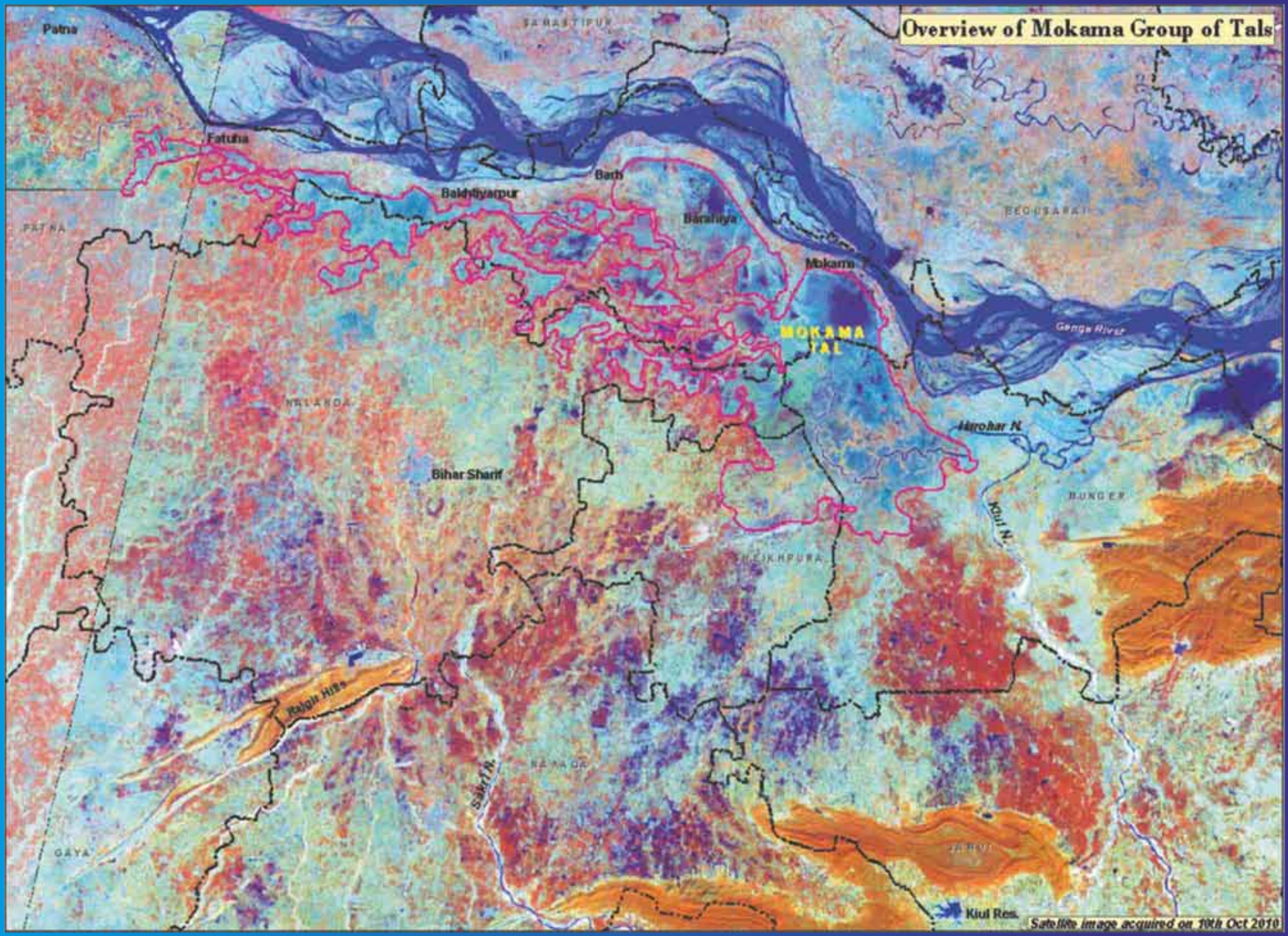
fmisc
Bihar

Flood Management Improvement Support Centre

Towards a Culture of Preparedness for Better Flood Management

Flood Report 2012

Water Resources Department
Government of Bihar


Overview of Mokama Group of Tals
Patna
Fatuha
Bakhtiyarpur
Barahiya
Mokama
MOKAMA TAL
Ganga River
Harohar N.
Bihar Sharif
Kiul N.
Rajgir Hills
Sakri N.
Kiul Res.
Satellite image acquired on 10th Oct 2010

Foreword

This gives me immense pleasure to present the end of the season **'Flood Report 2012'** which has been prepared by Flood Management Improvement Support Centre. This is the sixth annual report since its inception in the year 2007. Flood Management Improvement Support Centre (FMISC) has been set up under the aegis of Water Resources Department with the objective of improving the flood management practices in the State by introducing the use of latest modern techniques like Remote Sensing, Geographic Information System (GIS) and modeling. The report gives an account of 2012 floods in detail and deliberates the usefulness of modern technological tools like GIS and Remote Sensing in Flood Management.

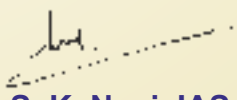
Like every year, FMISC, functioned in an emergency mode from 15 June to 15 October 2012 to monitor the rainfall and consequential flood events in the catchment of all the rivers coming in the purview of its focus area comprising of 24 districts. As usual, information and data regarding observed rain-fall, 3 day rain-fall forecast, river gauge levels, trend forecast of CWC and WRD gauge sites within highly flood prone districts were collected and posted in FMIS website and also sent to National Remote Sensing Centre, Hyderabad which in turn, delivered near real time satellite imageries and inundation layers. Based on the received data, flood inundation maps and other value added maps were prepared and disseminated to all stakeholders.

On the flood front, Gandak remained in spate since the beginning of monsoon and kept on exerting pressure on both its embankments. The incessant pressure on Gandak right embankment, especially in Pipra-Piprasi reach was so enormous that round the clock vigil and protection work had become necessary. Similarly, continuous high level of Ganga exerted pressure on some of the protecting structures along its left bank in Bhagalpur, Vaishali and Samastipur districts. Ismailpur Bindtoli Embankment on left bank of river Ganga; situated downstream from Vikramshila setu in Bhagalpur district suffered immense pressure. FMISC prepared probable inundation maps at both Pipra-Piprasi and Ismailpur Bindtoli erosion sites to alert administration for any eventualities that could have occurred due to a possible breach on these sites. Eventually, nothing serious happened and the embankments were saved with the untiring effort by the engineers of the department. There were threats to flood protection works at Raghopur- Khairpur site on the left bank of Ganga upstream of Vikramshila setu in Bhagalpur district and at left bank of river Ganga at Chandpur-Dhamaun-Rasalpur site in Samastipur district as well, which were successfully rescued.

Other than Disaster Management Department, FMISC provided support to Technical Advisory Committee (TAC), Water Resources Department, GoB by providing assistance with the satellite images of pre-flood and post-flood scenarios showing changes in the river regime of major rivers of north Bihar like Gandak, Kosi, Kamla, Bagmati, Burhi Gandak and some stretches of Ganga in planning the anti-erosion and river training works to be undertaken before the flood of 2013. FMISC also helped GFCC in clearing large schemes with the FMIS inputs in the form of latest satellite pictures.

The report also includes a brief history of floods in the FMIS focus area from year 2000 to 2012 and brief details of FMIS Phase 2 undertaken by FMISC at present.

FMISC is on move keeping its eyes set on its motto, ***"towards a culture of preparedness for better flood management."***



S. K. Negi, IAS
Principal Secretary,
Water Resources Department,
Govt. of Bihar

Acknowledgement

The end of the season 'Flood Report, 2012' is ready for publication and I am extremely happy to acknowledge the untiring and meticulous effort put forth by FMISC team in preparing this Report in time.

FMISC is running two projects simultaneously, the first one is **FMIS Phase 2** and another one is **Bihar Kosi Flood Recovery Project.** The *World Bank* is the driving and guiding force in both the projects. The Bank is supporting us not only financially but is providing a lot of opportunities in our capacity building, technical assistance and knowledge enhancement. The contribution of World Bank is highly acknowledged. We specially thank Dr. Winston Yu, Task Team Leader, Dr. S. Rajagopal and Dr. S.T. Chari, both WB Consultants not only for their continued support in implementing the FMIS Phase 2 Programme but also for their sustained help during our US study tour. In this regard, Dr. S. Rajagopal, Consultant and former Sr. Water Resources Specialist, WB and Ms. Natalie Giannelli, Water Resources Specialist, WB, deserve special mention. We also heartily thank another WB Team, Mr. Deepak Singh, Task Team Leader and Sr. Disaster Risk Management Specialist, Mr. Joop Stoutjesdijk, Lead Irrigation Engineer and Mr. Prabir Joardar, Water Resources Consultant in steering the Bihar Kosi Flood Recovery Project.

I sincerely thank National Remote Sensing Centre, Hyderabad, India Meteorological Department, Delhi and Patna, Central Water Commission, Ganga Flood Control Commission, Disaster Management Department, Agriculture Department of GoB, NIH Patna centre and NIT, Patna for their continued support and working in unison. The representatives of these organizations are on board of many of our Technical Review and Advisory Committees.

My sincere thanks are to Flood Monitoring Circle, WRD for providing us useful information and valuable suggestions in different activities being undertaken at FMISC.

I express my heartfelt gratitude to Mr. S. K. Negi, IAS, Principal Secretary, WRD; Mr. Afzal Amanullah, IAS, former Principal Secretary, WRD; Mr. Narmadeshwar Lal, IAS, Project Director, BAPEPS and Mr. Ajay Yadav, IAS, Ex Project Director, BAPEPS, who always enlightened, inspired and supported the FMISC team in achieving its objectives and goals.

Finally, I express my sincere and deepest gratitude to Shri Vijay Kumar Choudhary, Hon'ble Minister, Water Resources Department, Government of Bihar, for his guiding vision and encouraging support.

(Ajit Kumar Samaiyar)
Joint Director
FMISC, Patna

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LIST OF MAPS

Acronyms

ALTM	Airborne Laser Terrain Mapper
AOI	Area of Interest
ASAR	Airborne Synthetic Aperture Radar
AWiFS	Advance Wide Field Sensor
CWC	Central Water Commission
DEA	Department of Economic Affairs
DEM	Digital Elevation Model
DFID	Department For International Development
DOES	Directorate of Economics and Statistics
DL	Danger Level
DMD	Disaster Management Department
DMSP	Disaster Management Support Program
DRF	Daily Rainfall
DSC	Decision Support Centre
EAMS	Embankment Asset Management System
FMIS	Flood Management Information System
FMISC	Flood Management Improvement Support Centre
GDP	Gross Domestic Product
GSDP	Gross State Domestic Product
GFCC	Ganga Flood Control Commission
GIS	Geographic Information System
GoB	Government of Bihar
GoI	Government of India
GoN	Government of Nepal
HFL	Highest Flood Level
IMD	India Meteorological Department
LISS	Linear Imaging Self Scanning
LiDAR	Light Detection and Ranging
LPA	Long Period Average
MODIS	Moderate Resolution Imaging Spectroradiometer
NRSC	National Remote Sensing Centre
RS	River Stage
RTDAS	Real Time Data Acquisition System
SRTM	Shuttle Radar Topography Mission
TAC	Technical Advisory Committee
TOR	Terms of Reference
WRF	Weather Research and Forecasting
WGS 84	World Geodetic System 1984
WiFS	Wide Field Sensor
WRD	Water Resources Department

1.0 Preamble

Flood Management Improvement Support Centre (FMISC), Patna, like previous five years in sequence, presents the end of the season **'Flood Report 2012'**. This is the sixth in line since its inception. The focus area of FMISC now includes entire north Bihar covering all 21 districts and three districts of Patna, Bhagalpur and Munger adjoining river Ganga in south Bihar in FMIS Phase 2. This year, like last year, the rainfall was almost normal. Naturally, both kharif and rabi crops are expected to be good. This is worth noting that Bihar has won the prestigious "Krishi Karman Award" for the production of paddy this year.

Even at the flood front, the situation was, by and large, normal and less eventful than previous year. Gandak remained in spate since the beginning of monsoon and kept on exerting pressure on both its embankments. The incessant pressure on Gandak right embankment, especially in Pipra-Piprasi reach was so enormous that round the clock vigil and protection work had become necessary. The problem was accentuated by eroded length of spur at Dhuniawapatti at 26.75 km of PP right embankment. FMISC even prepared a probable inundation map in anticipation of possible threat to this portion of the embankment in the month of August. Gandak remained furious all through the early months of monsoon.

Heavy rain in the catchment of Burhi Gandak resulted in overbank flow in smaller rivers and rivulets causing some flash floods in West Champaran, where overtopping on railway track was reported at Sikta railway station.

Continuous high level of Ganga exerted pressure on some of the protecting structures along its left bank in Bhagalpur, Vaishali and Samastipur districts. Ismailpur Bindtoli Embankment on left bank of river Ganga; situated downstream from Vikramshila setu in Bhagalpur district suffered immense pressure and was almost on the verge of collapse between spur no. 5-6. Another probable inundation map was prepared to alert administration for any eventualities that could have occurred due to a possible breach on this site. Incessant threat on the left bank of Ganga upstream of Vikramshila setu at Raghopur- Khairpur site kept the department on its toes. The dowel at left bank of river Ganga at Chandpur-Dhamaun-Rasalpur in Samastipur district had to be strengthened continuously to save it from breach/overtopping.

This report, like previous years' reports has last thirteen years' flood history in short including flood events of this year. Hydrologic analyses, comparison between observed rainfall and three days' forecasted rainfall, and isohyets maps based on rainfall record have been prepared to better understand the rainfall pattern. Key information products with other important maps like *maximum inundation extent map*, *flood intensity map* along with *value added inundation maps* have also been included and analyzed in this report. A brief report on the components of FMIS phase 2 has also been added.

This year, too, flood calendar has been published by Water Resources Department and is being strictly followed. FMISC like previous years, has supported actively in deciding the anti-erosion works for the year 2013 flood with the help of satellite imageries.

Under Capacity Building activity of the FMIS Phase 2 project, a study tour to USA was undertaken by four officers of WRD from 20th June to 2nd July this year on the invitation of FMIS

Phase 2 Task Team Leader Dr. Winston Yu. The purpose of the tour was to get the know-how of ***maintenance and up-keeping of embankments in USA,*** and the tools used for this purpose, like *levee inspection tools, levee screening tools*, ***national levee database*** etc. and the activities undergoing in United States Army Corps of Engineers (USACE) and United States Geological Survey (USGS), both leading organizations engaged in the flood management activities in USA. The experiences were rich enough and some suggestions have been made to the department based on these experiences. Like ***national database*** of embankments in USA, a similar database of embankments in Bihar can also be prepared. We are contemplating this activity under EAMS activity of FMIS Phase 2.

Another study tour was taken up under Bihar Kosi Flood Recovery Project to Bangladesh. The team visited Institute of Water Modeling (IWM), Centre for Environmental and Geographic Information Services (CEGIS) and Flood Forecasting and Warning Centre (FFWC) at Dhaka. The objective of the tour was to collect a first hand concept which can be helpful in setting up Centre of Excellence in Water Resources Department, Bihar at Birpur.

FMISC website; highly acclaimed all across, is being improved further by a web hosting infrastructure, which includes a web server, database server and NAS (Network Attached Storage) media. This will effectively manage the heavy load on the website during peak hours, and ensure effective availability and performance.

FMISC, in addition to FMIS Phase 2 implementation programme, has also been assigned to take up implementation of **Bihar Kosi Flood Recovery Project** under **Bihar Aapda Punarniwas Evam Punarnirman Society (BAPEPS).** This society is under the administrative control of the State Planning and Development Department and have a Project Management Unit (PMU) responsible for the implementation of the Project. Component C of the project (BKFRP) is for WRD under which **"Strengthening Flood Management Capacity focusing on building capacity on flood forecasting, flood erosion management and limited structural measures in Kosi basin"** are being undertaken by FMISC**.** 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 will be achieved by implementing both structural and non-structural measures, mainly focusing on the Kosi River Basin, along with several activities benefitting flood management in the state as a whole.

2.0 Profile of FMIS Focus Area and Socio-Economic Profile of Bihar

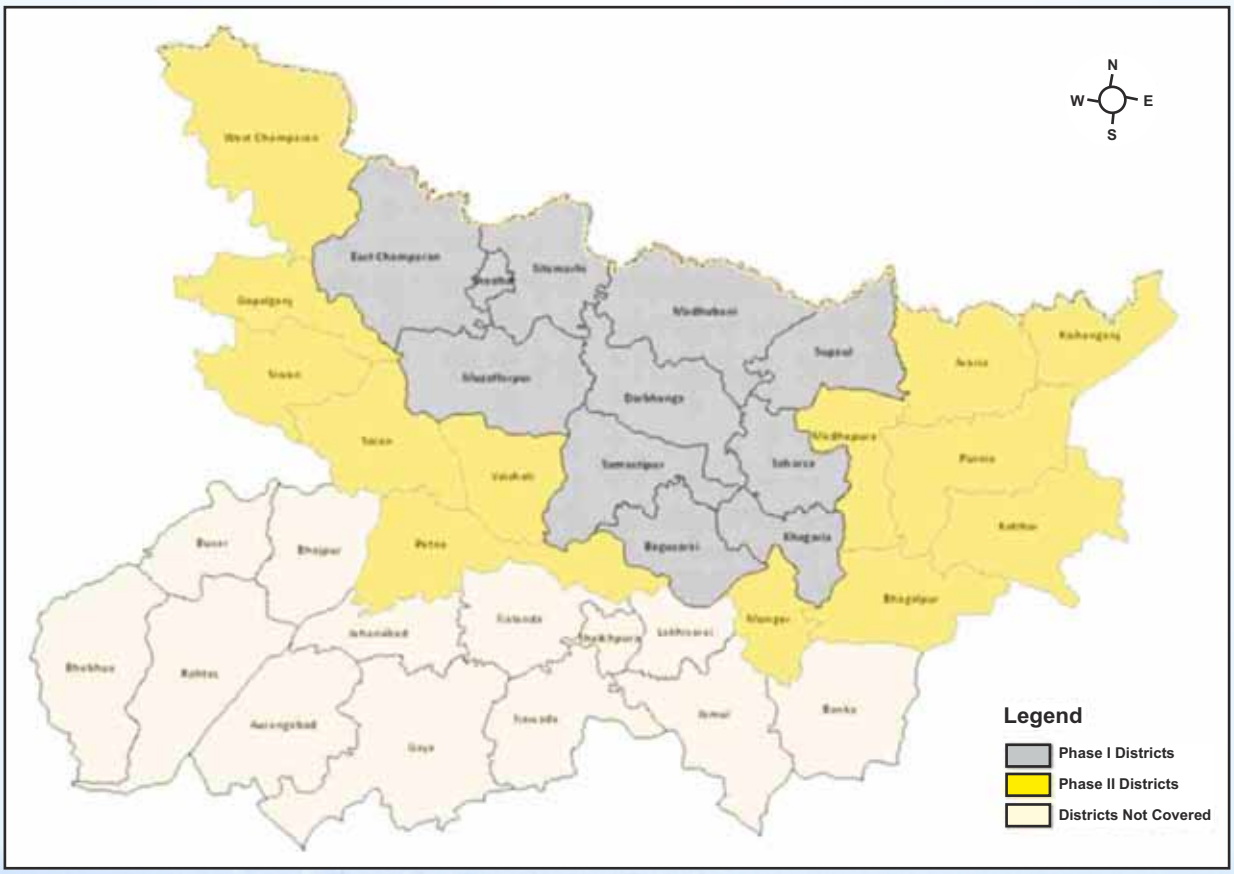
2.1 Profile of FMIS Focus Area

FMIS focus area covers the most flood prone districts in the State consisting of all the 21 districts of north Bihar and 3 districts adjoining river Ganga in south Bihar viz Patna, Munger and Bhagalpur as shown in the map 2.1.

The area is bounded by Himalayan foot hills and terai region of Nepal in the north, Mahananda on the east, river Ganges on the south and river Ghaghra on the west. The area comprises of rich alluvial plains of Indo-Gangetic plain. It comprises the tract of alluvial plains north of Ganga, falling between the Ganga and Indo-Nepal border having general slope from north-west to south-east and is drained by the rivers Ghaghra, Gandak, Burhi Gandak, Bagmati- Adhwara group of rivers, Kamla-Balan, Kosi and Mahananda which finally drain into the river Ganga.

2.2 The Geographical Features of Bihar and Focus Area

Bihar lies between latitude $24^0$20'10" N to $27^0$31'15" N and longitude $83^0$19' 50" E to 88^0 17' 40" E. The total geographical area of Bihar is 94,163 sq.km. The FMIS focus area comprising 21 districts in north Bihar and 3 districts (adjoining river Ganga) of south Bihar for phase II lies approximately between latitude $27^0$32'7" N to $24^0$53'2" N and longitude $83^0$47'15" E to $88^0$16'5" E with the geographical area of about 60119 sq. km. The geographical coverage is as shown in the figure below and the colored area is FMIS focus area.



Map 2.1 Focus Area of FMIS (All 21 districts of north Bihar & 3 districts of south Bihar)

The total geographical area of north Bihar is approximately 52928 sq. km. comprising of 21 Districts namely Muzaffarpur, East Champaran, Sitamarhi, Seohar, Saharsa, Supaul, Darbhanga, Madhubani, Khagaria, Samastipur, Begusarai, Araria, Madhepura, Purnea, Katihar, Kishanganj, Saran, Gopalganj, West Champaran, Vaisali and Siwan, all of which are covered under the FMIS Focus Area.

The geographical area in south Bihar is approximately 41235 sq. km. comprising 17 districts namely Rohtas, Buxar, Kaimur, Bhojpur, Arwal, Patna, Jahanabad, Aurangabad, Gaya, Nalanda, Sheikhpura, Nawada, Lakhisarai, Munger, Jamui, Bhagalpur and Banka. Some major rivers lying within this region are Sone, Punpun, Kiul etc. However, out of 17 districts only three districts viz Patna, Munger and Bhagalpur are covered under the FMIS Focus Area.

