] Read reports from World Bank and other similar agencies
- [ ] Read on internet
- [ ] Other:

निम्नलिखित विषयों में अपने कौशल का विवरण दें (Please describe your skill level on the following topics)

1 (I don't use), 2 (basic: I know key concepts), 3 (medium: I can use for my needs), 4 (expert: I can train others)

	1	2	3	4
Financial Management and Budgeting	○	○	○	○
Using computer / laptop for email and notes	○	○	○	○
Excel Modeling	○	○	○	○
Use of internet for research and knowledge building	○	○	○	○
Flood Modelling Systems	○	○	○	○
Flood Forecasting Techniques	○	○	○	○
River Basin Planning	○	○	○	○
Project and Operational Hydrology	○	○	○	○
Hydrological Modelling	○	○	○	○
Project Planning using MS Project and Primavera Software	○	○	○	○
Remote Sensing and GIS techniques	○	○	○	○
Preparation of Detailed Project Report of Water Resources Projects	○	○	○	○

किन विषयों का प्रशिक्षण आपको अत्यंत लाभप्रद लगता है (Which training will be extremely beneficial for you) ?

(1 not required; 2 basic level needed; 3 advanced level needed)

	1	2	3
Financial Management and Budgeting	○	○	○
Using computer / laptop for email and notes	○	○	○
Excel Modeling	○	○	○
Use of internet for research and knowledge building	○	○	○
Flood Modelling Systems	○	○	○
Flood Forecasting Techniques	○	○	○
River Basin Planning	○	○	○
Project and Operational Hydrology	○	○	○
Hydrological Modelling	○	○	○
Project Planning using MS Project and Primavera Software	○	○	○
Remote Sensing and GIS techniques	○	○	○
Preparation of Detailed Project Report of Water Resources Projects	○	○	○

बाढ़ नियंत्रण सम्बन्धी अनुभव (Flood management related experience)

बाढ़ नियंत्रण में आपका कितने वर्षों के अनुभव है? (How many years of flood management experience do you have) * *

- ○ Less than 5 years
- ○ 5 - 10 years
- ○ 10 - 15 years
- ○ More than 15 years
- ○ No direct experience

बाढ़ नियंत्रण से जुड़े किन किन कार्यों में आपने महत्वपूर्ण भूमिका निभाई है (Which aspects of flood management have you played a key role in) *

कृपया अपने अन्य सभी अनुभवों को "Other" वाली जगह पर लिखें

- ☐ Construction of embankments
- ☐ Planning of flood prevention structures
- ☐ Evaluation of proposed plans of construction
- ☐ Flood monitoring
- ☐ Preventing erosion of banks
- ☐ Zoning and land use
- ☐ Managing relief activities during flood
- ☐ Flood management information systems
- ☐ Other: _____

आपको किन किन नदी क्षेत्रों में काम करने का अनुभव है (Which river areas have you worked in)? *

कृपया अपने अन्य सभी अनुभवों को "Other" वाली जगह पर लिखें

- [ ] Ghaghra
- [ ] Gandak
- [ ] Buri Gandak
- [ ] Bagmati-Adhwara
- [ ] Kamla-Balan
- [ ] Kosi
- [ ] Mahananda
- [ ] Ganga - Bhagalpur
- [ ] Ganga - Patna
- [ ] Sone
- [ ] Other:

बाँध के मेंटेनेंस और एंटी इरोशन वर्क्स का प्राथमिक प्रस्ताव कौन देता है (Who is likely to propose the embankment maintenance and anti-erosion work)

	Villager / Community	JE / AE	EE / SE	CE and above	DM / MLA etc
Simple works (less than 10 lakhs)	○	○	○	○	○
Moderate works (10 lakhs to 1 Cr)	○	○	○	○	○
Complex work (1 Cr and above)	○	○	○	○	○

बाँध मरम्मत और एंटी इरोशन वर्क्स का तकनीकी प्लान के रीविय़ू में कौन कौन होता है (Who reviews the final proposal for embankment maintenance and anti-erosion work?)

	JE, AE and EE	AE, EE and SE	SE, CE and experts in Patna	CE and Experts in Patna
Simple works (less than 10 lakhs)	○	○	○	○
Moderate works (10 lakhs to 1 Cr)	○	○	○	○
Complex work (1 Cr to 3.5 Cr)	○	○	○	○
Large and Complex work (3.5 Cr and above)	○	○	○	○

बाँध के मेंटेनेंस और एंटी इरोशन वर्क्स प्राथमिक प्रस्ताव से आंके तो प्रस्ताव देने के उपरान्त मरम्मत का काम कितने दिनों में शुरू हो जाता है (When a need for embankment repair / strengthening is formally proposed, how many days will it typically take to eventually start the maintenance or anti-erosion work?)