The soil of Focus area is sandy alluvial, rich in lime and often contains high proportion of clay. There are pockets where soils are calcareous with high proportion of calcium carbonate. The soils are among the most fertile in India and can support a variety of crops with appropriate land and water management.

2.3 Climate and Rainfall

Bihar has monsoon type tropical climate with high temperature and medium to high rainfall. The temperatures are lowest during December-January with an average minimum of 8^0C to 10^0C and maximum of 24^0C to 25^0C. The temperatures in the hottest months of April to June are varying from minimum of 23^0C to 25^0C to the maximum of 35^0C to 38^0C.

The mean annual rainfall for the State is about 1270 mm varying from 1170 to 1580 mm in Focus area. Most of the rainfall (80% to 90%) is received from mid-June to mid-October. The late September-October rains (locally known as 'Hathia'), though only 50 to 100 mm in quantity, are very crucial to agriculture in the region and their timing and distribution make all the difference between plenty and scarcity.

2.4 River System of Bihar

2.4.1 North Bihar

Important rivers namely Ghaghra, Gandak, Burhi Gandak, Kosi and Mahananda etc. drain directly into river Ganga, the master drain flowing from west to east, whereas Bagmati- Adhwara, Kamla-Balan etc. drain into the Ganga through the Kosi.

The Ghaghra, Gandak and Burhi Gandak rivers of north Bihar are now more or less stabilized. It is believed that river Gandak has travelled from near Burhi Gandak on the east to its present course on the west in course of last several hundred years. In this process of shifting, it has

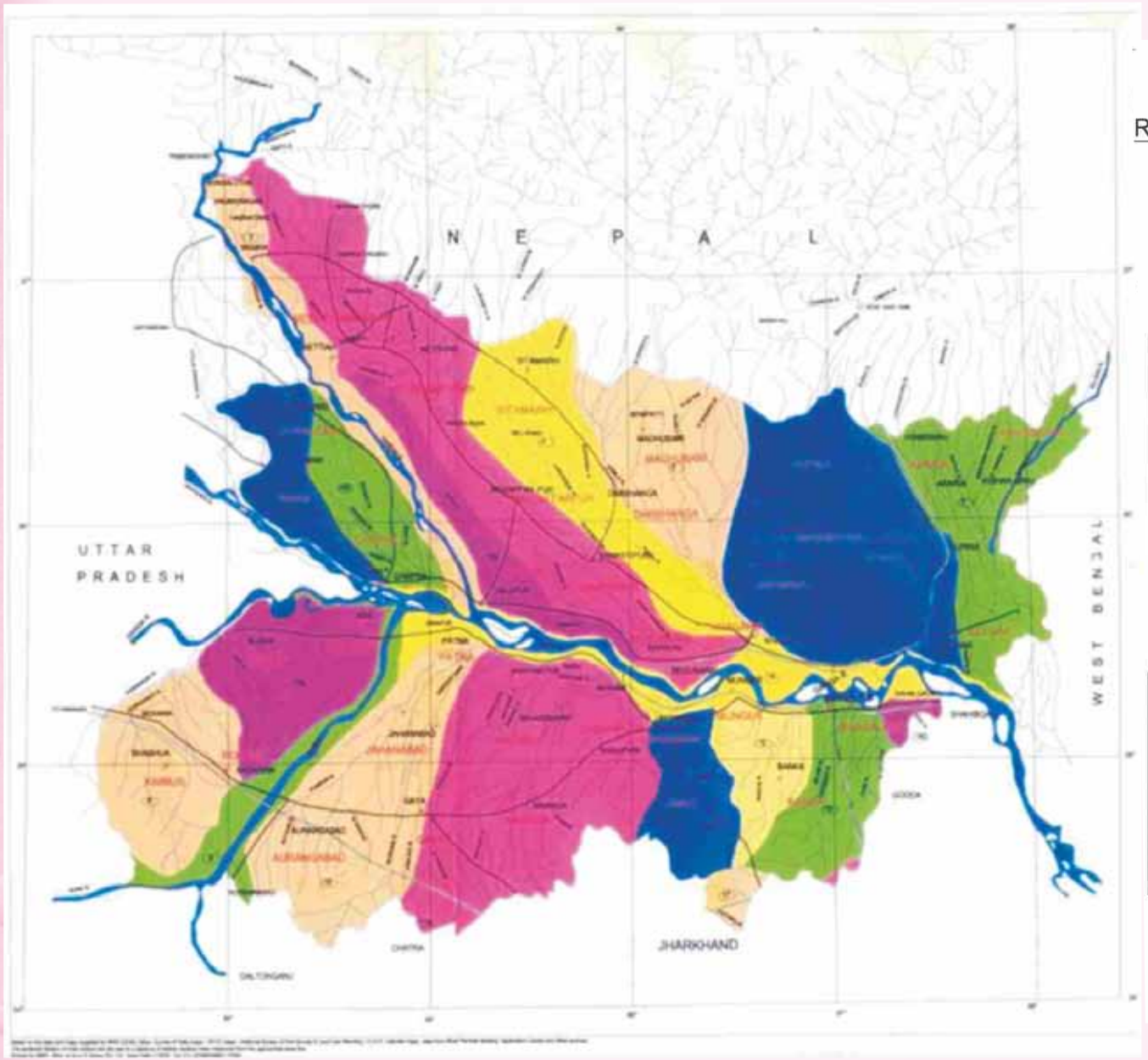
created numerous chaurs (saucer like depressions) and mauns (deep horse- shoe shaped water bodies formed due to avulsions/cut-offs) in the basin. The other north Bihar rivers such as the Bagmati, Adhwara group of rivers, Kamla-Balan and Kosi are still very unstable due to steep slopes in their upper reaches and high silt charges and are always exerting tremendous pressure on the embankments within which they are presently contained at enormous cost and efforts. The Kosi river is known to have shifted from near Purnea on the east to its present course on the west, before it was embanked. However, this river tried to move towards east from its present course after the Kusaha breach in Aug 2008, but was brought back to its present course in Jan 2009 by adopting suitable river diversion measures. In its lateral travel of about 120 km. in course of about two centuries, the Kosi has created a number of swamps and marshy lands in the basin, apart from depositing coarse silt and sand in almost entire area.

The major rivers of north Bihar have Himalayan origin and considerable portion of their catchments lie in the glacial region. They are, therefore, snow-fed and perennial in flow. These rivers have catchments in the Himalayan region in Nepal. Some of them have catchments even in Tibet. They receive very copious rainfall during monsoon which causes rise in discharge of these rivers by 50 to 90 times higher than fair weather flows. This causes frequent flooding of a large portion of north Bihar during monsoon.

2.4.2 South Bihar

This tract of land is drained mainly by rivers which are rainfed, having their origins either in the Vindhyachal hills or in the hills of Chhotanagpur and Rajmahal. These rivers are either dry or carry scanty discharges in non-monsoon months. Karmanasa, Sone, Punpun, Kiul, Badua, Chandan etc. are the important rivers of this region which fall ultimately into river Ganga.

A peculiar phenomenon in this region is the formation of Tal. The southern bank of the Ganga is naturally formed as a levee obstructing the drainage of the land on the south of it, which extends up to the foot of Chhotanagpur hills. The natural slope of this land is from south to north, i.e. from foot hills of the Chhotanagpur hills to Ganga. There are several rivers in this tract which drain the rain water of the tract and accumulate them behind the high bank of Ganga. This has resulted in formation of tals viz. Mokama group of Tals, the area just on the south of the high Ganga bank extending from Fatuha to Barahia, which comprises of Fatuha Tal, Bakhtiyarpur Tal, Barh Tal, More Tal, Mokama Tal, Barahiya Tal and Singhaul Tal. These Tals also receive backwater of the Ganga when the latter is in high spate. Therefore, the Tals get submerged in water during monsoon season and are thus deprived from kharif cultivation in most of the area. Even after the monsoon season, entire area does not get drained into the Ganga quickly. However bumper rabi & hot weather crops are grown in the Tal area when it gets freed from submergence in time.



RIVER BASIN MAP OF BIHAR

25 10 0 25 50 75
(In km)

RIVER BASIN / SUB-BASINS IN BIHAR STATE

Sr. No.	Name of main river/rivers	Allotted basin number	Outfall of the main river
1	Ghaghra	1	Ganga
2	Gandak	2	Ganga
3	Burhi Gandak	3	Ganga
4	Bagmati-Adhwara	4	Kosi
5	Kamla-Balan	5	Kosi
6	Kosi	6	Ganga
7	Mahananda	7	Ganga
8	Karmnasa	8	Ganga
9	Sone(Stem)	9	Ganga
10	Punpun	10	Ganga
11	Kiul	11	Ganga
12	Harahar	11A	Kiul
13	Badua-Belhama	12	Ganga
14	Chandan-Bilasi-Chir	13	Ganga
15	Ganga-Stem	14	Bay of bangal
16	Kao-Gangi etc	14A	Ganga
17	Baya	14B	Ganga
18	Koa-Bhena etc	14C	Ganga
19	Mahi	14D	Ganga

REFERENCES

1	RIVER
2	BOUNDARY
	I. INTERNATIONAL
	II. STATE
	III. DISTRICT
	IV. BASIN
3	DISTRICT H.Q.
4	RAILWAY
5	ROAD

Map - 2.2 River Basin Map of Bihar

2.5 Socio-Economic Profile of Bihar

Bihar is one of the most populous states of India. High proportion of population below the poverty line and its special social and economic situation pose challenges for the development of the state. However over the years in recent past, by means of several socio-economic measures, it has taken a leap forward and is now growing at a fast pace as will be evident from the following indicators.

2.5.1 Human development index indicator

	Bihar		INDIA
	2001	2011	2011
Per capita income (in Rupees)	6850	24681*	60972*
Literacy Rate	47% (M-54.68%, F-33.12%)	63.82% (M-73.39%, F-53.33%)	74.04% (M-82.14, F-65.46)
Infant Mortality Rate/1000 children born	56(2008)	48(2010)	47(2010) 44(2011)

Source: Director of Statistics, GOB, Census report 2001/2011

**trak.in (2011-12)*

2.5.2 Demography

	Bihar		INDIA
	(2001)	**2011**	**2011**
Total population	8.30 crore	10.38 crore	121.02 crore
Density of population (per sq km)	881	1102	382
Sex Ratio (per 1000 male)	921	916	940
% Population in rural area	89.54	88.70	68.84
% population in urban area	10.46	11.30	31.16
Population growth	25.07%	28.43%	17.64%

Source: Census report 2001, 2011(provisional)

2.5.3 Agriculture

The State has plenty of plain and fertile cultivable land of 64.41 lakh hectare which is almost 70% of its geographical area. The soil is mostly alluvium and very fertile, most suitable for multiple cropping and irrigated agriculture.

The ultimate, created and utilized irrigation potential of the state at the end of 11th Five Year Plan i.e 2012 are shown in table below:

***Table 2.4.3 Ultimate, Created and Achieved Irrigation Potential of the State**

(Area in Lakh Ha)

	Type of Irrigation	Ultimate Potential	Created Potential	Utilised Potential
(a)	Major-Medium Irrigation	53.53	28.86	16.36
(b)	Minor Irrigation			
(i)	Surface Irrigation (including Ahars & Pynes)	15.44	5.191	2.358
(ii)	Ground Water Schemes (mostly private shallow tube wells)	48.57	28.99	26.75
	Total	117.54	63.041	45.468

*Source: - Agriculture Road Map, Govt of Bihar 2012

2.6 Flood Typology

Conventionally the typology of flood management classes is based on flood type, source area, warning time, flood duration and recession, and impact on agriculture. FMISC has identified four classes of floods which can be classified as

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 rainy season, no Kharif cultivation,

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

Another classification which has been identified by FMISC resulted into four classes of Floods, which are following:

Not affected	<10% area inundated.
Low Flood	11%-30% area inundated.
Medium Flood	31%- 60% area inundated.
High Flood	> 60% area inundated

2.7 Occurrence of Floods in River Systems

A study has been made to see the flood stages in various river systems during floods in FMISC focus area. It was found that early flood takes place during the month of May-June in river Bagmati, Kosi and river Kamla. Thereafter flood generally comes in river Burhi Gandak in the month of mid July. During these months river Ganga generally remains low but by September river Ganga, the master drain, also rises making the flood problem more acute. However, during the year 2011 flood period, Ganga was constantly high after mid July and reached the HFL in Bhagalpur after 1987.

2.7.1 Floods since Year 2000 in the FMISC Focus Area

Floods have caused devastation and acute human sufferings frequently since the dawn of civilization and man has had to live with floods since time immemorial. The impact of flood was perhaps not felt to the same extent in the past as is felt now. This was due to the fact that there were smaller living population and pressure of industrial activities and other development work in the flood plains was far less compared to the present day activities. The flood problem was accentuated due to ever increasing encroachments on the flood plains by the growing population to meet its requirements of food and fiber. The destruction of forests for reclaiming areas for occupation and for obtaining fuel for domestic requirements had also caused changes in river regime. All these have resulted in an anomalous situation where, in spite of protection measures carried out so far in the State with a substantial investment on flood management works, flood damages have gone on increasing instead of decreasing. A brief summary of flood based on the Water Resources Department Annual Flood Report in chronological order from the year 2000 is given as follows:

2000- Bagmati left embankment at chain 273 near village Madhkaul was cut by anti-social elements. Embankment at chain 311 near village Madar was breached on 6/8/2000. Again in the last

week of September and first week of October at km 11, 12, 20, 35.5 and 48 were cut by the villagers. Incidents of embankment cut have been reported earlier also. This was done to bring silt to raise land by the villagers. Kamla-Balan and Bhutahi-Balan catchments received heavy rainfall during first and last week of July resulting in unexpected rise of water. Slope of left embankment of Kamla-Balan embankment between km 89-90 in a length of 200 m was damaged. Spur at 2.80 km of Eastern Kosi Afflux Bund was punctured in the night of 4/8/2000 in a length of 20 m and the nose was washed away due to heavy pressure of river. A new nose and shank were constructed in a length of 563 m and spur was made safe. The spur at km 14.5 was also damaged in half of its length in the night of 29/9/2000. Experts from head quarter camped at the site and brought it under control. Sikarhata Majhari Bund of western Kosi embankment between Km 6-7 was damaged in the night of 13/8/2000 but was saved by doing flood fighting work. Heavy pressure on spur at km 78.30 of eastern Kosi embankment was overcome by undertaking flood fighting works.

2001- Left bank of river Burhi Gandak at Rampurwa Pulwar, Pakridayal, Enarwa Ghat Mainpurwa and right embankment at Bihkhiya, Chakarniya, Bairiya, Koral, and Balochak was experiencing pressure but was saved by timely flood fighting. In Burhi Gandak left embankment at 69-70 km at village More, the bed bar, which was earlier constructed, was damaged due to heavy local rainfall and pressure over embankment. Burhi Gandak right embankment at 98-99 km at village Phulwaria was cut by the anti-social elements on 17/9/2001. The right embankment of Bagmati river at Kothia and Surgahi and left embankment at Kansar, embankments were experiencing heavy pressure throughout the entire flood season but were saved by timely flood fighting. No breach in this reach occurred. In western Kosi embankment at Ghoghardiha, Jamalpur embankment at 30.105 km and at Sikhta Manjhari, there were pressure over embankment which was safely overcome by timely flood fighting. In western Kosi embankment at 2.25 km, the D-part of spur nose was damaged. Bhutahi-Balan right embankment breached due to overtopping at 20.91 Km, 21.01 km, 21.4 km 22 km, and 60.7 km in the first week of October.

2002- Kamla Balan left embankment at km 81.20 (Bugras) was cut by anti-social elements in a length of 30 m which increased to 50 m. Overtopping was reported in Kamla Balan left embankment at km 38 at Bhadhuar on 23/7/2002 at 39 km near Bhadhuar sluice, at 50.5 km near Pipraghat, 51 km at junction point of rail cum road bridge and embankment and 74.8 km in Asma village on 23/07/02. Kamla Balan right embankment at km 37 near village Banaur and km 64 at village Thengha were cut by anti-social elements in a length of 30 m which increased to 300 m. Bagmati right afflux bank embankment at ch. 1025 near village Dharampur was cut by the villagers on 23/7/02. Bagmati left embankment near ch. 145 of Sirsia ring bund at 20 to 30 ch. and 29 to 32.5 ch. breached due to overtopping. Bagmati left embankment between ch. 145 to 149 was cut by villagers on 23/7/ 02. Khiroi left embankment at 7 km at village Masartharia and 5.25 km near

Maasma and Khiroi right embankment at 12 km near Belwara Milki village and at 3 km near Bagwasa village breached due to overtopping on 24/7/02. Western Kosi embankment at 29 to 30 km below Kasba Bharda was cut by anti-social elements at 2 places.

2003- Maximum discharge of 389000 cusec passed through river Kosi whereas discharge in excess of 250000 cusec passed four times which resulted in continuous pressure on spurs/embankments. This resulted into damage of spurs in western Kosi embankment at 25.57, 15.80 and 15.30 km. On 1/8/2003 due to high discharge in the river, the right embankment of Bagmati river at Surgahi site at chain 112-123 breached in 50 ft. which increased to 1100-2000 ft. On 1/8/2003 anti-social elements cut Kamla Balan right embankment at km 66.50 in a length of 50 ft. Status of flood in the rivers other than Ganga, and Gandak remained normal. In river Ganga the HFL at Bhagalpur surpassed the year 1978 record of 34.18 m and was at 34.20 m level while in Patna at Ghandighat the HFL was observed as 50.12 m in 2003 against HFL of 50.27 m recorded in 1994. This heavy flooding in Ganga resulted in damage to the road network in Samastipur district. In river Gandak the maximum discharge 6,69,750 cusecs passed through Valmikinagar barrage on 31/7/03.

2004- 2004 flood in the state of Bihar was unprecedented which proved to be very grave and damaging. Catchments area of north Bihar rivers received heavy rainfall in the first week of July itself which not only broke last three years flood record but also surpassed the 1987 flood. Flood level at Dubbadhar site on river Bagmati surpassed all time high flood level by about 1.18 m. Similarly Burhi Gandak river on 15.7.04 and Kamla Balan river on 10.7.04 touched all time high flood level. This itself speaks about the fury of flood in the year 2004. The embankments of north Bihar breached at many places resulting in flood inundation in a vast area of north Bihar. Unprecedented flood in river Bagmati, Burhi-Gandak, Kamla and Bhuthi-Balan and Adhwara group of rivers breached the embankments at many places and there was loss of life and property on a large scale. In river Kosi, situation by and large remained normal and a maximum discharge of 2,86,375 cusecs passed on 10.7.04.

2005 – The flood situation during 2005 was normal in comparison to the devastating flood of 2004. Whereas there were 63 numbers of breaches during 2004 flood, only 8 breaches occurred during the year resulting in flood inundation in Madhubani and Katihar districts only. Left and right embankments of Kamla also breached at seven places during this year. Bhutahi Balan left embankment at km 21.22 and 22.80 was cut by the anti-social elements and due to flash flood, embankment was damaged at few places.

2006 – The flood situation during 2006 was normal. Whereas there were 63 numbers of breaches during 2004 flood, this year only one breach occurred. Left embankment of Kamla was breached near village Asma at km 75.70 by anti-social elements but fortunately there was no loss of

life or property. Flood situation in other places remained normal by and large.

2007– Floods of 2007 will be remembered for high degree of rainfall which was even more than year 2004 flood period. Districts of Champaran, Gopalganj, Siwan, Madhubani, Darbhanga, Muzaffarpur, Samastipur, bore the fury of flood to a large extent. But fortunately compared to 2004 floods, there were fewer numbers of breaches (32 nos. in Bihar) in 2007 as compared to 63 in year 2004. Unprecedented flood in river Bagmati, Burhi-Gandak, Kamla and Bhutahi-Balan and Adhwara group of rivers breached the embankments at many places and there was loss of life and property. In river Kosi, situation by and large remained normal.

2008 – There was an unprecedented flood due to a breach near 12.9 km of Eastern Kosi Afflux Embankment near Kushaha village in Nepal on 18th August 2008 which very soon took the shape of a catastrophe leading to the miseries to lakhs of people in Sunsari and Saptari districts of Nepal, and Supaul, Madhepura, Araria, Saharsa, Katihar and Purnia districts of Bihar. River Kosi entirely changed its course but this was again tamed to its earlier course by WRD after tremendous effort keeping in line with the advice of Kosi Breach Closure Advisory Team (KBCAT).

2009 – The floods this year remained normal except few breaches such as Tilaktajpur on right embankment of river Bagmati under Runnisaidpur block of Sitamarhi district, Gobindpur site of Labha Choukia Paharpur embankment of Mahananda river and Sallehpur Tandeshpur site of Gandak river. The loss to life and property was brought to minimum by undertaking rescue and relief measures.

2010- The flood situation this year remained quite normal with normal average rainfall. Only a few cases of breaches were reported viz Saran embankment in a length of 200 m between 122.75 km and 122.95 km near Simaria village both due to sharp change in the river course.

2011- The floods this year remained normal except with a few exceptions such as damage of nose of spur no-9 between Ismailpur and Bindtoli and that of revetment in 30 m length near Kazikoria of Raghopur village u/s of Vikramshila Setu and at spur no-9 and spur no-7 in a length of 138 m and 65 m respectively in d/s of Vikramshila Setu under Gopalpur block of Bhagalpur district, both on left embankment of river Ganga. It is worth mentioning that H.F.L. attained by river Ganga at Bhagalpur this year was recorded as 34.17 m on 19.08.2011 against the H.F.L. of 33.26 m recorded last year on 03.09.2010. There was unprecedented flood in river Sone also with a maximum discharge of 9,58,000 cusec on 25.9.11 at Indrapuri Barrage whereas the same was 61,130 cusec last year on 14.7.10.

2012- Gandak remained in spate since the beginning of monsoon and kept on exerting pressure on both its embankments. The incessant pressure on Gandak right embankment, especially

in Pipra-Piprasi reach was so enormous that round the clock vigil and protection work had become necessary. The problem was accentuated by eroded length of spur at Dhuniawapatti at 26.75 km of PP right embankment.