	Within a month	In 2 months	In 6 months	In a year
Simple works (less than 10 lakhs)	○	○	○	○
Moderate works (10 lakhs to 1 Cr)	○	○	○	○
Complex work (1 Cr to 3.5 Cr)	○	○	○	○
Large and Complex work (3.5 Cr and above)	○	○	○	○

बाँध मरम्मती और निर्माण की विभागीय प्रक्रिया को आप कैसे आंकते हैं? (How do you rate the embankment maintenance and building process of the department?) *

- Mostly right, needs minor improvments
- Works most times, but needs review and many improvements
- Needs review and major changes

नदी कटाव के रोकथाम की विभागीय प्रक्रिया को आप कैसे आंकते हैं? (How do you rate the departmental process of preventing bank erosion?) *

- Mostly right, needs minor improvments
- Works most times, but needs review and many improvements
- Needs review and major changes

कौन से प्रस्ताव बाँध मरम्मती, निर्माण कार्य और एंटी इरोशन वर्क्स की प्रक्रिया को बेहतर बना सकते हैं (Which proposals can improve the embankment maintenance and anti-erosion works?)

	We often do it, can do better	We always do it	Not done, but very much needed	Not needed
Computer record of all maintenance works on any embankment				
Rating of embankments on their risk and maintenace				
Rating of embankments on their quality of construction				
Enabling JE/AE to take more decisions				
Having a field based expert committee to review works				
Involving community to review works				

बाँध मरम्मती और निर्माण कार्य की प्रक्रिया को और किस तरह से बेहतर बना सकते हैं (Which other proposals can improve the embankment maintenance work of the department?)

नदी कटाव से बचाव कार्य की प्रक्रिया को और किस तरह से बेहतर बना सकते हैं (Which other proposals can improve the bank erosion work of the department?)

FMIS के कार्य को आप कैसे आंकते हैं (How do you rate FMIS work)

	partially agree	mostly agree	do not agree
FMIS does timely flood forecasting	○	○	○
FMIS gives useful inundation maps	○	○	○
FMIS needs to be expanded to cover more basins	○	○	○
FMIS is the right begining	○	○	○
FMIS has relevant expertise	○	○	○

FMIS के सुधार के लिए सुझाव दें (Please suggest improvements in FMIS)

विभाग के संस्थागत दृष्टि से महत्त्वपूर्ण प्रश्न अगले पृष्ठ पर (Questions related to institutional strength of WRD on the next page)

विभाग में इन क्षेत्रों में भी किस स्तर की कार्य कुशलता है? (What is the current level of expertise in the department on these aspects ?) *

Rating (1 - low , 2 medium, 3 very high)

	1	2	3
Use of Flood Management Information Systems	○	○	○
Development of Flood Forecasting Models	○	○	○
Environmental and Ecological Expertise	○	○	○
Financial Management Expertise	○	○	○
Internet and IT Expertise	○	○	○
Mechanisms to regularly document and highlight best practices	○	○	○
Expertise in hydrology (example: hydrological modelling, review of hydrology of existing projects)	○	○	○
Remote sensing and GIS techniques	○	○	○
Expertise in project management software and excel modeling	○	○	○
Expertise in data collection and data processing (statistical models for forecasting)	○	○	○
Expertise in designing various structures related to flood management	○	○	○

यदि आदर्श जल संसाधन विभाग की परिकल्पना करें, तो बिहार के हालात के हिसाब से विभाग में किन किन कार्यों में पर्याप्त कुशलता होनी चाहिए ? इसके साथ ही अंकित करें कि बिहार के बिहार में इसका इतना महत्व है? (If one imagines an Ideal Water Resource Department in Bihar, what capabilities must be present in the department? How do you rate the importance of these capabilities for Bihar?

Rating (1 - low , 2 medium, 3 very high)

	1	2	3
Use of Flood Management Information Systems	○	○	○
Development of Flood Forecasting Models	○	○	○
Environmental and Ecological Expertise	○	○	○
Financial Management Expertise	○	○	○
Internet and IT Expertise	○	○	○
Mechanisms to regularly document and highlight best practices	○	○	○
Expertise in hydrology (example: hydrological modelling, review of hydrology of existing projects)	○	○	○
Remote sensing and GIS techniques	○	○	○
Expertise in project management software and excel modeling	○	○	○
Expertise in data collection and data processing (statistical models for forecasting)	○	○	○
Expertise in designing various structures related to flood management	○	○	○

यदि कोई पहलु उपर्युक्त दो प्रश्नों में चर्चित नहीं हैं तो कृपया यहाँ उसका संक्षिप्त विवरण दें (Please give a brief description of any aspect that is not covered in the above two questions)

इनमें से कौन से पहलू हैं जिनपर विभाग तत्परता से काम करता है (What aspects are proactively pursued by the department ?)

Please rate (1 - not properly done, 2 - average, 3 - very good)

	1	2	3
Engaging with educational institutes on research related to flood management	○	○	○
Showcasing the best practices and ideas that are developed internally	○	○	○
Dynamic / Flexible management of staff across various circles, divisions and sub-divisions	○	○	○
Planning for staffing shortages caused by retirements, disability or demise	○	○	○
Rating the contractors based on their level of expertise and performance	○	○	○
Enabling talented and committed employees to develop professionally	○	○	○
Managing the cost-benefit trade-offs related to various flood management projects	○	○	○
Engaging with community in a constructive manner	○	○	○

वह कौन से पहलू हैं जो बिहार के जल संसाधन विभाग को देश के सर्वोत्तम विभागों की श्रेणी में खड़ा करते हैं (What aspects of the department will make it the best in India) *

- [ ] Alertness of the engineers
- [ ] Quality of constructions
- [ ] Knowledge of engineers in flood management
- [ ] Timeliness of work
- [ ] Appreciation of sincere work done by employees
- [ ] Integrity / honesty of the employees
- [ ] Quality of planning and design
- [ ] Financial management
- [ ] Management of assets
- [ ] Other:

किसी बाढ़ प्रभावित क्षेत्र में JE / AE स्तर के कितने कर्मचारी रहेंगे इसका आंकलन किस आधार पर होता है (what is the basis of JE / AE staffing in any flood effected area)

- [ ] Existing department guidelines (16 JE : 4 AE etc)
- [ ] Length of embankment
- [ ] 2 year history of flooding in the region
- [ ] 5 -10 year history of flooding in the region
- [ ] depending on request from EE
- [ ] depending on request from SE, CE or higher level leadership
- [ ] distance from office
- [ ] quality of existing embankment
- [ ] Other:

क्या मौजूदा पदोन्नति की व्यवस्था पर्याप्त है (Is the present promotion setup adequate)

- Absolutely Not
- Needs to be discussed and adequately improved
- Absolutely Yes

यदि कोई और महत्वपूर्ण पहलू है जिसकी अभी तक चर्चा नहीं हुई तो कृपया उसका विवरण दें (Please describe any other aspect that has not been discussed so far)

बाढ़ प्रबंधन के प्रयास में विभाग की प्राथमिकताओं को रैंक करें (Rank department's priorities in flood management)

	Highest (top 2)	High (3 or 4)	Moderate (5 or 6)	Low (7 or 8)
Embankment Maintenance and construction				
Works related to preventing bank erosion				
Saving the villages from flooding				
Monitoring during flood to check embankment breach				
Comprehensive research on flooding in Bihar				
Enabling community to take lead role in flood management				
Interlinking of rivers				
Ensuring work satisfaction among JE and AE level staff				

Annex C: Questionnaire for Householders & Businesses

Survey Code No.

The purpose of this survey is to:

1. Quantify the impact on flood affected households, businesses and industries in flood affected districts in Bihar
2. Identify the level of knowledge held about the flood risks
3. Identify the level and quality of interactions with the WRD on flooding issues
4. Identify the extent and timeliness of flood warnings
5. Identify the level of knowledge held about embankment maintenance and management

District
Block
Name of village

Name(s) of the nearest rivers:

Name of river	Distance from village
1	km
2	km
3	km

Name of respondent(s) to this questionnaire

Name	Position in household

Date
Interviewer's Name (Print clearly)
Interviewer's Signature

Notes

A Is this survey for a householder or for a business owner?

Householder	Business owner	
		(tick)

A1. Background data on householder

1 How long have you lived in the village? _____ years

2 What is your age? _____ years

3

Male	
Female	

4 What is your main language? _____

5 What is your religion? _____

6 Are you married?

Yes	No

How many children?

Male	
Female	

4 What is your main occupation/activity:

	Status	Days employed per year
Farmer/Landowner		
Tenant farmer		
Agricultural laborer		
Skilled laborer		
Unskilled laborer		
Other (specify)		

A2. Background data on business owner

1 What is your business? _____

2 In which year did you establish your business? ☐

3 How long have you lived in the village? ☐ years

4 What is your age? ☐ years

3 Male ☐
Female ☐

5 What is your main language? ☐

6 What is your religion? ☐

B. Flood location and flood risk

1 What is the name of the nearest river? ☐

2 What is the location of your house/business relative to the river?

On the embankment	☐	
Within 500 metres from the river	☐	
Within 1 kilometre from the river	☐	
More than 1 km from the river	☐	Specify approx. Distance ☐
Don't know	☐	

3 Are you in a flood risk area?

Yes	No	Don't know

4 How would you assess the flood risk in your locality?

High	
Medium	
Low	
Other (specify)	

5 How often does the locality flood?

Every year	
Most years	
Some years	
Never	
Don't know	

6 In the last 10 years how often has your locality been flooded? _____ times

7 What is the nature of flooding in your locality?

Direct from rainfall		
Embankment breached due to erosion		
Embankment breached due high water level in river (overtopped)		
Flood flow from upstream location		
Other cause (please give details)		Details:
Don't know		

8 Do you think the flooding:

Can be prevented?		How, any suggestions?
Is an act of God?		
Is something to be lived with?		
Something you can do something about?		If so, what can you do?
Don't think anything can be done		
Not bothered, doesn't affect me or my family?		
Other (please give details)		Other details:

9 Do you think that you could be better protected from flooding?

Yes	No	Don't know

If Yes, how?