Heavy rain in the catchment of Burhi Gandak resulted in overbank flow in smaller rivers and rivulets causing some flash flood in West Champaran, where overtopping on railway track was reported at Sikta railway station.

Continuous high level of Ganga exerted pressure on some of the protecting structures along its left bank in Bhagalpur, Vaishali and Samastipur districts. Ismailpur Bindtoli Embankment on left bank of river Ganga between spur no. 5-6; situated downstream of Vikramshila setu in Bhagalpur district was severely threatened. Incessant threat on the left bank of Ganga upstream of Vikramshila setu at Raghopur- Khairpur site kept the department on its toes. The dowel at left bank of river Ganga at Chandpur-Dhamaun-Rasalpur in Samastipur district had to be strengthened continuously to save it from breach/overtopping.

2.8 Flood Characteristics of Focus Area

FMIS Phase-I focus area earlier comprised of only eleven districts of north Bihar namely Muzaffarpur, Sitamarhi, Sheohar, East Champaran, Madhubani, Darbhanga, Samastipur, Begusarai, Khagaria, Saharsa, and Supaul. FMIS Phase-II focus area now comprises of all the districts under FMIS Phase-I; and remaining ten districts of north Bihar viz West Champaran, Gopalganj, Siwan, Saran, Vaishali, Madhepura, Araria, Kishanganj, Purnea and Katihar i. e. all the 21 districts of north Bihar besides three districts of south Bihar namely Bhagalpur, Munger and Patna. A study has been made with the help of data obtained from DMD, Patna (Table 2.8.1) to see the frequency of flood events in the development blocks of these districts in terms of inundation during 1987 to 2012 (26 years). A summary of the findings is also given below:-

Table 2.8.1 Frequency of Flood Events in Bihar during 1987-2012.

Sl No	Name of Districts	Number of Blocks affected out of last 26Years (1987 to 2012)			
		16Years and more	11Years–15 Years	6 Years–10 Years	1 Years–5 Years
FMIS Phase-I Focus Area					
1	Muzaffarpur	5	3	2	6
2	Sitamarhi	6	6	6	0
3	Sheohar	1	2	1	1
4	East Champaran	-	10	9	9
5	Madhubani	2	8	9	5
6	Darbhanga	6	6	6	2
7	Samastipur	3	3	6	10
8	Begusarai	-	5	3	8
9	Khagaria	6	1	-	-
10	Saharsa	5	1	-	3
11	Supaul	6	0	1	5
Total of FMIS Phase-I Focus Area		40	45	43	49
Additional Area of FMIS Phase-II					
12	W. Champaran	3	4	8	3
13	Gopalganj	3	2	-	9
14	Siwan	-	-	-	15
15	Saran	-	2	6	10
16	Vaishali	-	3	3	10
17	Madhepura	2	-	6	4
18	Araria	1	7	1	-
19	Kishanganj	-	4	3	-
20	Purnea	3	1	5	4
21	Katihar	5	5	6	2
22	Bhagalpur	5	6	5	-
23	Munger	-	-	4	5
24	Patna	2	3	8	9
Sub Total		24	37	55	71
Total of FMIS Phase-II Focus Area		**64**	**82**	**98**	**120**
Rest Districts of Bihar					
25	Nalanda	-	-	9	11
26	Gaya	-	-	-	-
27	Nawada	-	-	-	-
28	Aurangabad	-	-	-	-
29	Jehanabad	-	-	-	-
30	Arwal	-	-	-	-
31	Bhojpur	-	2	4	8
32	Buxar	-	-	-	9
33	Rohtas	-	-	-	-
34	Bhabhua	-	-	-	-
35	Lakhisarai	-	-	-	-
36	Sheikhpura	-	-	-	-
37	Jamui	-	-	-	-
38	Banka	-	-	-	-
	Sub Total	-	2	13	28
Total for Whole Bihar		**64**	**84**	**111**	**148**

(Source: Disaster Management Department, Bihar)

The table above indicates that out of 364 blocks in FMIS Phase-II focus area, there are as many as 64 blocks that are most frequently flood affected and 82 blocks are frequently flood affected in terms of number of times they were affected by floods in last 26 years.

2.9 Loss of Life and Public Property since year 2000

Loss of public property, human and animal lives due to floods since year 2000 as obtained from Disaster Management Department; Government of Bihar are given in table below:

Loss of Public Property

Year	Number of Affected									Crop Damaged (Rs Lac)	House Damaged		Public Property Damaged (in Rs. Lac)	Deaths	
	Districts	Blocks	Villages	(in Lac)		Area (in Lac ha.)					Total	Value (in Rs. Lac)		Human	Animal
				Human	Animal	Agric	Non- Agric	Total	Cropped						
2012(P)	11	27	265	2.44	0.082	0.8525	0.1	0.9525	0.145	299.03	1940	152.49	162.20	8	0
2011	25	166	3577	71.43	6.627	35.42	2.877	38.197	3.439	10295.7	851	6904.44	153.67	249	183
2010	9	44	679	7.18	3.57	1.602	0.39	1.992	0.101	311.92	6868	704.87	169.2	32	0
2009	16	91	1546	22.03	1.346	1.71	9.339	11.05	0.475	2182.57	7674	528.15	530.1	97	2
2008	18	116	2585	49.952	12.166	6.40495	2.11922	8.8242	3.67211	3420.25	297916	8451.4	9771.96	258	878
2007	22	269	18832	244.42	27.13	13.323	5.51	18.833	10.603	7683782	784328	83144.52	64241.52	1287	2423
2006	14	63	959	10.89	0.1	1.52	0.297	1.81	0.87	706.63	18,637	1,225.03	8,456.17	36	31
2005	12	81	1,464	21.04	5.35	3.343	1.261	4.6	1.35	1,164.50	5,538	382.79	305	58	4
2004	20	211	9,346	212.99	86.86	20.99	6.010	27.00	13.99	52,205.64	9,29,773	75,809.51	1,03,049.60	885	3272
2003	24	172	5,077	76.02	11.96	9.943	5.140	15.08	6.10	6,266.13	45,262	2,032.10	1,035.16	251	108
2002	25	6	8,318	160.18	52.51	14.446	5.244	19.69	9.4	51,149.61	419,014	52,621.51	40,892.19	489	1450
2001	22	194	6,405	90.91	11.7	9.042	2.91	11.95	6.5	26,721.79	222,074	17,358.44	18,353.78	231	565
2000	33	213	12,351	90.18	8.09	6.57	1.476	8.05	4.43	8,303.70	343,091	20,933.82	3,780.66	336	2568

Source: (Disaster Management Department, Bihar website: http://www.disastermgmt.bih.nic.in/) & Provisional figures based on Form-IX dated 15.10.2012.

2.10 District-Wise Damage Statistics for Flood – 2012

District-wise flood damage statistics as obtained from Disaster Management Department; Government of Bihar for Flood 2012 for Phase-II Focus area and rest area of Bihar is given below:-

Sl. No.	District	Number of Affected Blocks	Nos. of Affected villages	Cropped Area (Lakh hect.)	Estd. Crop damage (Rs. Lac)	No. of houses/ huts damaged (Fully /Partially)						Estimate d Value of house damage In (Rs. Lac)	Public Properties damage (Rs. Lac)	Live Lost (Nos)		
						Pucca (F)	Pucca (P)	Kachcha (F)	Kachcha (P)	Huts	Total			Human: Flood	Human: Others	Animal
1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
FMIS Phase-I Area (11 Districts)																
1.	Muzaffarpur	2	38	0.06	-	0	0	0	0	0	0	0	141.00	3	-	-
2.	Sitamarhi	1	9	-	-	0	0	0	0	0	0	-	-	-	-	-
3.	Sheohar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4.	E.Champaran	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5.	Madhubani	1	5	-	-	-	-	-	-	-	-	-	-	-	-	-
6.	Darbhanga	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7.	Samastipur	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8.	Begusarai	6	40	0.08	135.20	-	-	-	-	-	-	-	-	-	-	-
9.	Khagaria	3	33	-	-	-	-	-	-	-	-	-	-	-	-	-
10.	Saharsa	3	25	-	-	-	-	-	-	569	569	14.22	-	4	-	-
11.	Supaul	3	61	0.02	3.86	-	-	-	-	719	719	68.40	-	1	-	-
Total for FMIS Phase-I Area (11 Dstricts)		19	211	0.16	139.06	0	0	0	0	1288	1288	82.62	141	8	0	0
Additional area in FMIS Phase-II (13 Districts)						-	-	-	-	-						
12.	W. Champaran	-	-	-	-	-	-	-	-		-	-	-	-	-	-
13.	Gopalganj	2	6	0.002	159.97	-	-	53	85	210	348	49.77	16.00	-	-	-
14.	Siwan	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
15.	Saran	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
16.	Vaishali	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
17.	Madhepura	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
18.	Araria	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
19.	Kishanganj	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
20.	Purnea	3	23	-	-	-	-	230	-	-	230	20.10	5.2	-	-	-

Sl. No.	District	Number of Affected Blocks	Nos. of Affected villages	Cropped Area (Lakh hect.)	Estd. Crop damage (Rs. Lac)	No. of houses/ huts damaged (Fully /Partially)						Estimate d Value of house damage In (Rs. Lac)	Public Properties damage (Rs. Lac)	Live Lost (Nos)		
														Human		
						Pucca (F)	Pucca (P)	Kachcha (F)	Kachcha (P)	Huts	Total			Flood	Others	Animal
21.	Katihar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
22.	Bhagalpur	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
23.	Munger	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
24.	Patna	1	5	-	-	-	-	-	-	-	-	-	-	-	-	-
Sub Total		6	34	0.002	159.97	0	0	283	85	210	578	69.87	21.2	0	0	0
Total for FMIS Phase-II Focus Area (24 Districts)		25	245	0.162	299.03	0	0	283	85	1498	1866	152.49	162.2	8	0	0
Additional area to be covered in FMIS Phase-III(14 Districts)																
25.	Nalanda	2	20	0.001	-	-	-	8	66	-	74	-	-	-	-	-
26.	Gaya	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
27.	Nawada	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
28.	Aurangabad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
29.	Jehanabad	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
30.	Arwal	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
31.	Bhojpur	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
32.	Buxar	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
33.	Rohtas	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
34.	Bhabhua	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
35.	Lakhisarai	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
36.	Sheikhpura	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
37.	Jamui	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
38.	Banka	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sub Total		2	20	0.001	0	0	0	8	66	0	74	0	0	0	0	0
Grand Total (For Whole Bihar)		27	265	0.163	299.03	0	0	291	151	1498	1940	152.49	162.2	8	0	0

(Source: Disaster Management Department, Bihar, Patna

(Cumulative Form-IX dated 15.10.2012)

3.0 ACTIVITIES OF FMISC DURING 2012 FLOODS

3.1 Activities of FMISC in 2012 during Flood Season

Like previous years, this year too, FMIS Centre, Patna with all its resources and as per its mandate was ready and prepared for the flood season 2012. The satellite data for north Bihar, which were received in FMISC, Patna from NRSC, Hyderabad, were further processed, value added and disseminated almost same day or next day to the user/stakeholder departments like WRD, DMD, GFCC, Agriculture Department, NRSC, CWC etc. as per their needs.

3.1.1 Flood Control Cell at FMISC

Similar to previous years, FMISC was ready to face any emergent situation during flood. The Centre started working in two shifts, from 7 a.m. to 2 p.m. and from 2 p.m. to 9 p.m. daily including holidays during flood period, i.e., 15th June 2012 to 15th Oct 2012. This year too FMIS Centre geared up with its limited personnel and resources at its disposal and started collecting daily data of rainfall & river Water Levels, maps and satellite images etc. from all possible sources; indigenous or global. Flood bulletins were issued daily to all concerned after incorporating all these information and data in the bulletin and were also posted on the website of FMISC.

There was continuous liaison with CM Secretariat, Water Resources Department and Disaster Management Department and value added maps were provided as and when required in shortest possible time.

3.1.2 Information disseminated by FMIS Centre

3.1.2.1 Information provided to WRD

Yet another rainy season and FMISC was again ready to face any situation and to provide logistic support to the stakeholders.

This year the sky condition was not conducive to satellite based observation. Hence our main tool, i.e., satellite images were scarcely available, leaving us with little scope for authenticating field reports. Still we kept trying to get usable images available from whatever source possible.

3.1.2.2 The Flood Scenario

Gandak remained in spate since the beginning of monsoon and kept on exerting pressure on both its embankments. The incessant pressure on Gandak right embankment, especially in Pipra-Piprasi reach was so enormous that 24 x 7 hour vigil and protection work had become necessary. Gandak remained furious all through the early months of monsoon. The problem was accentuated by eroded length of spur at Dhuniawapatti at 26.75 km of PP right embankment. We even prepared a probable inundation map in anticipation of possible threat to embankment in this portion in the month of August.

Heavy rain in the catchment of river Burhi Gandak resulted in overbank flow in smaller rivers and rivulets causing some flash floods in West champaran where overtopping on railway track was reported at Sikta Station.

During early part of the monsoon Bihar did not receive much of its share of rain but its rivers were in near bank full stage mainly due to sustained rainfall in western half of Nepal as well as in U.P.

Continuous high level of Ganga exerted pressure on some of the protecting structures along its left bank in Bhagalpur, Vaishali and Samastipur districts. Ismailpur Bindtoli Embankment; situated downstream of Vikramshila setu in Bhagalpur district suffered immense pressure and was almost on the verge of collapse between spur no. 5-6. A probable inundation map was prepared to alert administration for any eventualities. Incessant threat on the left bank of Ganga upstream of Vikramshila setu at Raghopur- Khairpur site kept the department on its toes. The dowel at left bank of river Ganga at Chandpur-Dhamaun-Rasalpur in Samastipur district had to be strengthened continuously to save it from breach/overtopping.

Early part of monsoon also caused some damages to Zamindari Bandh along Lokain River in Patna & Nalanda Districts when the region witnessed heavy rain around mid-August.

On the whole the season was less eventful than the previous year.

3.1.2.3 Information provided to DMD

Satellite imageries were provided to DMD as and when asked for, which helped them in taking necessary rescue and rehabilitation measures.

3.1.3 Contribution of FMIS Centre to Technical Advisory Committee (TAC), WRD and GFCC in taking decisions for Anti-Erosion Works for the Year 2013.

This year too, meeting of TAC of WRD to approve Flood Protection Measures in the state was held in the newly built conference Hall of FMISC. All available logistic supports were also provided to the meeting by FMISC. Our specialists sat with the committee and provided pre-flood and post-flood maps showing changes in the river regime at specific sites of major rivers of north Bihar like Gandak, Kosi, Kamla, Bagmati, Burhi Gandak and some stretches of Ganga. This value addition to our GIS databank came handy in deciding Embankment maintenance and Anti-erosion works. All the schemes submitted by field officers to TAC were scrutinized with the help of these maps.

Nearly all large schemes, referred to GFCC for clearance, were aided by FMIS inputs in the form of latest satellite pictures. This helped a lot in judicious decision making at State level and High Level Committees.

3.1.4 e-bulletin:

e-bulletins were issued monthly during Flood period and posted on FMIS website regularly during flood season. e-bulletin for the month of October 2012 is annexed at the end of this report.

4.0 FMIS website

URL :http://fmis.bih.nic.in

The FMISC website is an information dissemination interface. The presentation of the information is in text & graphical maps. The main motto of the project is to provide the user with a platform where they can get flood information related to any particular area.

Apart from a brief discussion about the technology used and the activities carried out by the FMISC, the site also provides detailed maps related to the flood inundation status, breach points on the embankments, inundation levels etc, of the area covering the focus area of FMIS Phase I comprising of 11 flood affected districts of north Bihar presently. It is, however, planned to extend it to focus area of FMIS Phase II comprising of 21 districts of north Bihar and 3 districts adjoining river Ganga in south Bihar, after completion of FMIS phase II.

FMIS website includes:

- ***Daily hydro-meteorological status*** of north Bihar rivers, having DL (Danger Level), WL (Water Level) and RF (Rainfall) in their catchments during the flood season i.e. 15th of June to 15th of October.
- ***Gate Status : Gate opening position of Kosi and Gandak Barrage.***
- ***MODIS satellite data showing current river status.***
- ***Embankments news: Flashes embankments status.***
- ***Daily flood bulletins*** are issued every day during the flood season. These bulletins contain summarized information about the observed rainfall, water level and basin wise maximum forecasted rainfall for 3 days obtained from IMD.

- ***Inundation maps*** for WRD and DMD, show aerial extent of flood water spread. The inundation extent is derived from RADARSAT Layers/Imagery provided by NRSC in processed 1 bit image format.
- ***Monthly e-Bulletin*** is published every month during flood season. This is an in house production and gives a brief account of activities of FMISC.
- ***End of Season Flood Report*** is also published at the end of flood season.
- ***District level rainfall forecast of 5 days for Bihar and Jharkhand*** as obtained from IMD are included on daily basis during flood season.
- ***Important links, Photo Gallery, Weather Widget are also included in the website.***

Future actions

FMISC has started setting up a web hosting infrastructure on its own which included a web server, Database server and NAS (Network Attached storage) media. Thus FMISC, implemented on its infrastructure, will effectively manage the heavy load on the websites during peak hours, and ensure a high degree of availability and performance.

Over the years the website has silently but surely established itself as a medium which introduces the users within and without, to the activities which are being carried out in the FMISC. With the number of stake holders rising every day, FMISC is trying its best to meet the myriad demands of Thematic maps and Imageries. Under these circumstances the website will have an important role in catering to increasing demands of customized maps and other information products. It is, therefore, mandatory to have a website that will allow the users to generate maps and other information products as per their needs.

The salient features of the future website will be:

Interactive Maps

- Working for an organization that manages geographic information, we are faced with the challenge of sharing our collection of geographic information with people inside our organization and those outside as well. For this challenge we have decided to choose Map Server. Map Server provides the platform for sharing our GIS resources, such as maps, with our user community, whether they are sitting in the same office using ArcGIS Desktop or sitting across the country accessing and viewing maps through the Internet.
- Today, it is common place to see maps or other geographic information integrated seamlessly into websites. Map Server helps us to put our geographic information on the Web, where we need an application that simply displays a map or a more sophisticated one that incorporates specialized GIS tools. Access to the GIS server is embedded inside the web application and typically hidden from the user of the application.
- FMISC will provide Bulk SMS Services to cover the entire State including Private GSM BSNL+MTNL GSM & Reliance IndiaMobile CDMA (Mobile & Fixed Wireless Phones-FWP) & Tata Indicom CDMA (Mobile & Fixed Wireless Phones - FWP). It also provides Push and Pull Services.

5.0 2012 Floods –Hydrologic Analysis

Flood Management Improvement Support Center, Bihar collects hydrological and hydrometeorological data from different Government Agencies mainly for Burhi Gandak, Bagmati, Kamla and Kosi rivers. As the GIS data base available with FMIS Centre is for only 11 districts of North Bihar (Phase-I Focus Area), hence various maps and analyses could be carried for these 11 districts only. The Table 5.0 below shows Gauge Stations along with their location, data type and source from where these data are collected. Map 5.0 shows the locations of the stations mentioned in the Table 5.0

Table 5.0 Basinwise List of River Gauge and Rain Gauge Stations :-

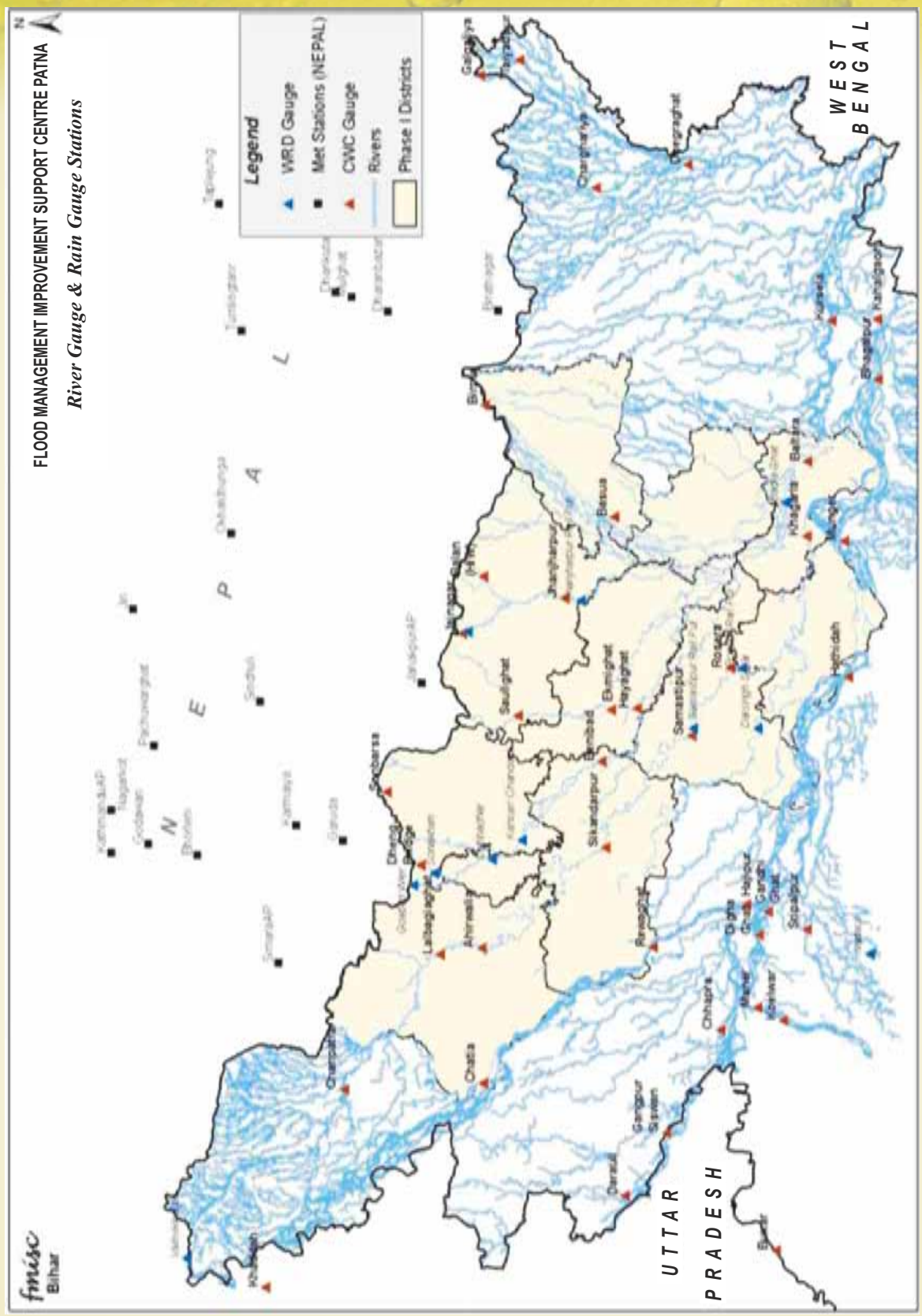
Sl. No.	Gauge Station	Location		Maintained by	Type of data	Mode of data acquisition
		Basin/River	(Nepal/Bihar)			
1	2	3	4	5	6	7
1.	Simara	BurhiGandak	Nepal	GON	DRF	www.mfd.gov.np
2.	Lalbegiaghat	BurhiGandak	Bihar	CWC, GoI	DRF& RS	Email
3.	Sikandarpur	BurhiGandak	Bihar	CWC, GoI	DRF& RS	Email
4.	Samastipur	BurhiGandak	Bihar	CWC, GoI	DRF& RS	Email
5.	Rosera	BurhiGandak	Bihar	CWC, GoI	DRF& RS	Email
6.	Khagaria	BurhiGandak	Bihar	CWC, GoI	DRF& RS	Email
7.	Kathmandu	Bagmati	Nepal	GON	DRF	www.mfd.gov.np
8.	Nagarkot	Bagmati	Nepal	GON	DRF	www.mfd.gov.np
9.	Garuda	Bagmati	Nepal	GON	DRF	www.hydrology.gov.np
10.	Godavari	Bagmati	Nepal	GON	DRF	www.hydrology.gov.np
11.	Karmaiya	Bagmati	Nepal	GON	DRF	www.hydrology.gov.np
12.	Bhorleni	Bagmati	Nepal	GON	DRF	www.hydrology.gov.np
13.	Sonakhan	Bagmati	Bihar	WRD, GoB	RS	Flood News
14.	Dubbadhar	Bagmati	Bihar	WRD, GoB	RS	Flood News
15.	Kansar	Bagmati	Bihar	WRD, GoB	RS	Flood News
16.	Benibad	Bagmati	Bihar	CWC, GoI	DRF& RS	Email
17.	Hayaghat	Bagmati	Bihar	CWC, GoI	DRF& RS	Email
18.	Kamtaul	Bagmati/Khiroi	Bihar	CWC, GoI	DRF& RS	Email
19.	Sonbarsa	Bagmati/Khiroi	Bihar	DOES, GoB	DRF	Messenger
20.	Ekmighat	Bagmati/ Darbhanga-Bagmati	Bihar	CWC, GoI	RS	Email
21.	Jainagar	Kamla	Bihar	DOES, GoB	DRF	Messenger
22.	Janakpur	Kamla	Nepal	GON	DRF	www.mfd.gov.np

Sl. No.	Gauge Station	Location		Maintained by	Type of data	Mode of data acquisition
		Basin/River	(Nepal/Bihar)			
1	2	3	4	5	6	7
23.	Sindhuli	Kamla	Nepal	GON	DRF	www.hydrology.gov.np
24.	Jainagar	Kamla	Bihar	WRD, GoB	RS	Flood News
25.	Jhanjharpurrailpul (u/s)	Kamla	Bihar	WRD, GoB	RS	Flood News
26.	Jhanjharpurrailpul (d/s)	Kamla	Bihar	CWC, GoI	DRF& RS	Email
27.	Okhaldunga	Kosi	Nepal	GON	DRF	www.mfd.gov.np
28.	Taplejung	Kosi	Nepal	GoN	DRF	www.mfd.gov.np
29.	Dhankutta	Kosi	Nepal	GoN	DRF	www.mfd.gov.np
30.	Dharan	Kosi	Nepal	GoN	DRF	www.mfd.gov.np
31.	Mulghat	Kosi	Nepal	GON	DRF	www.hydrology.gov.np
32.	Jiri	Kosi	Nepal	GON	DRF	www.hydrology.gov.np
33.	Pachuwarghat	Kosi	Nepal	GoN	DRF	www.hydrology.gov.np
34.	Tumlingtar	Kosi	Nepal	GoN	DRF	www.hydrology.gov.np
35.	Basua	Kosi	Bihar	CWC, GoI	DRF& RS	Email
36.	Baltara	Kosi	Bihar	CWC, GoI	DRF& RS	Email
37.	Kursela	Kosi	Bihar	CWC, GoI	DRF& RS	Email
38.	Kahara	Kosi	Bihar	DOES, GoB	DRF	Messenger
39.	Biratnagar	Mahananda	Nepal	GoN	DRF	www.mfd.gov.np
40.	Dhengraghat	Mahananda	Bihar	CWC, GoI	DRF& RS	Email

Note : DRF: Daily Rainfall Fall

DRF & RS: Daily Rainfall and River stage.

DOES: Directorate of Economics and Statistics



Map 5.0 Locations of River-Gauge and Rain-Gauge Stations

5.1 Rainfall

This year South West Monsoon arrived in Bihar on 21st June with a delay of almost a week. According to the report of IMD, the total rainfall from 1st June to 31st October 2012 has been 856.1 mm against the long period average of 1094.4 mm. At the end of the month September the monsoon was in a deficient condition for Bihar region as per IMD criteria given in Table 5.1.1. It is about -22 % away from Long Period Average (LPA). The monthly cumulative statistics from June'2012 to October' 2012 is given in Table 5.1.2. From the Table 5.1.3 it is clear that the monsoon was very poor in the month of June as the departure from LPA is -47%. However, it started improving in next month i.e. July, but it rained very less in August hence the departure increased and the situation was of water stress. In the month September it was almost equal to LPA but the monsoon started receding and the situation is October was worst with -42 % departures from LPA. Overall the situation at the end of season remained stressed. If we look at the graphical representations in Fig 5.1.1 on the LPA and the Actual rainfall, it is clear that in the month September the departure is the least.

Table 5.1.1 IMD Weekly/ Seasonal Distribution on regional Scale

Excess	Percentage departure of realised rainfall from normal rainfall is + 20% or more.
Normal	Percentage departure of realised rainfall from normal rainfall is between - 19 % to + 19 %.
Deficient	Percentage departure of realised rainfall from normal rainfall is between – 20 % to - 59 %.
Scanty	Percentage departure of realised rainfall from normal rainfall is between – 60 % to - 99 %.
No rain	Percentage departure of realised rainfall from normal rainfall is– 100 %

Table 5.1.2 Monthly Statistics of Rainfall in monsoon 2012

Month	Normal	Actual	Departure
June'2012	169.7	89.3	-47
July'2012	338.9	299.6	-12
August'2012	292.4	203.2	-31
September'2012	223.1	222.8	0
October'2012	70.3	40.7	-42
June-Oct' 2012	1094.4	856.1	-22

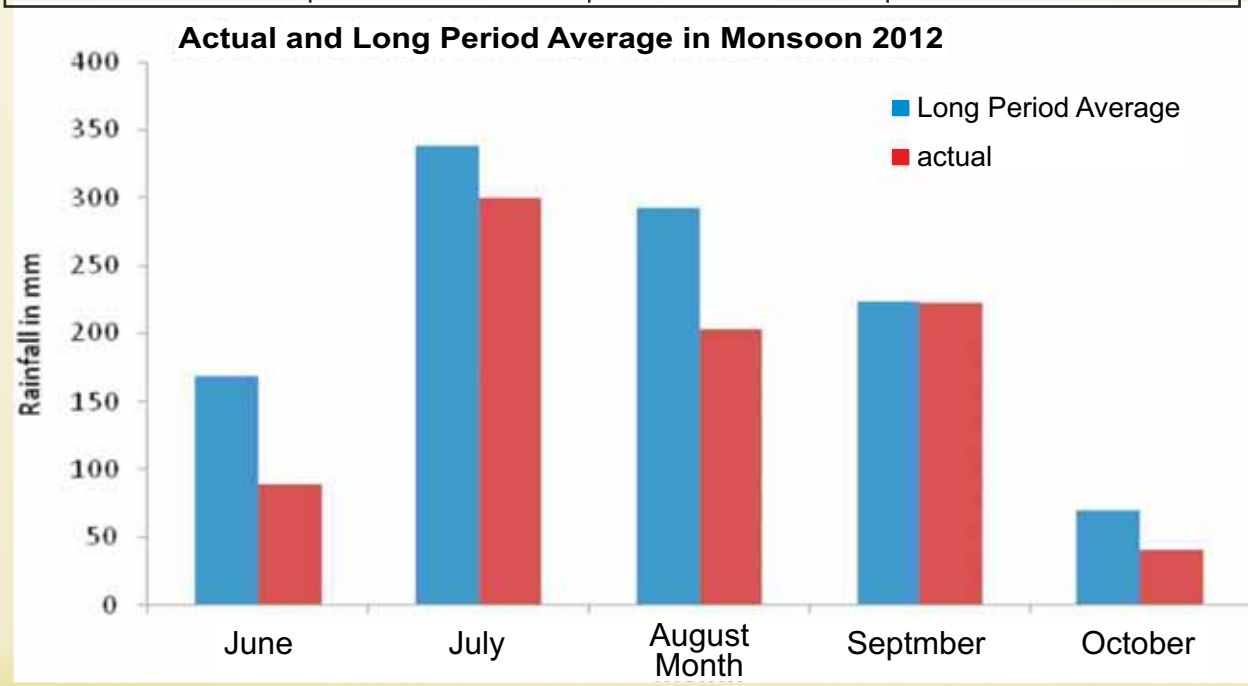


Fig: 5.1.1 Month wise Actual and LPA Rainfall in Monsoon 2012

River Basins	Rain Gauge stations	Monthly Rainfall						No. of Rainy days		
		June (from 15 June)	July	August	September	October (up to 15 Oct)	Total	2012	2011	2010
1	2	3	4	5	6	7	8	9	10	11
Burhi Gandak	Simra	168.4	209.8	168.6	110.8	4.6	662.2	47	53	50
	Lalbegiaghat	99.1	467	156.2	300.8	0	1023.1	45	55	37
	Sikandarpur	61.2	271.8	236.4	331	30.6	931	49	55	43
	Samastipur	60.8	321.6	153.4	159.4	34.2	729.4	59	60	55
	Rosera	42	177.6	106.4	187.4	22	535.4	55	58	56
	Khagaria	57.3	210	303.9	353.6	83.4	1008.2	50	53	48
Bagmati	Kathmandu	118.6	462.1	284	476.1	1.5	1342.3	85	94	88
	Benibad	21.8	324.5	129.4	346.9	28	850.6	50	51	40
	Hayaghat	16.8	547.9	256.6	313	58.6	1192.9	43	58	44
	Kamtaul	8.6	386.6	147	212.4	43.2	797.8	42	51	47
	Sonbarsa	205.8	251.6	91.0	NA	NA	548.4	24	50	NA
Kamla	Jainagar	57.3	126.8	148.9	108.0	NA	441.0	32	40	NA
	Jhanjharpur	45	317.4	142.8	111.8	49.4	666.4	56	59	51
Kosi	Okhaldunga	192.1	119.2	469.8	169.6	2.4	953.1	56	71	68
	Taplejung	NA	NA	NA	NA	NA	NA	NA	84	65
	Dhankutta	85.4	275.8	37.9	55.3	16.3	470.7	45	52	70
	Dharan	123.4	358.1	151.0	346.4	127.5	1106.4	61	63	83
	Basua	40.6	370	227.4	114.6	46.4	799	61	70	59
	Baltara	38.5	233	856.4	251	27.4	1406.3	55	56	38
	Kursela	64.6	249.8	222.4	163	77.8	777.6	81	84	73

Table 5.1.3 Monthly Monsoon Rainfall (mm) observed in the river basins of AoI-Flood 2012

Table 5.1.3 shows Basinwise monthly/monsoon rainfall in 2012 monsoon period. Column 9, Column 10 and Column 11 show the rainy days at the raingauge stations in monsoon 2012, 2011 and 2010 respectively. Also it is evident that in Nepal, number of rainy days in 2012 at almost all the raingauge stations are fewer in number than the last two years. It may be noted that at Sonbarsa in Bagmati Basin the rainfall data for September and October are not available and at Jainagar in Kamla Basin rainfall data for month October is not available. Hence the rainy days in column 9 of Table 5.1.2 for these stations are underlined.

A graphical representation showing rainy days at all the rain gauge stations basin wise for 2010, 2011 and 2012 is shown in Fig: 5.1.2.

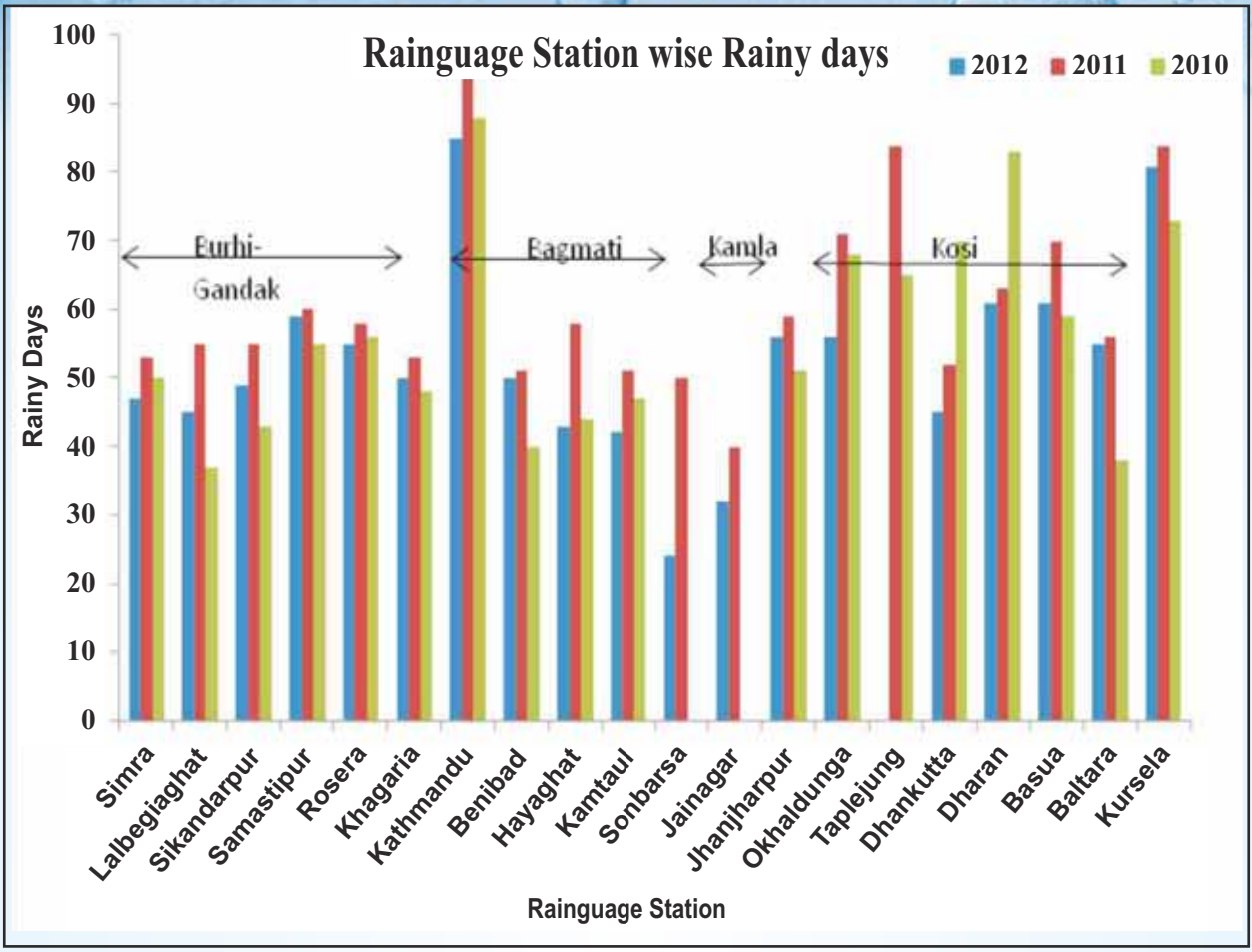


Fig: 5.1.2 Number of Rainy days based on data from 15th June 2012 to 15th Oct' 2012.

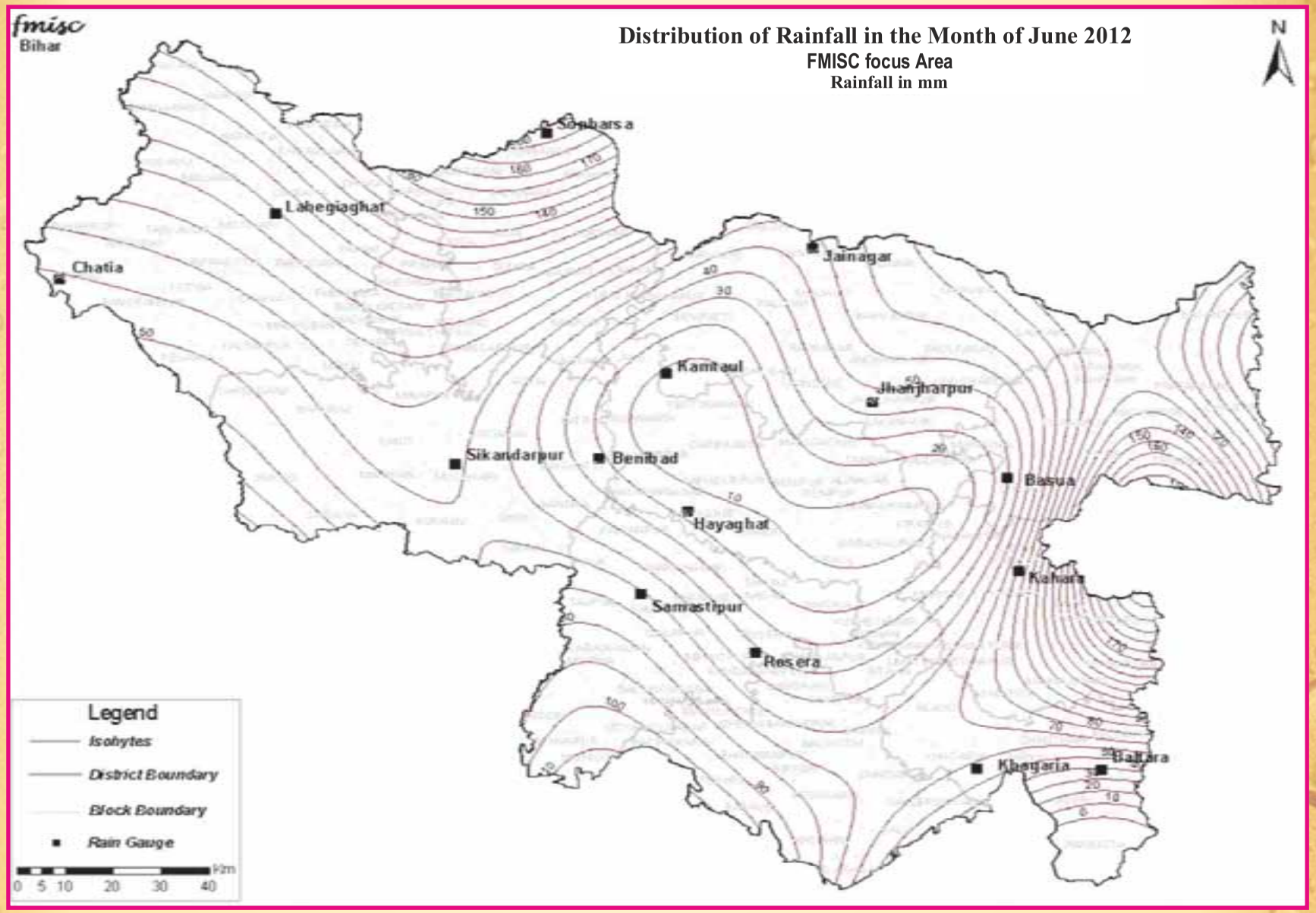
Isohyets Map:

Isohyets maps are drawn for each month from June to October to show the rainfall distribution in the 11 districts of FMISC –Phase-I focus area at Map 5.1.3 to Map 5.1.7. The Map 5.1.7 shows the monsoon rainfall distribution i.e. total rainfall from June to October. If we closely look at the rainfall distribution we find that this year western part received more rainfall than in the eastern part of North Bihar.