_____

_____

C. Flood forecasting and flood warning

1 Does any government agency provide you with information on flooding and flood risk?

Yes	No	Don't know

a). If Yes, which agency or agencies? _____

b.) What information do they provide? _____

c.) When do they provide this information? _____

d.) Is the information useful?

2 Do you get any information on flooding from the radio/TV/newspapers? How useful and timely is the information?

	Source	Usefulness	Timeliness
Radio			
Television			
Newspapers			
Other (specify)			

1=excellent, 2=good,

3 = moderate, 4 = poor,

5 = very poor, 9 = don't know

3 Do you think that the current flood warning system is adequate or not?

What is wrong with the system?

a.

b.

c.

Do you have any suggestions for improvements?

a.

b.

c.

d.

e.

4 Once a warning is provided are you given any help with evacuation?

No warning provided		
No help with evacuation		
Some help with evacuation		Detail:
A lot of help with evacuation		Detail:
Don't know		

5 How would you assess the flood evacuation systems?

1=excellent, 2=good,

3 = moderate, 4 = poor,

5 = very poor, 9 = don't know

6 Do you have a mobile telephone?

Yes	No

a) Would you like to have future flood warnings on your mobile?

b) Would you be prepared to pay for this service?

Yes	No

c) How much? [ ] Rupees/year

7 Do you have any other comments or suggestions for flood warning and flood evacuation?

_____

_____

_____

_____

_____

_____

_____

D. Flood preparedness and mitigation

1 Which government department is responsible for flood prevention?

_____

9 = Don't know

2 a) Do you know any WRD staff personally?

Yes	No

9 = Don't know

b) If Yes, who do you know and in what capacity?

---

3 a) Have you ever interacted with the WRD?

Yes	No

9 = Don't know

b) If Yes, when and in what way?

---

4 a) What is your understanding of the work that WRD do? Please describe it:

---

b) How well do you think they do these tasks?

1=very well, 2=well

3 = adequately, 4 = poor,

5 = very poor, 9 = don't know

c) What do they need to do better?

5 a) Are there any flood defence works in your locality?

Yes	No

9 = Don't know

b) What are these works?

Embankments	
River groynes	
Other (specify)	

c) What is your opinion about the condition of these works?

1= very well maintained, 2=well maintained

3 = adequately maintained, 4 = poorly maintained,

5 = very poor maintained, 9 = don't know

d) Do you ever inspect the flood protection works?

Yes	No

9 = Don't know

- If Yes, how frequently?

_____

e) Have you ever commented or complained about the condition of the flood protection works?

Yes	No

9 = Don't know

- If Yes, when and to whom?

_____

6 Do you have any suggestions on how floods can be prevented or reduced in your locality?

_____

_____

_____

E. Flood events

1 Have you ever been affected by a flood?

Yes	No

9 = Don't know

2 How many times in the last 10 years?

Once	
Twice	
More than twice	
Every year	

3 Please summarise the flood event (up to 4 events):

	Year	How severe?	Duration (days)	Type of flood
1.				
2.				
3.				
4.				
		1=very bad, 2=bad, 3 = moderate impact, 4 = little impact		*1=Heavy rainfall 2 = embankment breach*

5 = no impact, 9 = don't know

3 = overland flow

9 = don't know

4 Please describe one flood event:

a) Year of flood		
b) How severe was the flood?		
c) What duration?		
d) Type of flood?		
e) Were you given any warning (Yes/No)?		By whom?

f) What happened?

g) Did you have to leave your home/business (Yes/No)?

- For how long? days

h) **Householder only** - Did you lose any assets?

Estimated value of lost

Notes

items (Rs)

House			
Household goods			
Crops			
Livestock			
Motorbike			
Vehicle			
Other (specify)			

i) **Householder only** -Was your income affected by the flooding (Yes/No)?

Yes	No

9 = Don't know

- Please describe how:

j) **Businesses only** - Did you lose any assets?

		Estimated value of lost items (Rs)	Notes
Business property			
Business goods			
Business vehicle(s)			
Motorbike			
Vehicle			
Other (specify)			

i) Was your income affected by the flooding (Yes/No)?