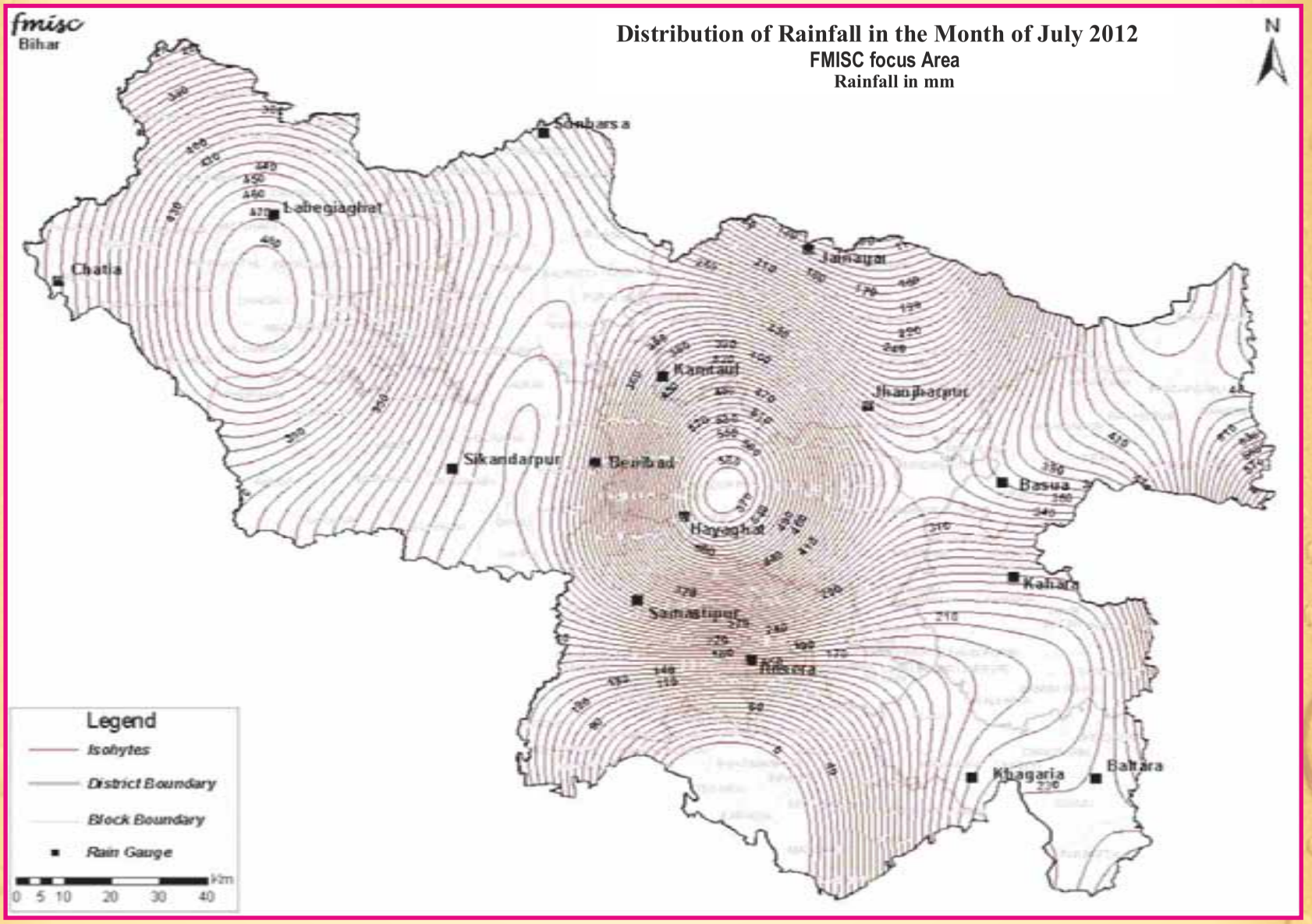
Actual Rainfall, Normal Rainfall and Percentage Departure:

This year we have added Maps showing districtwise actual and normal rainfall and percentage departure from normal rainfall for each month from June to October at Map 1.1.8 to Map 1.1.12. Based on the above data End of Season scenario cumulative actual and normal rainfall and % departure from June to October is shown at Map 1.1.13. The color composition of map and corresponding legend is self explanatory and gives an overall rainfall excess / normal / deficient / scanty state of concern district. The actual and the normal rainfall for each district have been shown in the form of vertical bars.

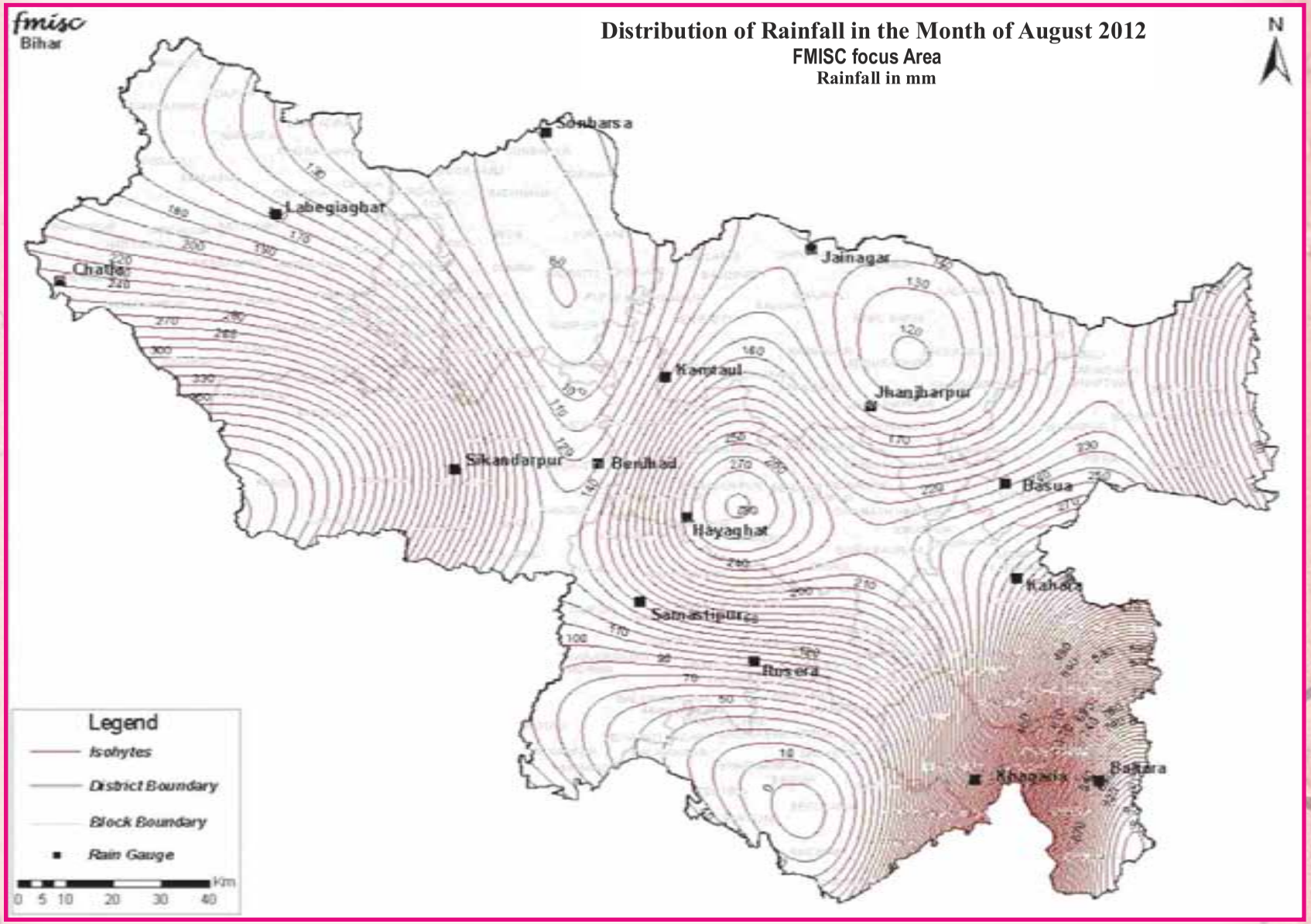
Map: 5.1.3


fmisc
Bihar
Distribution of Rainfall in the Month of June 2012
FMISC focus Area
Rainfall in mm
N
Sonbarsa
Lahegiaghat
Chatia
Jainagar
Kamtaul
Jhanjharpur
Sikandarpur
Benibad
Basua
Hayaghat
Kahara
Samastipur
Resera
Khagaria
Legend
Isohytes
District Boundary
Block Boundary
Rain Gauge
0 5 10 20 30 40

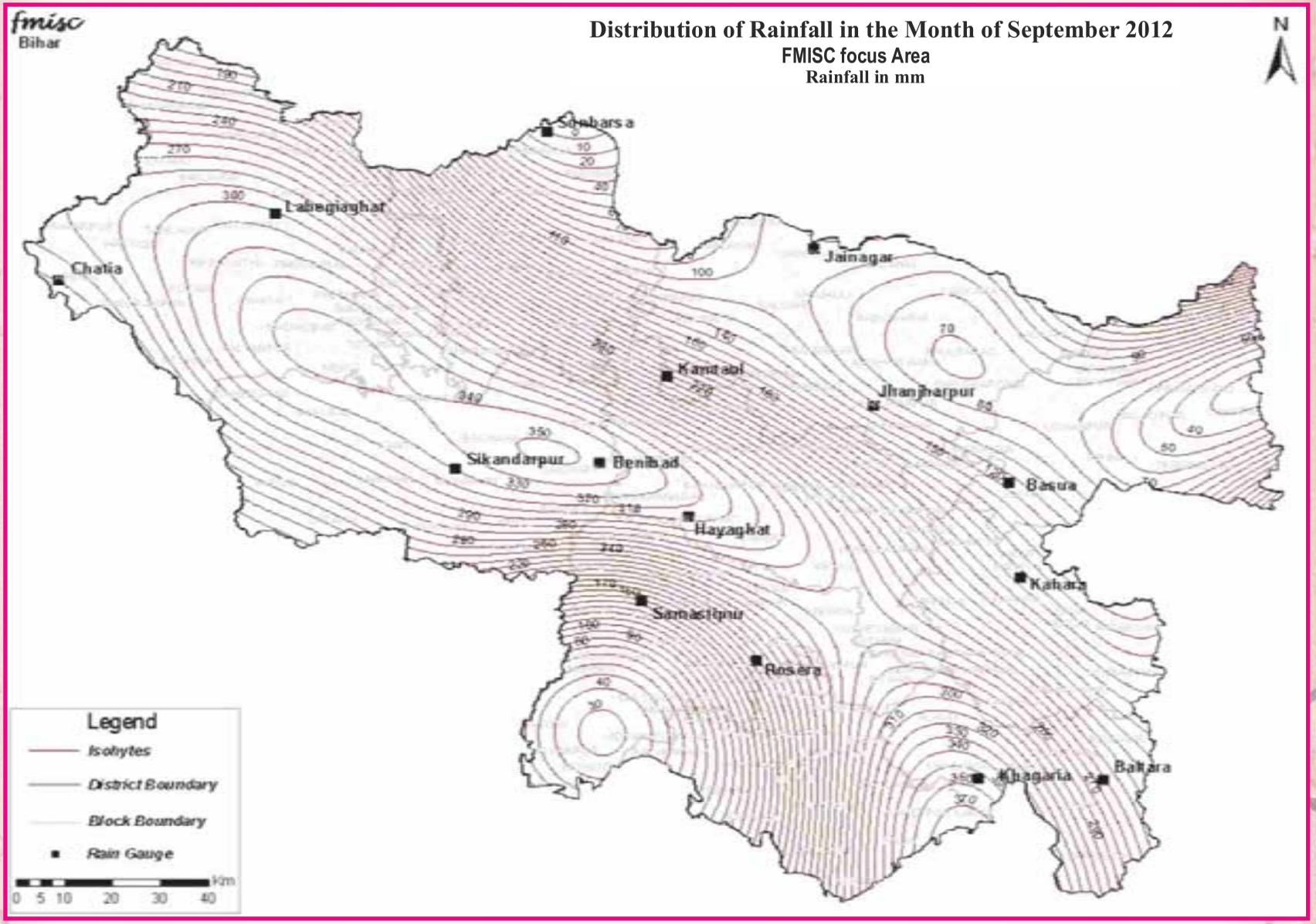
Map: 5.1.4


fmisc
Bihar
Distribution of Rainfall in the Month of July 2012
FMISC focus Area
Rainfall in mm
N
Sonbarsa
Chatia
Jamalpur
Kamtaul
Jhanjharpur
Sikandarpur
Basua
Hayaghat
Kalyan
Samastipur
Khagaria
Bahara
Legend
Isohytes
District Boundary
Block Boundary
Rain Gauge
0 5 10 20 30 40

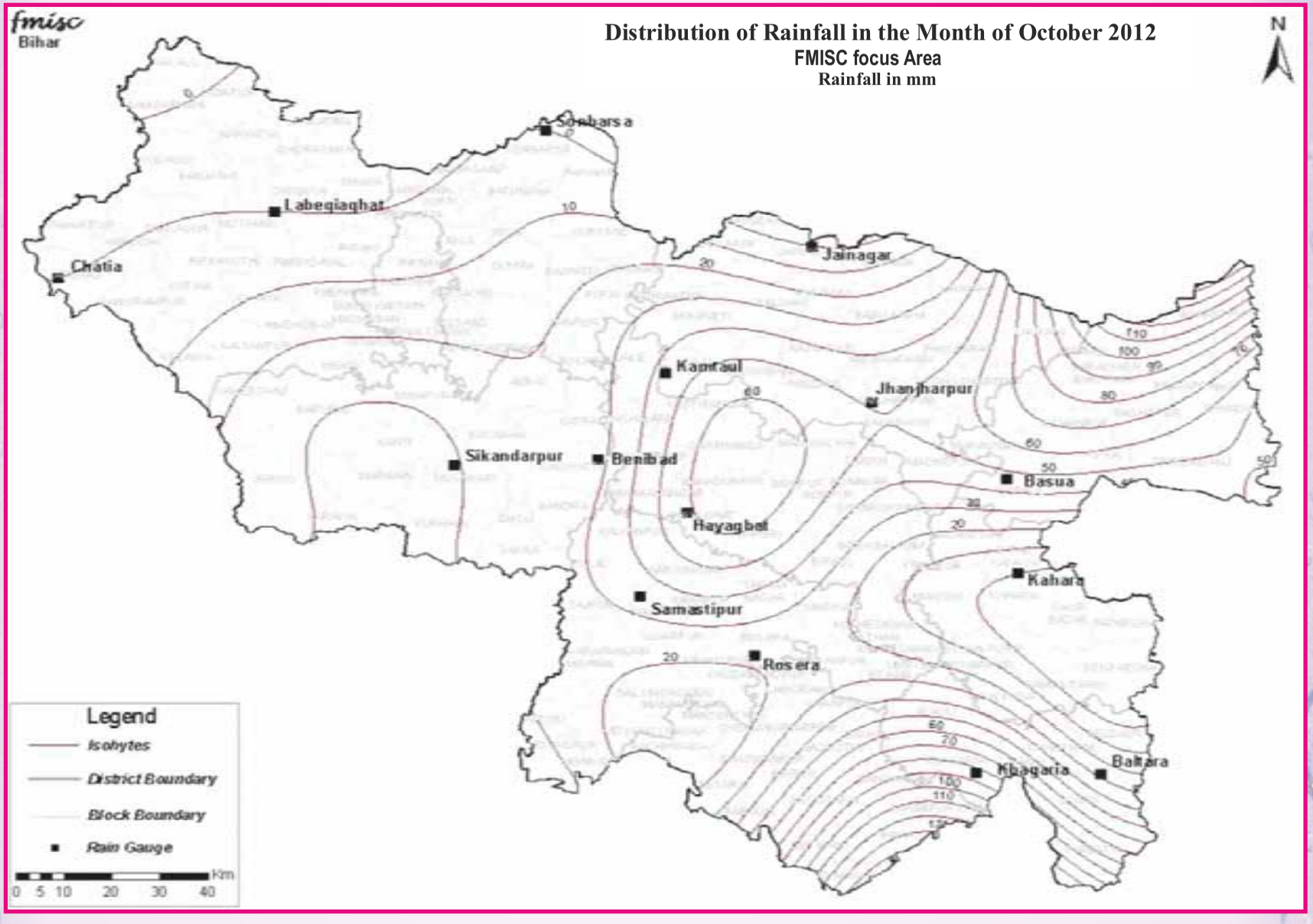
Map: 5.1.5


fmisc
Bihar
Distribution of Rainfall in the Month of August 2012
FMISC focus Area
Rainfall in mm
N
Sonbarsa
Labegiaghat
Chatia
Jainagar
Kamtaul
Jhanjharpur
Sikandarpur
Benibad
Basua
Hayaghat
Kahara
Samastipur
Rusera
Khagaria
Baktara
Legend
Isohytes
District Boundary
Block Boundary
Rain Gauge
Km
0 5 10 20 30 40

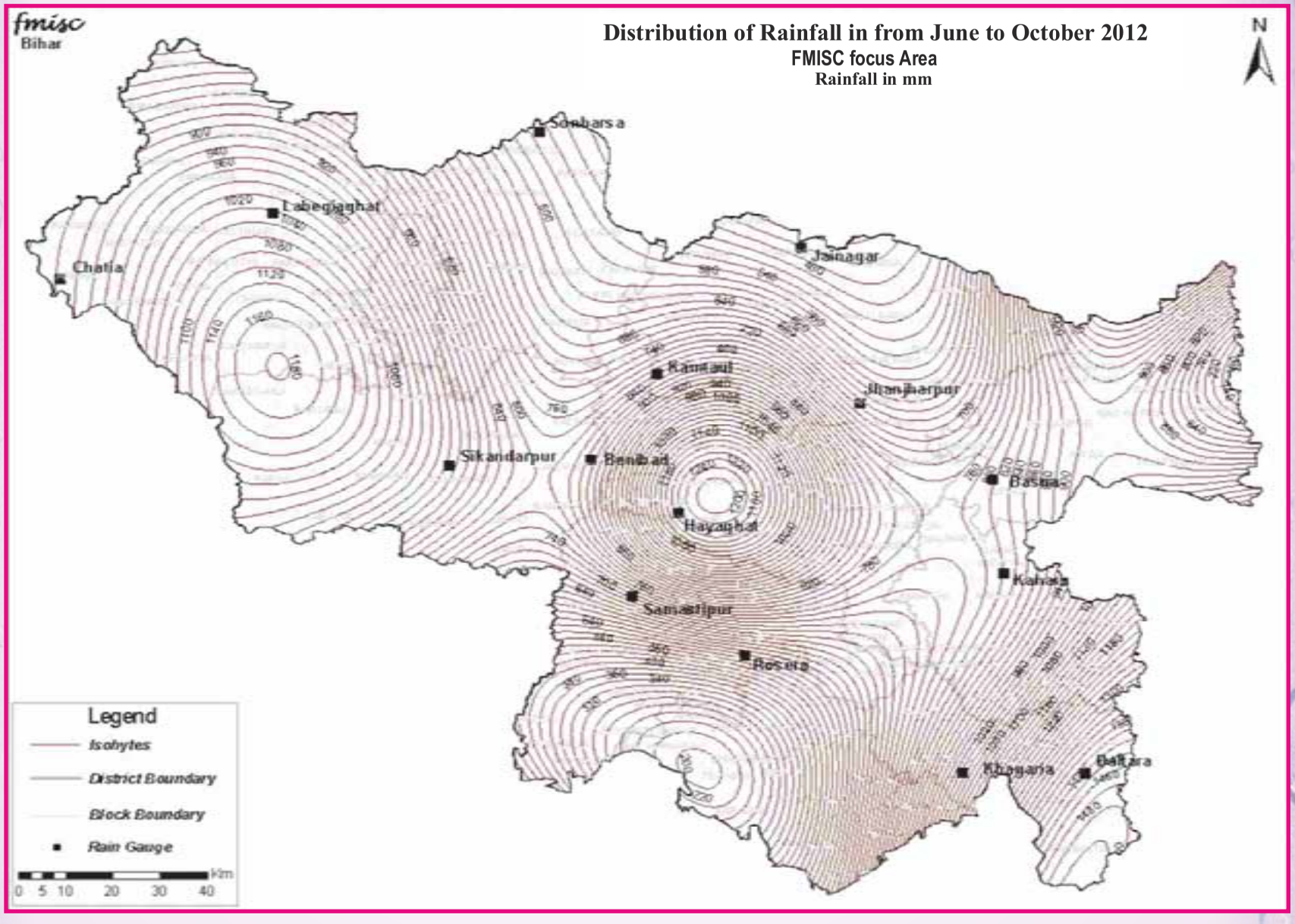
Map: 5.1.6


fmisc
Bihar
Distribution of Rainfall in the Month of September 2012
FMISC focus Area
Rainfall in mm
N
Simbarsa
Lalbegiaghat
Chatia
Jainagar
Kamtaul
Jhanjharpur
Sikandarpur
Benibad
Basua
Hayaghat
Kahara
Samastipur
Rosera
Khagaria
Baltara
Legend
Isohytes
District Boundary
Block Boundary
Rain Gauge
Km
0 5 10 20 30 40

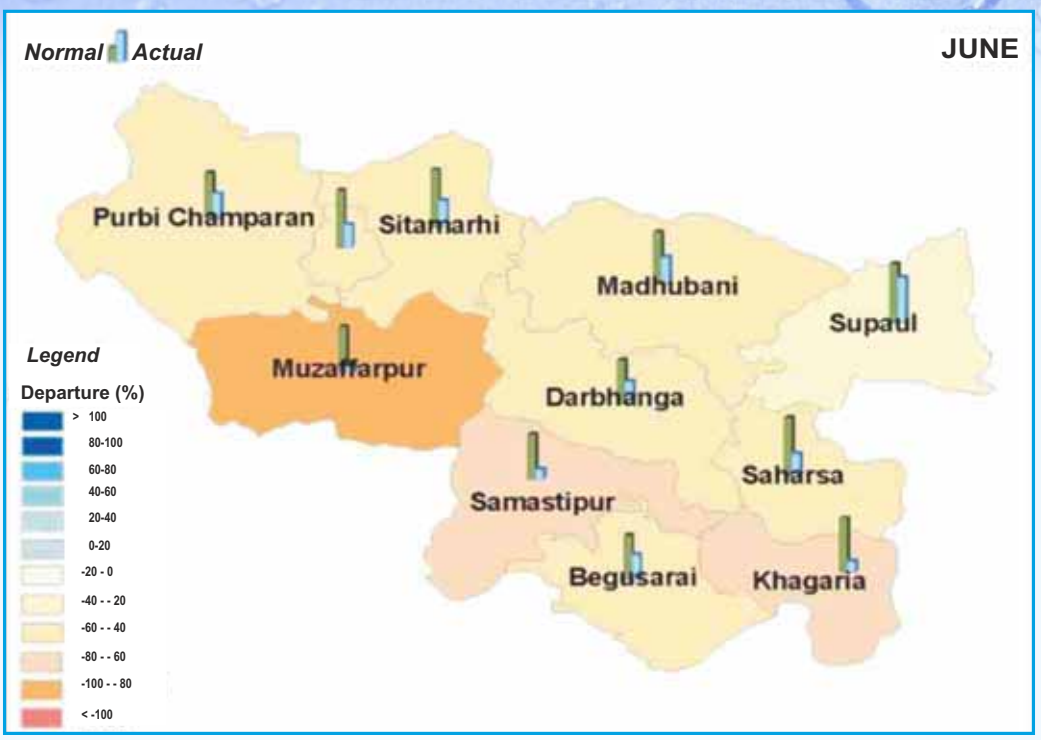
Map: 5.1.7


fmisc
Bihar
Distribution of Rainfall in the Month of October 2012
FMISC focus Area
Rainfall in mm
N
Saharsa
Labeqiaghat
Chatia
Jainagar
Kamtaul
Jhanjharpur
Sikandarpur
Benibad
Basua
Hayaghat
Kahara
Samastipur
Rosera
Khagaria
Baltara
Legend
Isohytes
District Boundary
Block Boundary
Rain Gauge
Km
0 5 10 20 30 40

Map: 5.1.8

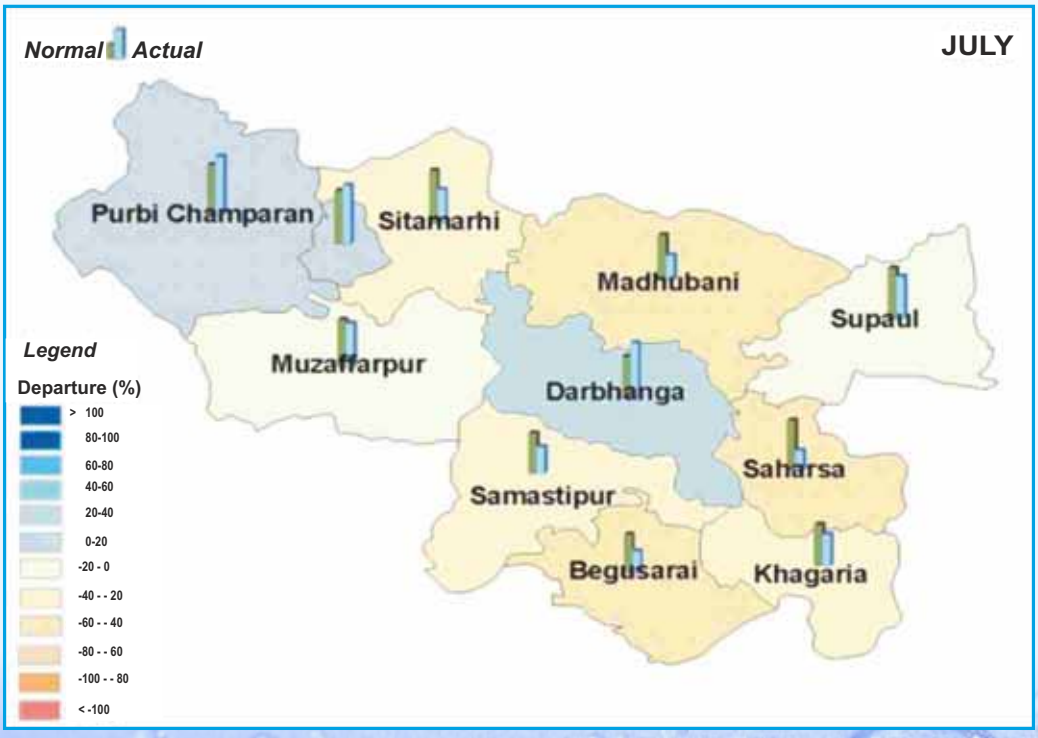

fmisc
Bihar
Distribution of Rainfall in from June to October 2012
FMISC focus Area
Rainfall in mm
N
Sonbarsa
Jainagar
Chatia
Ramnaul
Jhanjharpur
Sikandarpur
Benibad
Basua
Hayaghat
Kahala
Samastipur
Rosera
Khagaria
Bakhtiarpur
Legend
Isohytes
District Boundary
Block Boundary
Rain Gauge
0 5 10 20 30 40
Km

Map 5.1.9 Districtwise Actual, Normal Rainfall and % Departure for June'12



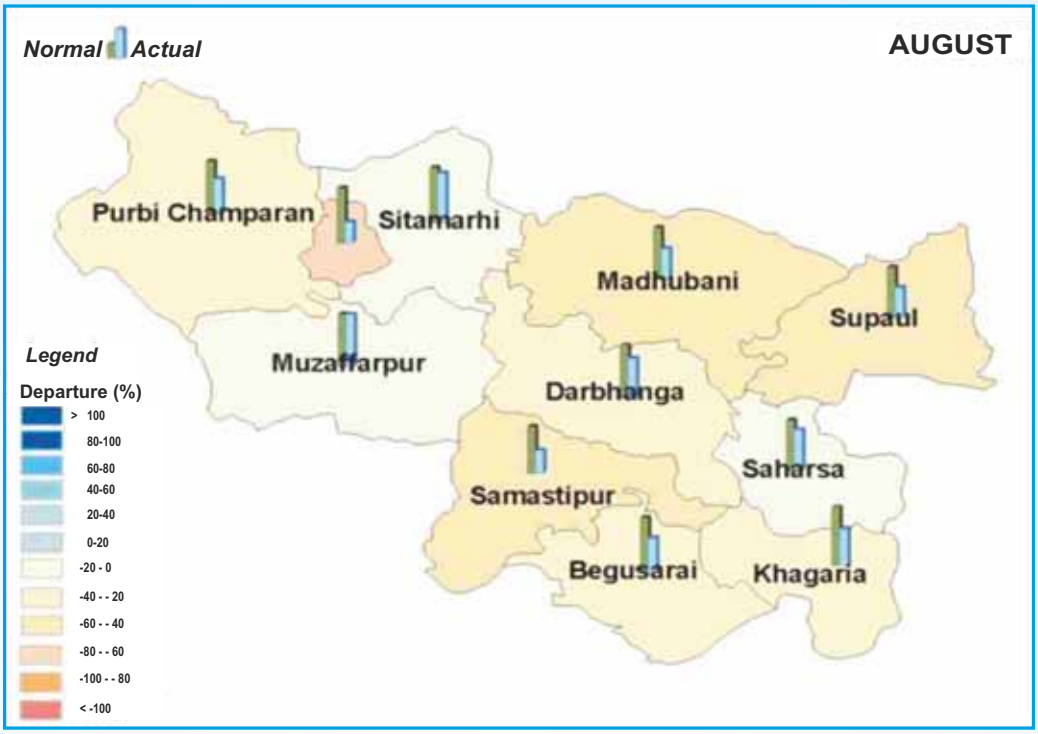
As already mentioned this season monsoon arrived late by almost a week. Therefore in the month June'12 we find that almost all the districts received either deficient or scanty rainfall. The bars drawn in the Map give the real feel of departure from normal rainfall to actual in each district.

Map 5.1.10 Districtwise Actual, Normal Rainfall and % Departure for July'12



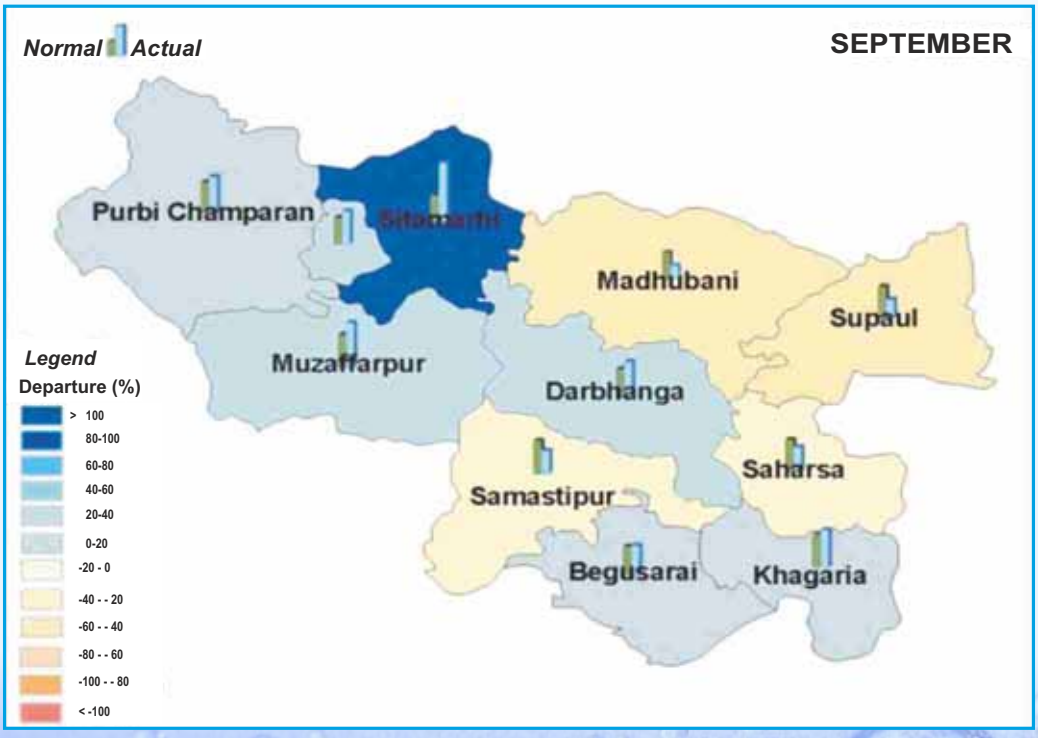
In the next month, i.e. July'12 situation in Purbi Champaran, Sheohar and Darbhanga improved while in all other districts remained deficient and scanty.

Map 5.1.11 Districtwise Actual, Normal Rainfall and % Departure for August'12



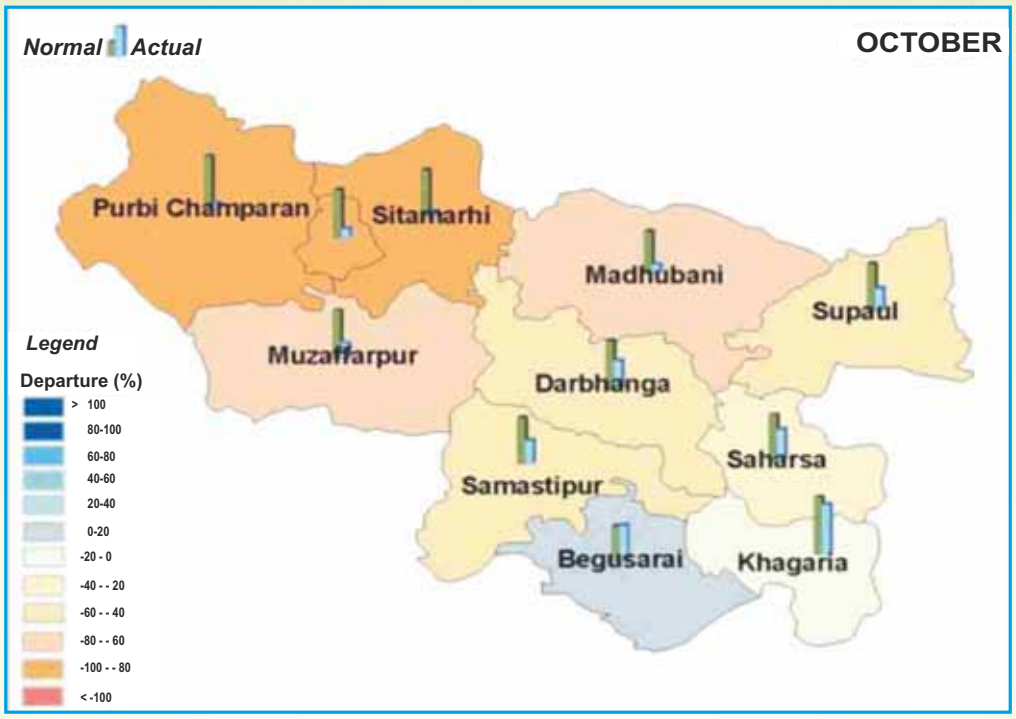
Again in month of August'12 the situation worsend even after a better rainfall in July'12.

Map 5.1.12 Districtwise Actual, Normal Rainfall and % Departure for September'12



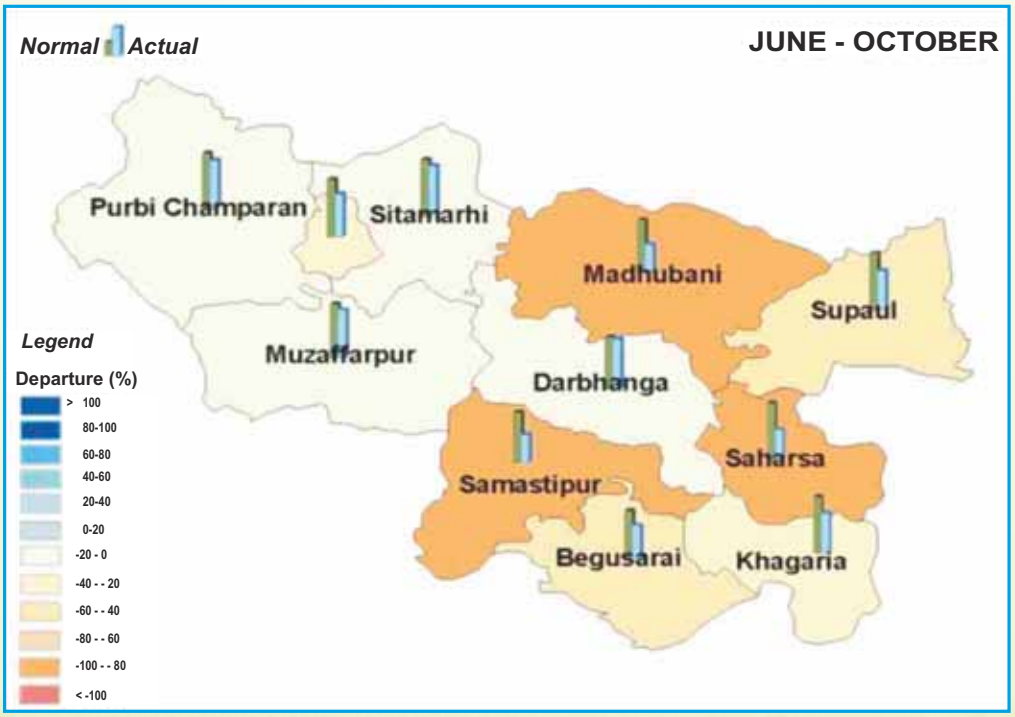
The Scenario in September'12 is much better except in Madhubani, Supaul, Saharsa and Samastipur districts where rainfall was still deficient..

Map 5.1.13 Districtwise actual, normal rainfall and % departure for October '12



As the monsoon started receding in the month of October'12, only Begusarai received normal rainfall else all other districts are in deficient or scanty rainfall situation.

Map 5.1.14 Districtwise End of Season Scenario of Rainfall (June'12 to October'12)



The end of season Map 5.1.13 above shows that all the districts received deficient or scanty rainfall this year.

5.2 Effect of Rainfall in Nepal on the river-stages in Bihar

The catchment area of the rivers in North Bihar primarily lies in Nepal. To better understand the effect of rainfall in upper catchment on the river gauge close to the Indo-Nepal border for the river basin of FMISC AOI at Lalbegiaghat on BurhiGandak, Sonakhan on Bagmati, Jainagar on Kamla and Basua on Kosi was considered. For each basin graph of daily river water levels vis-a-vis daily average rainfall of the locations mentioned below are shown in Fig. 5.2.1 to 5.2.4.

Name of basin	Part under consideration	Rain-gauge stations considered for averaging
1	2	3
Burhi Gandak	Up to Lalbegia ghat	Simara
Bagmati	Up to Sonakhan	Kathmandu, Godavari, Karmaiya, Bhorleni, Garuda
Kamla	Up to Jainagar	Sindhuligadhi
Kosi	Up to Basua	Okhaldunga, Chatra, Mulghat, Taplejung, Dhankutta, Jiri, Pachuwarghat, Tumlingtar

Since the rainfall stations are less in number, the correlation between average rainfall and water level of different rivers may not be truly matching because of temporal and spatial variability.

Number of rain-gauge stations is too less to account for the aerial variability of rainfall. Therefore, instead of using rigorous methods, simple arithmetic mean has been used for averaging the rainfall.

Few data were not available both in case of water level and rainfall. In case of water level these are obvious as discontinuity in the graph, whereas the rainfall are shown as vertical column hence the gaps are not evident.