Yes	No

9 = Don't know

- Please describe how:

j) Have you been able to recover from the flood?

Completely	
Moderately well (>70%)	
Partially (>50%)	
Not well (<50%)	
Not at all (0%)	

k) Did you get any assistance during the flood?

Yes	No

9 = Don't know

- From who and in what form?

l) Did you get any assistance after the flood?

Yes	No

9 = Don't know

- From who and in what form?

5 Does the community work together during flood events?

Yes	No

9 = Don't know

a) If Yes, please describe how:

b) If No, please describe why not:

6 Do you expect to get flooded again in the future?

Yes	No

9 = Don't know

- If Yes, what are you doing about it?

7 Other comments or suggestions:

F. Flood relief and recovery

1 a) Have you ever been given help with flood relief?

Yes	No

9 = Don't know

b) If Yes, please describe when, by whom and nature of help given:

c) Was this help adequate?

Yes	No

9 = Don't know

d) If not, why not?

_____

_____

_____

_____

a) Following a flood event have you had to borrow additional money in order to recover from the

2 flood?

Yes	No

9 = Don't know

b) From whom did you borrow the money, and at what interest rate?

_____

_____

_____

c) Have you been able to pay the money back?

Yes	No

9 = Don't know

3 a) Did the government provide any assistance to the community following flooding?

Yes	No

9 = Don't know

b) What was the nature of this assistance (new buildings, shelters, etc.)?

_____

4 a) Does the community work together to rebuild the damage following a flood event?

Yes	No

9 = Don't know

b) If Yes, describe work done/help provided:

c) If No, why does the community not work together?

5 Can you provide any suggestions for improving flood relief and recovery?

Annex D: Bagmati Basin Village Profiles

Village 1

1. Experience with floods: The nearest river from this village is Manushmara to which large quantities of water rush from Nepal in the rainy season and floods the village. The other two main reasons for flooding in this village are:

(i) There is large quantity of siltation at the point where Manushmara meets the Bagmati and checks the flow of the river.

(ii) Near Belsand (Pachhiyari Math) the ring embankment had been breached in 2002 and since then there has been flooding. Occurs regularly in this village.

2. Village Name: Kune
3. Block: Belsand
4. District: Sitamarhi
5. River Basin: Bagmati
6. Location of village: Outside but not near to the embankment
7. Distance from District Headquarter: 30 km
8. Distance from Block Headquarter: 3 km
9. No. of Household (Caste wise):

Sl. No.	Name of Caste	No. of H. Hold	Sl. No.	Name of Caste	No. of H. Hold
1	Yadav	200			
2	Sonar	50			
3	Bhumihar	10			
4	Dom	13			
5	Chamar	13			
6	Baniya	07			
7	Lohar	03			
Total		296			

Total Population: 1465

Main Crops: Paddy& Wheat

Percentage of households dependant on Agriculture: 80%

Village 2

1. Experience with floods: Villagers are united around the issue of the safety of the embankment. In the rainy season whenever water pressure increases on embankment villagers divide themselves into groups for undertaking safety work of embankments.

2. Village Name: Rampur Kanth

3. Block: Suppi

4. District: Sitamarhi

5. River Basin: Bagmati

6. Location of village: Some part of the village is outside but near the embankment & some parts are on the embankment.

7. Distance from District Headquarter: 25 KM

8. Distance from Block Headquarter: 10 KM

9. No. of Household (Caste wise):

Sl. No.	**Name of Caste**	**No. of H. Hold**	**Sl. No.**	**Name of Caste**	**No. of H. Hold**
1	Surhi	75	8	Chamar	04
2	Dusadh	50	9	Dhobi	04
3	Brahmin	25	10	Nai	02
4	Kayasth	15	11	Mali	02
5	Kanu	17	12	Koiri	04
6	Yadav	10	13	Tatwa	05
7	Chanou	07	14		
Total		**199**	**Total**		**21**

10. Total Population: About - 1000

11. Main Crops: Paddy and sugar cane

12. Percentage of Households depends upon Agriculture: 90 %

Village 3

1. Experience with floods: For about 4 months in a year this village is not accessible.
2. Village Name: Benipur Dakshin
3. Block: Aurai
4. District: Muzaffarpur
5. River Basin: Bagmati
6. Location of village: Under the embankment
7. Distance from District Headquarter: 28 KM
8. Distance from Block Headquarter: 8 KM
9. No. of Household (Caste wise):

Sl. No.	**Name of Caste**	**No. of H. Hold**	**Sl. No.**	**Name of Caste**	**No. of H. Hold**
1	Bhumihar	200	8	Kumhar	08
2	Mallah	50	9		
3	Dhanuk	10	10		
4	Nai	10	11		
5	Tatma	20	12		
6	Chamar	10	13		
7	Musahar	07	14		
Total		**307**	**Total**		**08**

10. Total Population: 1400
11. Main Crops: Khesari
12. Percentage of Households depends upon Agriculture: 50%

Village 4

1. Experience with floods: This village is situated within the embankments of national highways. The main problem of this village is water logging. There is no provision for water drainage. No drainage work was taken up by the govt. or by community.