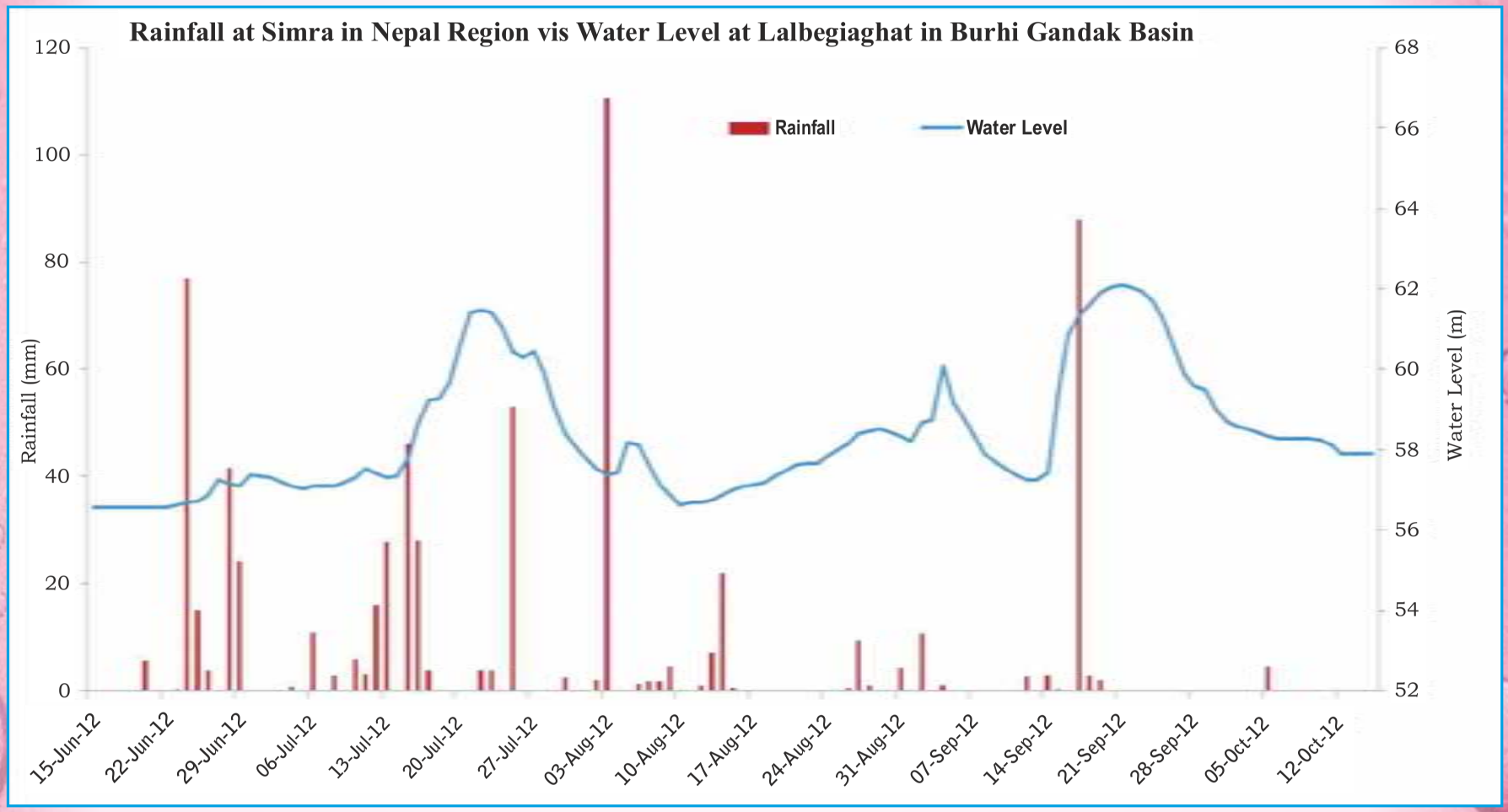


Fig. 5.2.1 Lalbegiaghat on River Burhi Gandak From 15th June to 15th October

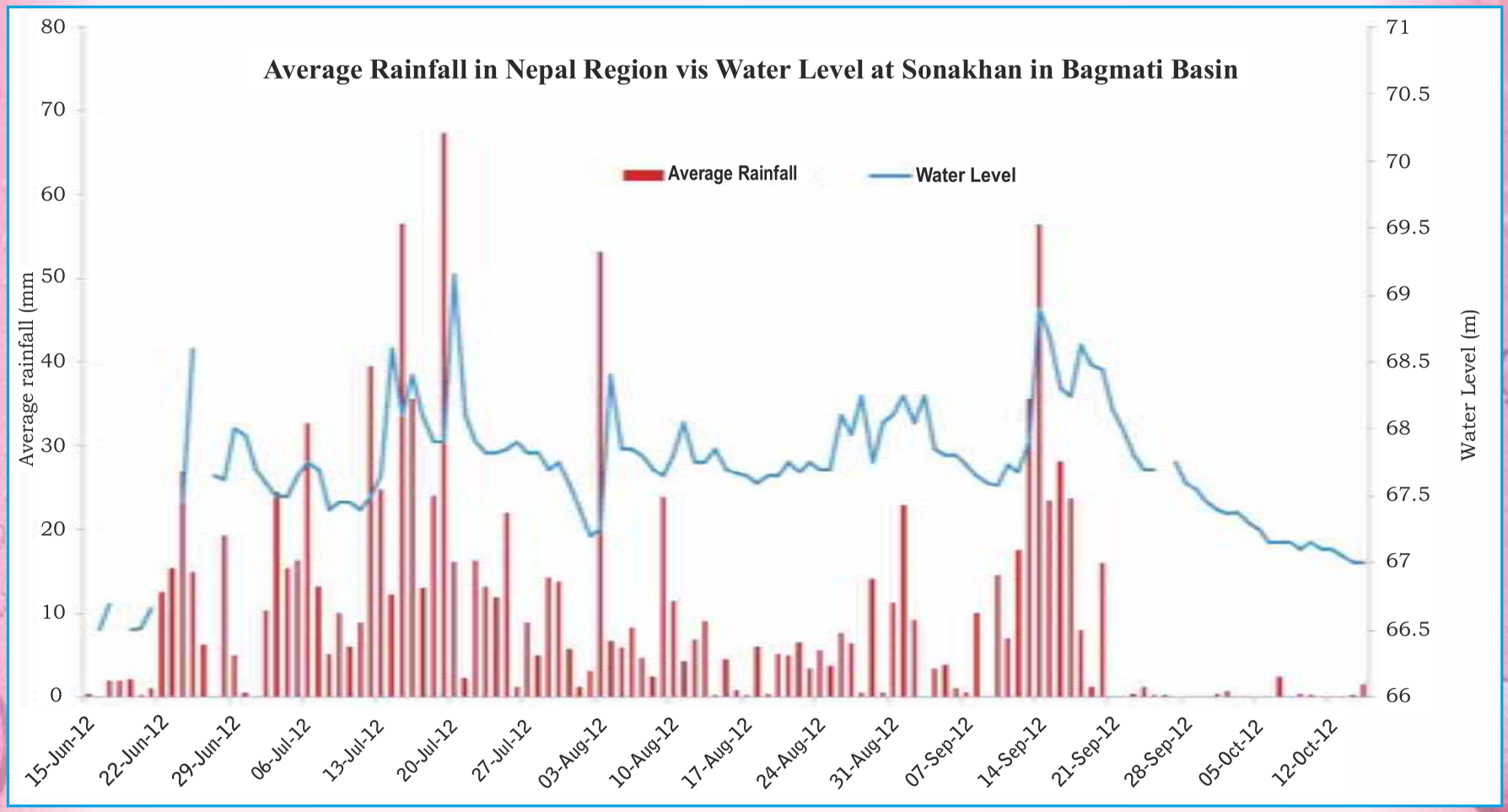


Fig. 5.2.2 Sonakhan on River Bagmati From 15th June to 15th October

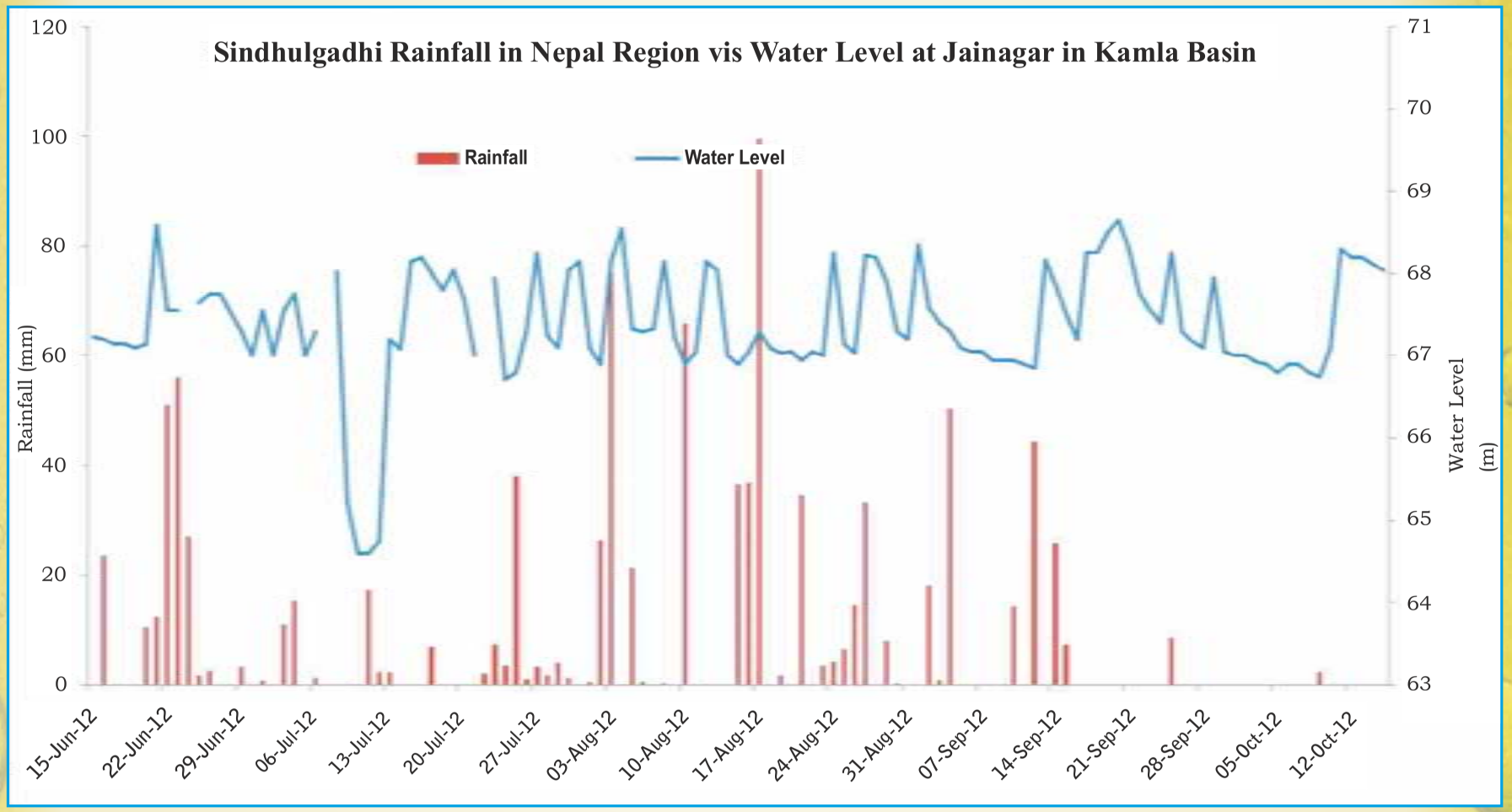


Fig. 5.2.3 Jainagar on River Kamla From 15th June to 15th October

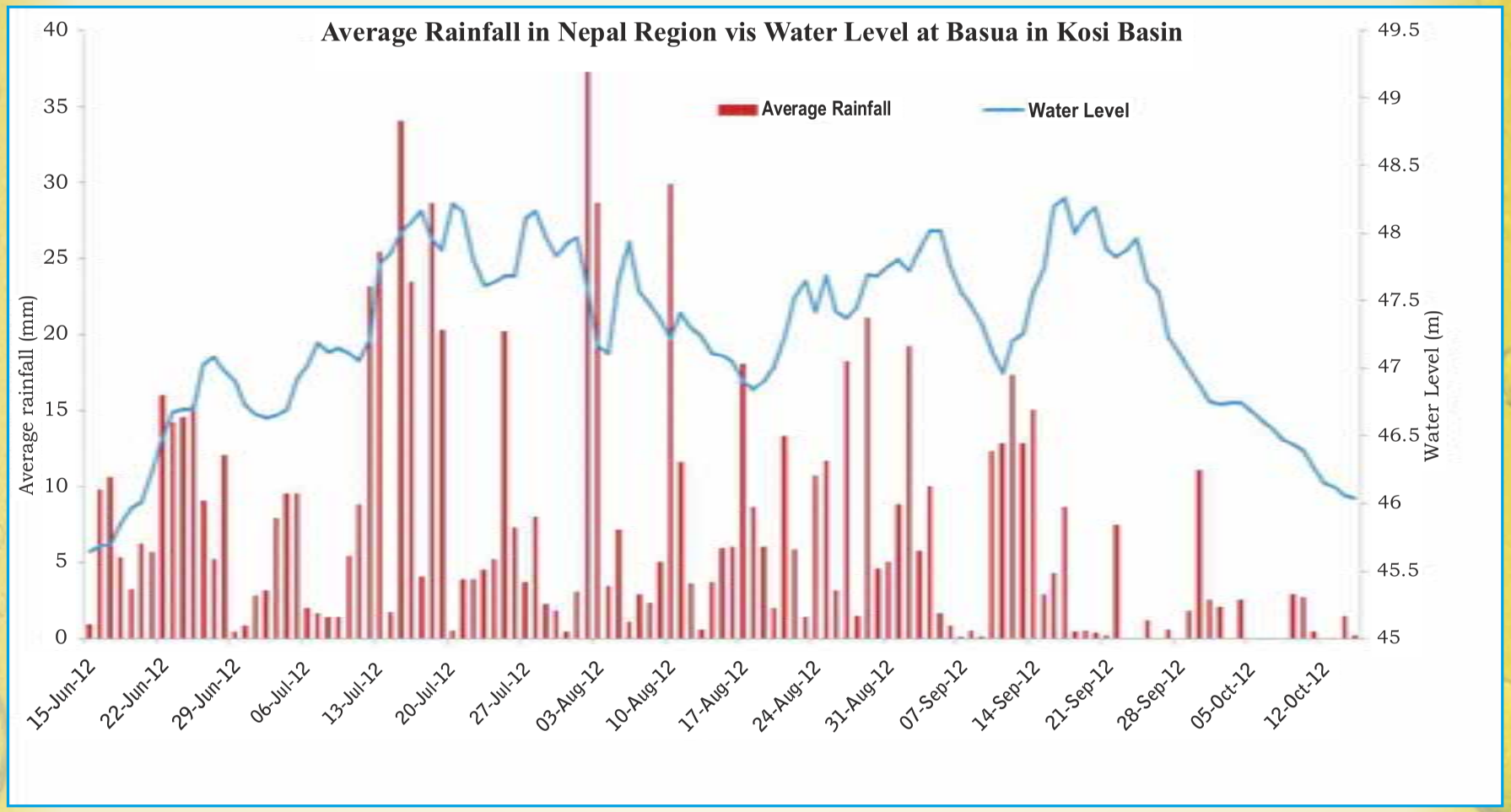


Fig. 5.2.4 Basua on River Kosi From 15th June to 15th October

5.2.1 Conclusions

Water level rises and recedes as the magnitude of rainfall in basins rise or fall, of course, with a certain lead time. Nevertheless water level doesn't seem to have a very systematic relationship with average rainfall. The possible reason may be the inadequate number of rain gauge stations used to compute average rainfall. The available rain gauge stations are too less in number to capture the spatial variability of rainfall. Secondly, arithmetic mean doesn't hold well in hilly terrain

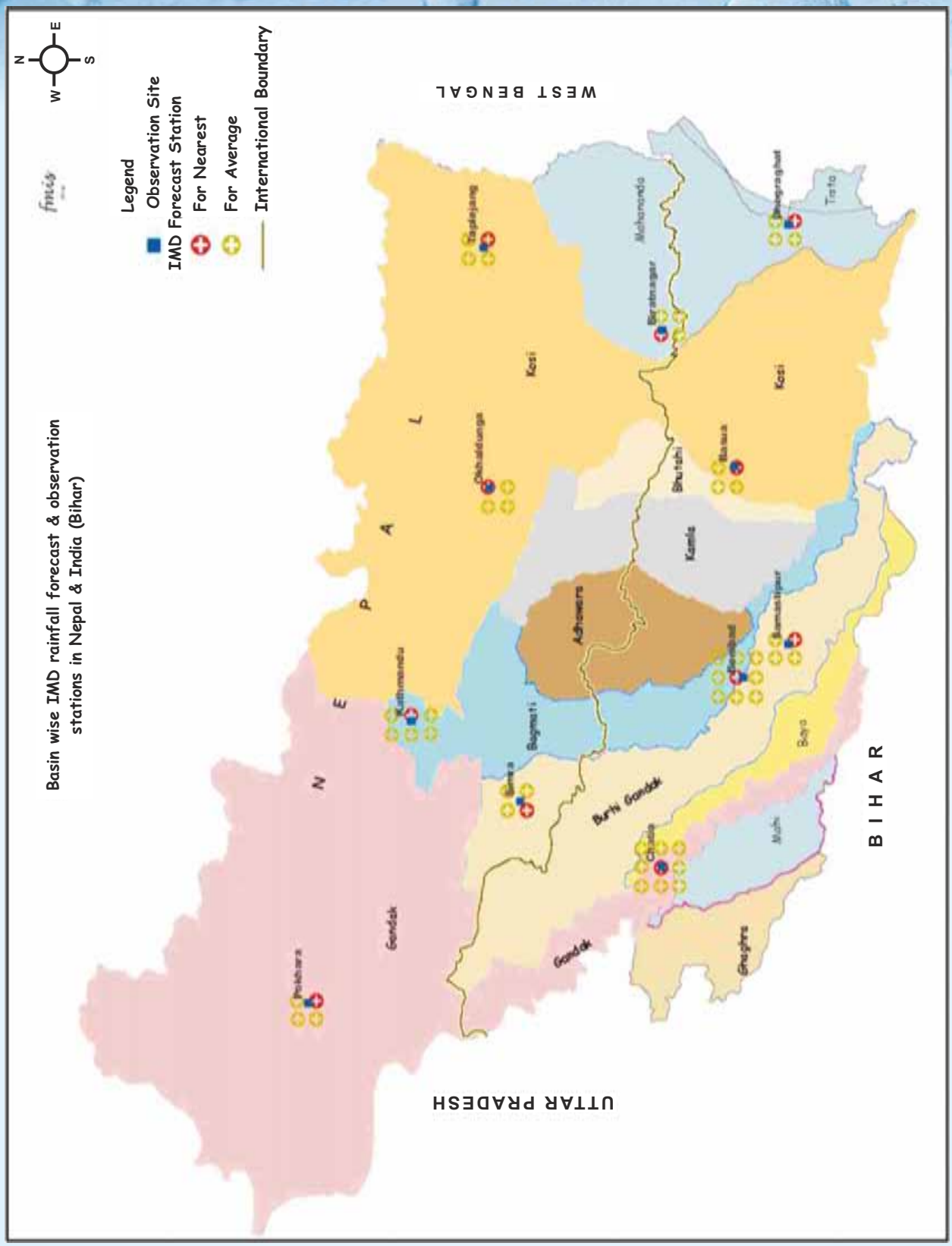
5.3 Rainfall Forecast

Under a MoU signed between FMISC, Bihar and IMD, New Delhi, the IMD has been providing rainfall forecast for an area between Latitude 25.53^0 N to 28.77^0 N and Longitude 83.24^0 E to 88.50^0 E. This area entirely covers the focus area of FMIS, catchments area in Nepal of all rivers within our area of interest and some adjoining area in Bihar. The forecasts were done using the Weather Research and Forecasting (WRF) Model. It is a next-generation mesoscale numerical weather prediction system designed to serve both operational forecasting and atmospheric research needs. WRF model rainfall forecast, from IMD, Delhi is for 9x9 km resolution, i.e. total 1386 numbers of grids covering the area. FMISC Bihar received rainfall forecast via mail on daily basis for the next three consecutive days separately i.e. for day1, day2 and day3. Maximum value of forecasts for each river basins of the focus area of FMIS were extracted and provided in the Daily Flood Information Bulletin issued from the FMISC. These forecasts were used to acquire the availability of satellite images with NRSC, Hyderabad on the days likely to have critical rainfall.

A study was undertaken within FMIS to compare the 3 day WRF model forecast with the actual observed rainfall for Gandak, Burhi Gandak, Bagmati, Kosi and Mahanada basin. The forecast station that was chosen from 1386 grid stations are the one which lay within 4.5 km radius of the observation station both in Nepal and India (Bihar region). This was done by applying nearest neighbourhood analysis in GIS environment. To better understand the relation between forecasted rainfall and observed rainfall, two different set of forecasted values were taken, one which lay within 4.5 km radius and another taking average of the stations lying nearby the observed station. Thus eleven forecast stations for one to one comparison and fifty six forecast stations were selected among the available data set of IMD for averaging the forecasted value and compare with nearest observed rainfall. To illustrate, the forecasted stations taken for study are being depicted in Map 5.3.1 and Table 5.3.1.below, which indicate the station name, basin name, region and position of the observation sites and WRF model stations.

Graphs were drawn for observed rainfall vrs. 3-day IMD rainfall forecast. Sample graph for Bagmati Basin for Kathmandu in Nepal and Benibad in Bihar is shown at Figure 5.3.2 and 5.3.3 respectively compared with forecast rainfall lying within 4.5 km. Also averaged forecasted rainfall data as per Table 5.3.2 vrs observed rainfall is shown for Kathmandu and Benibad at figure 5.3.4 and 5.3.5 respectively.

Correlation Coeffient were also calculated for each station mentioned in Table 5.3.1 and tabulated in Table 5.3.2 and Table 5.3.3.



Map 5.3.1 Basinwise IMD rainfall forecast stations and observation stations in Nepal and India (Bihar)

Table 5.3.1 : Names of Stations taken for comparison with WRF model forecast

Sl. No.	Name of Basin	Region	Name of Station	Position	WRF model Station Name	Position	Forecast stations for averaging
1	Gandak	Nepal	Pokhara	84.00E 28.2N	F-659	84.015E 28.16N	F- 616, 615, 660, 659
		India (Bihar)	Chatia	84.66E 26.48N	F-949	84.62E 26.48N	F-906, 905, 904, 950, 949, 948, 994, 993, 992
2.	Burhi-Gandak	Nepal	Simra	84.98E 27.17N	F-1088	84.93E 27.14N	F-1089, 1088, 1133, 1132
		India (Bihar)	Samastipur	85.74E 25.86N	F-1470	85.76E 25.83N	F-1427,1426, 1471, 1470
3.	Bagmati	Nepal	Kathmandu	85.37E 27.7N	F-1314	85.4E 27.69N	F-1271, 1270, 1269, 1315, 1314, 1313
		India (Bihar)	Benibad	85.58E 26.08N	F-1385	85.58E 26.11N	F-1342, 1341, 1340, 1386, 1385, 1384, 1430, 1429, 1428
4.	Kosi	Nepal	Taplejung	87.67E 27.35N	F-2410	87.70E 27.32N	F-2367, 2366, 2411, 2410
		Nepal	Okhaldunga	86.5E 27.32N	F-1838	86.50E 27.32N	F- 1794, 1793, 1838, 1837
		India (Bihar)	Basua	86.60E 26.12N	F-1869	86.6E 26.11N	F-1826, 1825, 1870, 1869
5.	Mahananda	Nepal	Biratnagar	87.27E 26.48N	F-2181	87.24E 26.48N	F- 2181, 2180, 2225, 2224
		India (Bihar)	Dhengraghat	87.78E 25.86N	F-2438	87.8E 25.83N	F- 2395, 2394, 2439, 2438

A Sample graph for Bagmati Basin is included in this report.