2. Village Name: Janarh

3. Block: Aurai

4. District: Muzaffarpur

5. River Basin: Bagmati

6. Location of village: outside but near the embankment

7. Distance from District Headquarter: 25 KM

8. Distance from Block Headquarter: 14 KM

9. No. of Household (Caste wise):

Sl. No.	**Name of Caste**	**No. of H. Hold**	**Sl. No.**	**Name of Caste**	**No. of H. Hold**
1	Brahmin	225	8	Ravidas	50
2	Vaishya	100	9	Dhobi	60
3	Surhi	100	10	Dusadh	70
4	Mandal	50	11	Musahar	50
5	Sahani	60	12	Dom	40
6	Lohar	75	13		
7	Takur	40	14		
Total		**650**	**Total**		**270**

10. Total Population: 5000

11. Main Crops: Paddy, Wheat, & Sugarcane

12. Percentage of Households depends upon Agriculture: 50%

Annex E: Kosi Basin Village Profiles

Village 1

1. Experience with floods: This village is situated within embankments of national highways. The main problem of this village is water logging.

2. Village Name: Laukaha

3. Block: Saraigarh Bhaptiyahi

4. District: Supaul

5. River Basin: Kosi

6. Location of village: Under the embankment

7. Distance from District Headquarter: 45 KM

8. Distance from Block Headquarter: 13 KM

9. No. of Household (Castewise):

Sl. No.	**Name of Caste**	**No. of H. Hold**	**Sl. No.**	**Name of Caste**	**No. of H. Hold**
1	Yadav	250	8	Bantar	04
2	Muslim	100	9		
3	Halwai	70	10		
4	Khatwe (Chaupal)	70	11		
5	Koyari	30	12		
6	Chamar	10	13		
7	Teli	10	14		
Total		**540**	**Total**		**04**

10. Total Population: 2500

11. Main Crops: wheat

12. Percentage of Households depends upon Agriculture: 40 %

Village 2

1. Experience with floods: Before 2008 this village was situated by the banks of the River Hohiya. During the 2008 Kosi floods, a new channel of the Kosi is now flowing along this village. All agricultural fields are still full of silt due to the flood.

2. Village Name: Mansi Piprahi

3. Block: Basantpur

4. District: Supaul

5. River Basin: Kosi

6. Location of village: Outside but not near the embankment

7. Distance from District Headquarter: 85 KM

8. Distance from Block Headquarter: 5 KM

9. No. of Household (Castewise):

Sl. No.	**Name of Caste**	**No. of H. Hold**	**Sl. No.**	**Name of Caste**	**No. of H. Hold**
1	Kewat (Mandal)	133	8		
2	Yadav	62	9		
3	Rajput	05	10		
4			11		
5			12		
6			13		
7			14		
Total		**200**	**Total**		

10. Total Population: 900

11. Main Crops: Paddy, Wheat, & Pastan

12. Percentage of Households depends upon Agriculture: 25%

Village 3

1. Experience with floods: The main problem of this village is water seepage due to the River Kosi. All agricultural operations of this village have halted due to seepage of water.

2. Village Name: Kodhli

3. Block: Saraygarh Bhaptiyahi

4. District: Supaul

5. River Basin: Kosi

6. Location of village: Outside but near the embankment

7. Distance from District Headquarter: 48 KM

8. Distance from Block Headquarter: 14 KM

9. No. of Household (Castewise):

Sl. No.	**Name of Caste**	**No. of H. Hold**	**Sl. No.**	**Name of Caste**	**No. of H. Hold**
1	Yadav	225	8	Teli	03
2	Chamar	50	9	Barhai	02
3	Mallah	40	10		
4	Bantar	05	11		
5	Koiri	06	12		
6	Amartya (Roy)	03	13		
7	Dom	04	14		
Total		**333**	**Total**		**5**

10. Total Population: 1250

11. Main Crops: Paddy & Wheat

12. Percentage of Households depends upon Agriculture: 50%

Village 4

1. Experience with floods: About 40-50 households are living under the embankment just beside the River Kosi. This village is affected by floods and water seepage.

2. Village Name: Kalyanpur

3. Block: Saraigarh Bhaptiyahi

4. District: Supaul

5. River Basin: Kosi

6. Location of village: both sides of the embankment

7. Distance from District Headquarter: 32 KM

8. Distance from Block Headquarter: 07 KM

9. No. of Household (Castewise):

Sl. No.	**Name of Caste**	**No. of H. Hold**	**Sl. No.**	**Name of Caste**	**No. of H. Hold**
1	Koiri	200	8	Chamar	20
2	Muslim	120	9	Khatwe	20
3	Yadav	50	10	Barhai (Carpenter)	10
4	Mallah	50	11	Nai	10
5	Dhobi	30	12	Dusadh	10
6	Teli	30	13	Sardar (Bantar)	04
7	Musahar	25	14		
Total					**579**

10. Total Population: 3000

11. Main Crops: Wheat, Paddy (Garma), Paddy (Aghani) & Makhana

12. Percentage of Households depends upon Agriculture: 40%

Annex F: Mahananda Basin Village Profiles

Village 1

1. Experience with floods: Prior to 2011, there used to be annual floods that came through Kachaura where the embankment is located. In 2011, Kachaura embankments were repaired and now this village is safe from floods. However, most of the villagers were not satisfied with maintenance of the embankments.

2. Village Name: Kathghar Durgapur

3. Block: Pranpur

4. District: Katihar

5. River Basin: Mahananda

6. Location of village: outside but near the embankment

7. Distance from District Headquarter: 35 KM

8. Distance from Block Headquarter: 5 KM

9. No. of Household (Castewise):

Sl. No.	**Name of Caste**	**No. of H. Hold**	**Sl. No.**	**Name of Caste**	**No. of H. Hold**
1	Mallah	175	10	Chain (Mandal)	30
2	Yadav	100	11	Chamar	10
3	Kaivarth	200	12	Dusadh	8
4	Dom (Hari, ST)	80	13	Dom	8
5	Kisan (Bangali)	300	14	Rajput	5
6	Kumhar	70	15	Teli	5
7	Baniya	50	16	Turi	6
8	Chunari	50	17	Nai	5
9	Sonar	35			
Total					**1137**

10. Total Population: 5000

11. Main Crops: Wheat, Maize, Garma Paddy, &Oilseeds

12. Percentage of Households depends upon Agriculture: 50%

Village 2

1. Experience with floods: This village is located within the embankments. The riverside embankment (ring embankment) has been breaching since 2009 in this village. This village experiences floods from both the Rivers Ganga and Mahananda.

2. Village Name: Lakhitola

3. Block: Amdabad

4. District: Katihar

5. River Basin: Mahananda

6. Location of village: outside but near the embankment

7. Distance from District Headquarter: 65 KM

8. Distance from Block Headquarter: 5 KM

9. No. of Household (Castewise):

Sl. No.	**Name of Caste**	**No. of H. Hold**	**Sl. No.**	**Name of Caste**	**No. of H. Hold**
1	Sosath Bangali	50	8	Kahar	5
2	Dusadh	45	9	Chain (Mandal)	8
3	Chamar	35	10	Nai	6
4	Bind	24	11		
5	Dhobi	15	12		
6	Mallah	10	13		
7	Brahmin	10	14		
Total					**208**

10. Total Population: 1132

11. Main Crops: Wheat, Maize, & Patsan

12. Percentage of Households depends upon Agriculture: 30%

Village 3

1. Experience with floods: Lobha village is extensively affected by floods from the Mahananda River. About 20 households are living within the embankments & the remaining outside. Main occupation of the villagers is fisheries and there is large scale migration from this village to Delhi, Punjab, etc.

2. Village Name: Lalganj (Bhagat Tola)

3. Block: Pranpur

4. District: Katihar

5. River Basin: Mahananda

6. Location of village: both sides of the embankment

7. Distance from District Headquarter: 28 KM

8. Distance from Block Headquarter: 04 KM

9. No. of Household (Castewise):

Sl. No.	**Name of Caste**	**No. of H. Hold**	**Sl. No.**	**Name of Caste**	**No. of H. Hold**
1	Kharwar (ST)	60	8		
2	Parihar	20	9		
3	Yadav	10	10		
4	Dhobi	10	11		
5					
6					
7					
Total		**100**			

10. Total Population: 625

11. Main Crops: Wheat, Jute, & Garma Paddy

12. Percentage of Households depends upon Agriculture: 30%

Village 4

1. Experience with floods: This village is spread into two Gram Panchayats. One is Durgapur & the other is South Amdabad. About five years ago, this village was flooded from the Ganga River due to an embankment breach between Golaghat & Babulbanna.

2. Village Name: Bholamari

3. Block: Amdabad

4. District: Katihar

5. River Basin: Mahananda

6. Location of village: outside but near the embankment

7. Distance from District Headquarter: 50 KM

8. Distance from Block Headquarter: 3 KM

9. No. of Household (Castewise):

Sl. No.	**Name of Caste**	**No. of H. Hold**	**Sl. No.**	**Name of Caste**	**No. of H. Hold**
1	Muslim (Shershahbadi)	400	8		
2	Muslim (Shaikh)	100	9		
3	Chausat Bangali	200	10		
4	Dusadh	10	11		
5	Mallah	30	12		
6	Yadav	35	13		
7			14		
Total		**775**			

10. Total Population: 5000

11. Main Crops: Wheat, Patsan, Maize, and Garma Paddy

12. Percentage of Households depends upon Agriculture: 40%

Annex G: Focus Group Discussion Questions

I. Past experiences with floods

- **a.** What have been the causes of the flood in your area – rainfall, embankment breach or water released suddenly from upstream?
- **b.** What has been the frequency of floods?
- **c.** Were you warned about flood? Who warned you and how much time did you have on hand?
- **d.** What was the extent of damages from past floods (most recent)?
- **e.** Which groups do you think are most vulnerable to floods?
- **f.** What coping mechanisms do you utilize?
- **g.** Over the years have you seen the frequency/intensity of floods increase or decrease?

II. Community experiences with embankments

- **a.** What is the length of embankment in your village?
- **b.** Are the embankments well maintained?
- **c.** Have the river behaviour changed in recent times? How has the embankment affected your village?

III. Assessment of flood anti-erosion works in village

- **a.** How often do you see WRD officers doing anti-erosion or other flood management work here?
- **b.** Is the work scheduled automatically by WRD or do you have to request again and again?
- **c.** Do you have any say in the quality of work that is done?

IV. Assessment of community interactions with WRD officers before, during, and after floods

- **a.** How often do WRD officers visit the village?
- **b.** Do they discuss the problems with you and take your suggestions?
- **c.** Are you satisfied with the solutions that they have provided?
- **d.** Are they adequately knowledgeable about the work? Are they efficient and alert?
- **e.** How was your interaction with WRD during and after floods?

V. Community participation for flood management in the village

- **a.** Is your community by themselves prepared for future floods – do many people know swimming, especially women, is there a clearly marked high point known to everyone, do many people know first aid for drowning, snake-bites, other flood related accidents?
- **b.** What initiatives has your village taken towards flood management independent of Government?
- **c.** What are the danger symptoms about which you will promptly inform the Government at times of flooding possibility?
- **d.** What fears do you have about future flooding – do you think your village is at high risk, are you adequately prepared?

Annex H: FMIS Questionnaire

1. What is the purpose of FMIS?

2. What is the funding? Is this short term or long term? Externally or internally funded?

3. What is the organisational structure? How is it linked into the WRD? Is it in the main WRD building? Is it seen as an integral part of WRD, or a separate project supported entity? Please provide the FMIS Organizational Chart

4. What is the staffing – permanent government staff or contract staff?

5. Are the staffing levels sufficient for the work that needs to be carried out?

6. What tasks do they carry out?

7. What are the key issues that they are currently facing? What issues have they faced?

8. What is their linkage to other organisations – Disaster Management Department (DMD), Agricultural Department?

9. What processes and procedures do they follow during the flood season? How do they monitor floods, flood events, etc? Who do they liaise, work with, etc. during this period?

10. Who do they share/send information to on flood events. How frequently?

11. Do they have any systems for communicating information to Panchayats or villagers?

12. What is the staff training and capability in staff management?

13. What is the role of the Flood Management Improvement Support Centre (FMISC)? What is its staffing?

Annex I: List of Participants for WRD Introductory Workshop

S. No.	Name	Designation	WRD Unit
1	Randhir Kumar Sinha	Executive Engineer	Flood Monitoring of Flood Protection Works
2	Jawahar Lal	Superintending Engineer	Flood Control Circle, Patna
3	Rabindra K. Shanker	Executive Engineer	Flood Control Planning & Monitoring Division, Patna
4	Dinesh Prasad	Executive Engineer	Flood Control Planning & Monitoring Division, Patna
5	Girnanad Singh	Assistant Engineer	Flood Control Planning & Monitoring Division, Patna
6	Sanjay Kumar Tiwari	Assistant Engineer	Flood Control Planning & Monitoring Division, Patna
7	Jamil Ahmed	Assistant Engineer	Flood Fighting and Anti-Erosion Works of Chief Engineer Siwan
8	Priya Shankar	Assistant Engineer	Flood Control Planning & Monitoring Division, Patna
9	Shashi Ranjan Kumar Pandey	Assistant Engineer	Flood Control Planning & Monitoring Division, Patna
10	Rajesh Kumar	Assistant Engineer	Flood Control Planning & Monitoring Division, Patna
11	Rajesh Kumar Thakur	Assistant Engineer	Flood Monitoring Cell
12	Subodh Kumar	Assistant Engineer	Flood Control Planning & Monitoring Division, Patna
13	Hare Ram Singh	Assistant Engineer	Flood Control Planning & Monitoring Circle, Patna

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