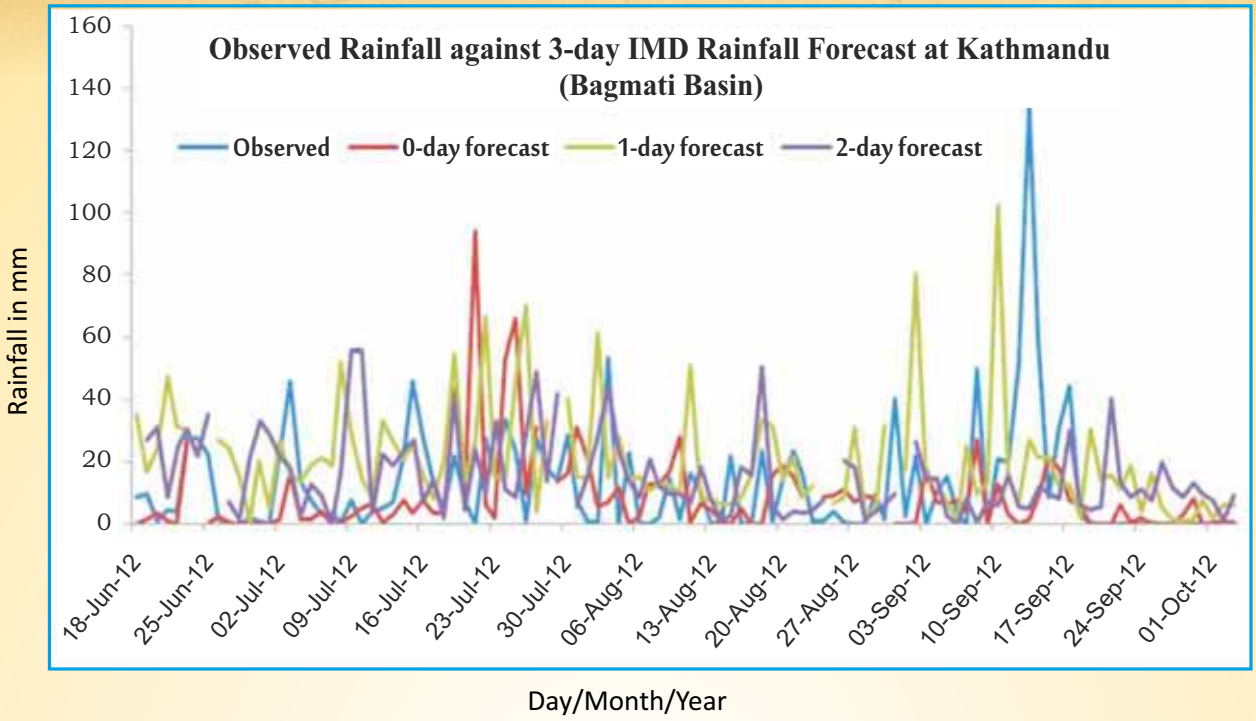


Fig. 5.3.2 Kathmandu

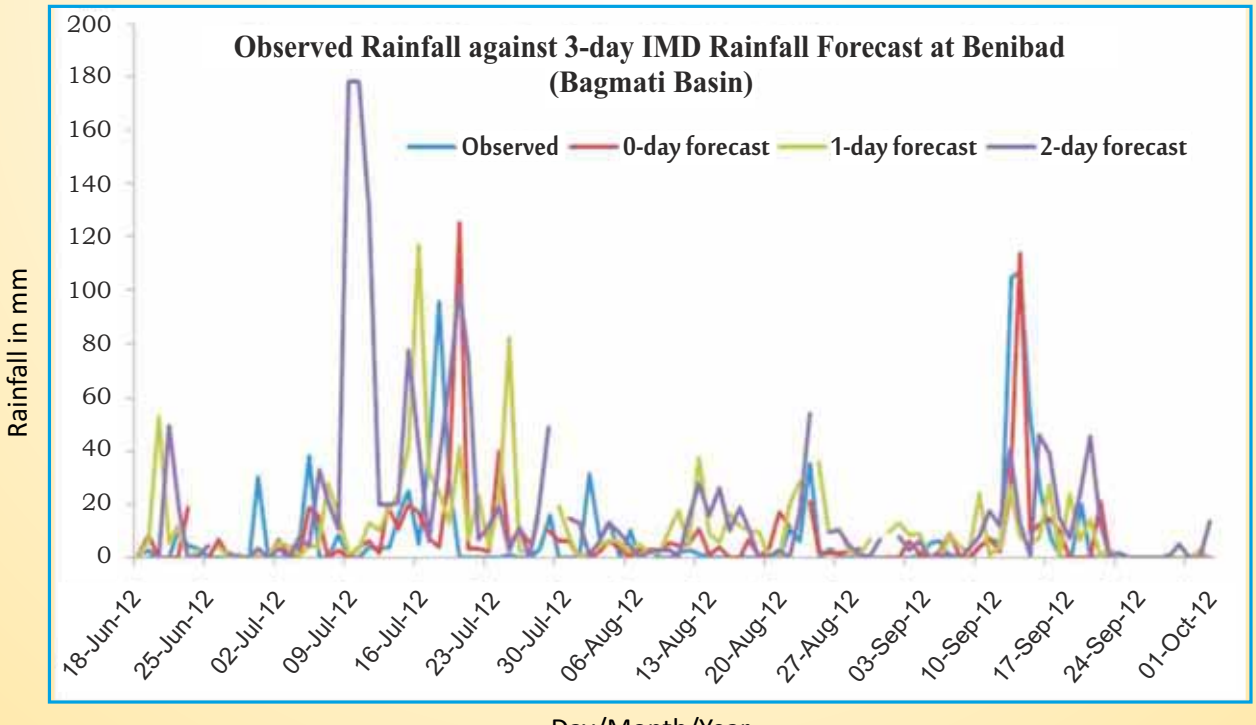


Fig. 5.3.3 Benibad

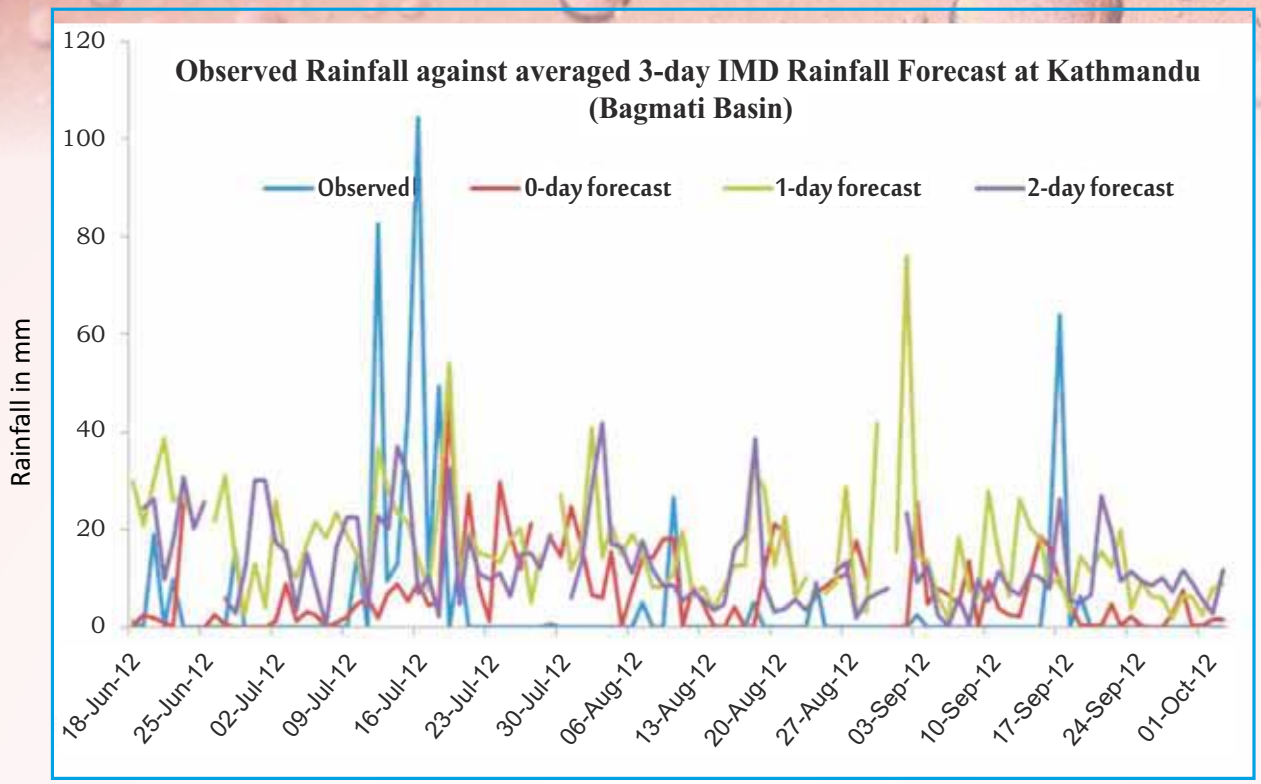


Fig. 5.3.4 Kathmandu

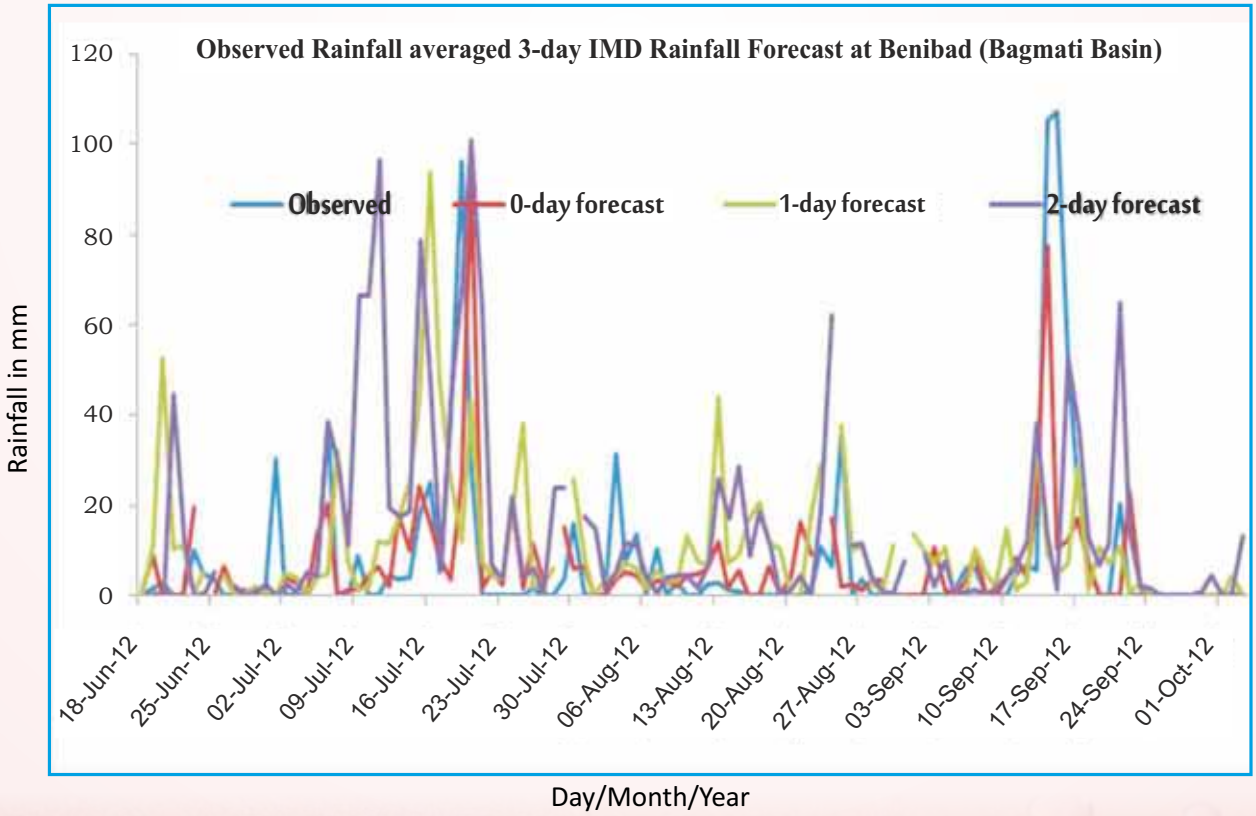


Fig. 5.3.5 Benibad

The correlation coefficient between the observed rainfall and 3- day forecast is tabulated below:

Table 5.3.2 Nearest forecast station vs. observed station

Sl. No.	Name of Basin	Region	Name of Station	Correlation coefficient		
				0-day	1-day	2-day
1	Gandak	Nepal	Pokhara	0.11	0.16	0.18
		India (Bihar)	Chatia	0.46	0.16	0.34
2.	Burhi-Gandak	Nepal	Simra	0.09	0.23	0.24
		India (Bihar)	Samastipur	0.20	0.33	0.23
3.	Bagmati	Nepal	Kathmandu	0.18	0.12	0.06
		India (Bihar)	Benibad	0.50	0.12	0.16
4.	Kosi	Nepal	Taplejung	0.09	0.02	0.13
		Nepal	Okhaldunga	-0.01	-0.16	-0.02
		India (Bihar)	Basua	0.32	0.25	-0.01
5.	Mahananda	Nepal	Biratnagar	0.17	0.57	0.03
		India (Bihar)	Dhengraghat	0.26	0.14	0.06

Table 5.3.3 Average of nearest forecast station vs. observed station

Sl. No.	Name of Basin	Region	Name of Station	Correlation coefficient		
				0-day	1-day	2-day
1	Gandak	Nepal	Pokhara	0.10	0.32	0.21
		India (Bihar)	Chatia	0.44	0.23	0.36
2.	Burhi-Gandak	Nepal	Simra	0.11	0.23	0.24
		India (Bihar)	Samastipur	0.30	0.36	0.33
3.	Bagmati	Nepal	Kathmandu	0.15	0.13	0.12
		India (Bihar)	Benibad	0.51	0.15	0.28
4.	Kosi	Nepal	Taplejung	0.05	0.05	0.17
		Nepal	Okhaldunga	-0.07	-0.04	0.03
		India (Bihar)	Basua	0.38	0.21	0.01
5.	Mahananda	Nepal	Biratnagar	0.27	0.78	0.05
		India (Bihar)	Dhengraghat	0.14	0.11	0.07

5.3.1 Conclusion

One can conclude from the preceding paragraphs that the WRF model rainfall forecast still needs improvement to match the value. From the graphs for all the stations show very poor relation between the forecasted and observed rainfall. More or less both in Nepal and Bihar the model result was far from what was observed. The sample graph of Bagmati Basin at Kathmandu in Nepal and Benibad in Bihar if looked minutely will show vast difference in the value of observed rainfall and forecasted rainfall. This year even trend of the forecasted 0-day, 1-day, 2-day forecast is not matching.

The correlation table also shows that very poor correlation between the forecasted and observed rainfall exists. In general the forecasted values and the observed values are not in agreement and varying widely. The average forecast gave no better match. This may be because monsoon this year was deficient. One very important observation is that the correlation coefficient for each station is poor than last year i.e. 2011 monsoon.

In Table 5.3.2 and in Table 5.3.3 we find that only one rainfall station namely Okhaldunga in Nepal is showing negative correlation coefficient. The released data set needs to be reviewed.

5.4 Satellite based monitoring of north Bihar rivers and Flood Impact

This year there was no major flood event, hence no major inundation or breach reported. FMIS customized the inundation layers provided by NRSA under National Disaster Management Programme (NDMSP)

Radarsat-1, Radarsat-2 and Risat-1 images covering the AOI were obtained during the flood season to view the flood impact. These images were procured and primarily processed under national disaster management support program by NRSC, Hyderabad, and then given to the Flood Management Improvement Support Center, Patna where value addition was done and disseminated to the user departments: Water Resources, Disaster Management, and Agriculture Departments. The maps depict the extent of flood inundation. The Maps elaborate the name of blocks / villages under inundation area affected. Also the same were hosted to FMISC website at near real time for public viewing.

Since FMIS is having Spatial database for only 11 districts of North Bihar (Focus Area Phase-I) our study are limited to these districts only.

Details of the satellite data acquired are as mentioned in the following table.

SL. No.	Date of Satellite data Acquired	Date of satellite data received / product Dissemination	Type of Satellite/ Sensor	Trigger / Incidence
1	18-Jul-12	19-Jul-12	Radarsat-1	Flood Inundation in North Bihar
2	20-Jul-12	20-Jul-12	Radarsat-1	Flood Inundation in North Bihar
3	22-Jul-12	23-Jul-12	Radarsat-2	Flood Inundation in North Bihar
4	23-Jul-12	26-Jul-12	Radarsat-2	Flood Inundation in North Bihar
5	25-Jul-12	27-Jul-12	Radarsat-1	Flood Inundation in part of North Bihar
6	26-Jul-12	27-Jul-12	Radarsat-1	Flood Inundation in Part of North Bihar
7	08-Aug-12	09-Aug-12	Radarsat-2	Flood Inundation in part of North Bihar
8	20-Sep-12	23-Sep-12	Risat-1	Flood Inundation in part of North Bihar
9	25-Sep-12	26-Sep-12	Radarsat-2	Flood Inundation in North Bihar

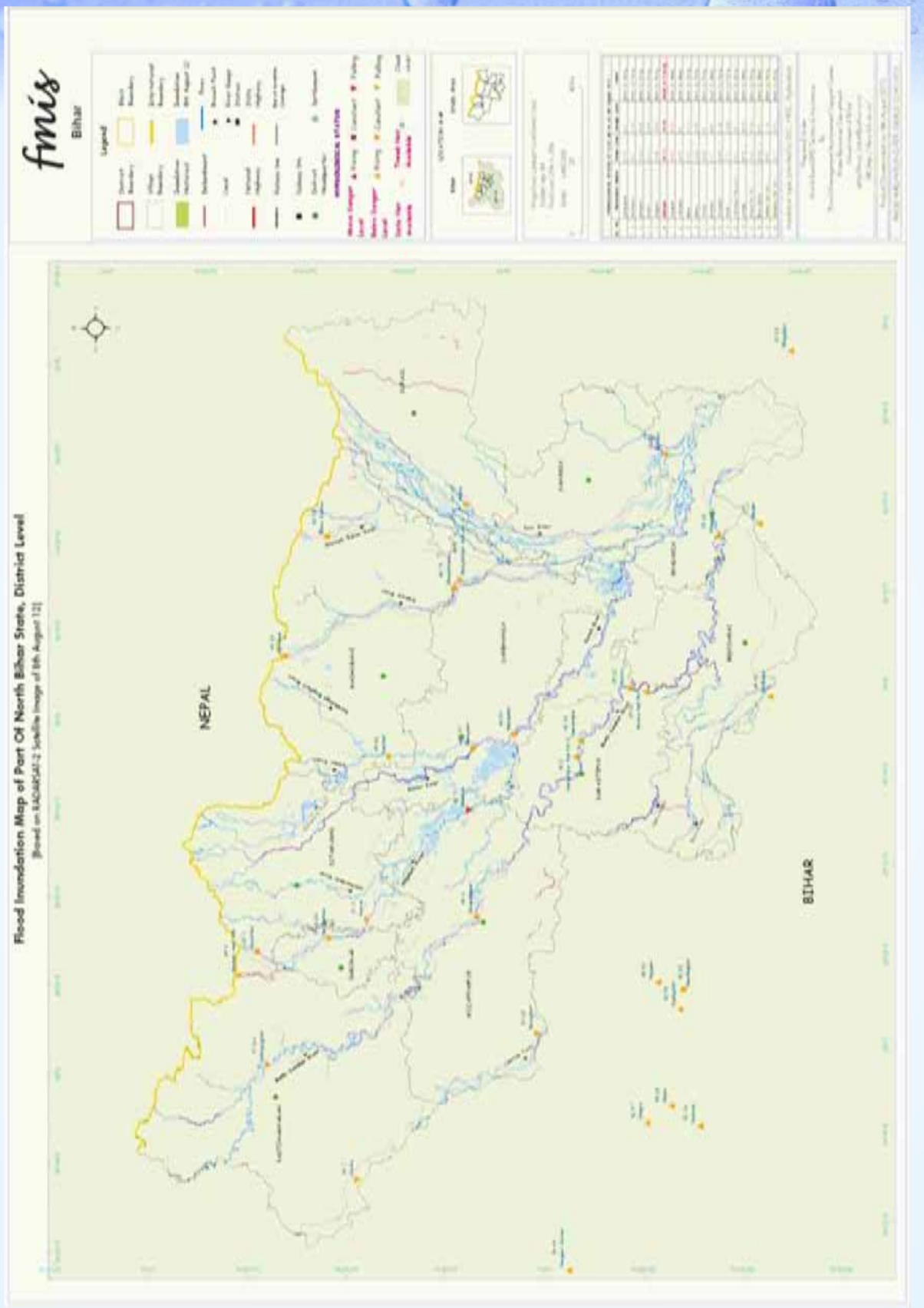
Total no. of layers received during the flood season 2012 – 9 no.

5.4.1 Value Added Inundation Maps

Based on our past experience of previous flood seasons we have tried to make our maps more useful to a greater number of users with varied interest and responsibilities. The maps are customized showing the administrative boundaries, important settlements, location of gauge sites; both for water level and rainfall along with trend of water level; relief camps as well as location of sites where roads have been overtopped by flood waters. Also for more value addition we have enriched our Geo database from various sources. The Information products are found to be very useful in planning Anti Erosion structures by Flood Management Offices.

The customized products prepared in flood season 2012 for uses for different stakeholders of State and Central Govt. Offices. are as below:

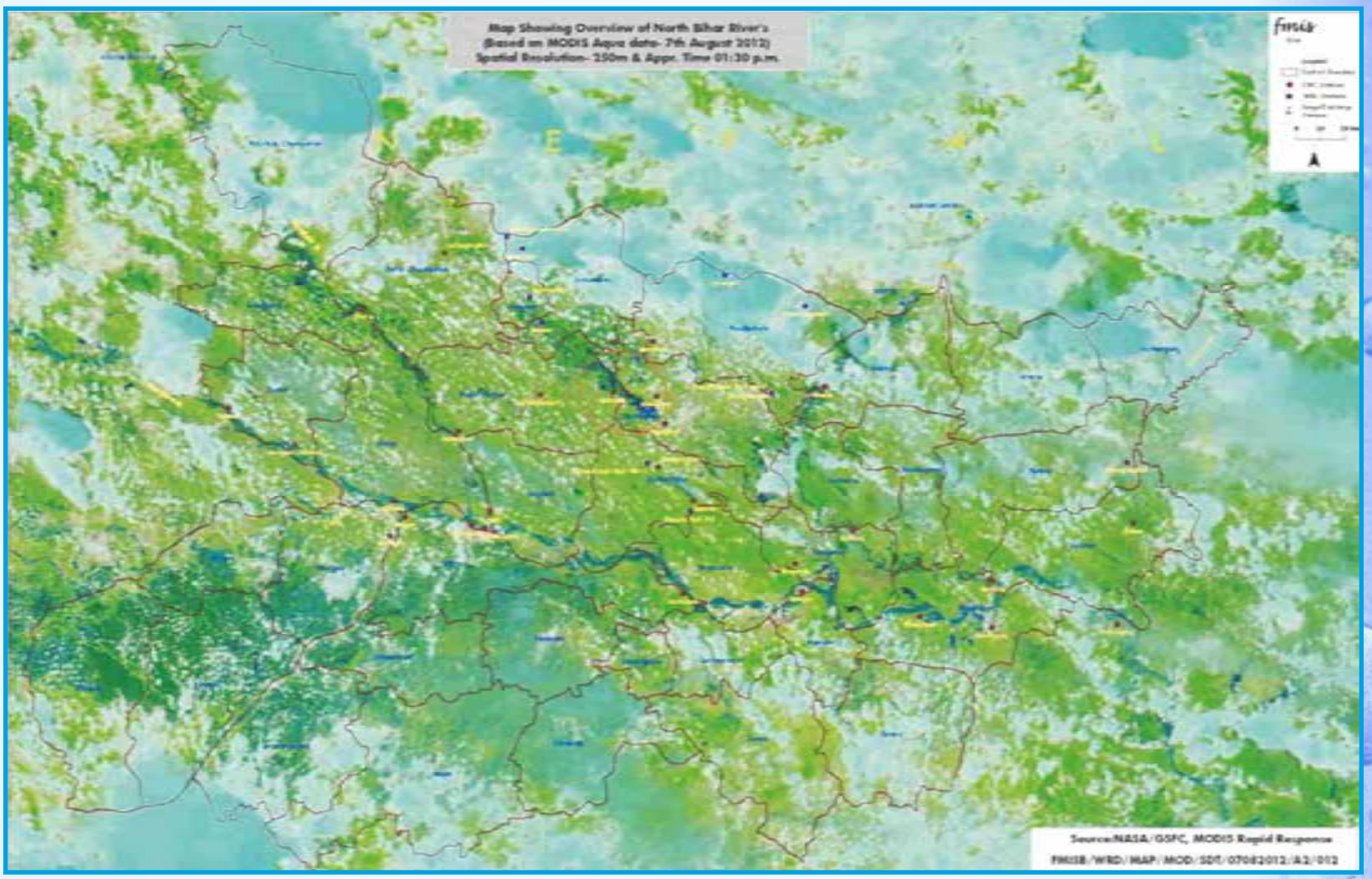
- Flood Inundation Maps
- During Flood river status maps based on MODIS data
- Area Specific Maps
- Probable Inundation Map



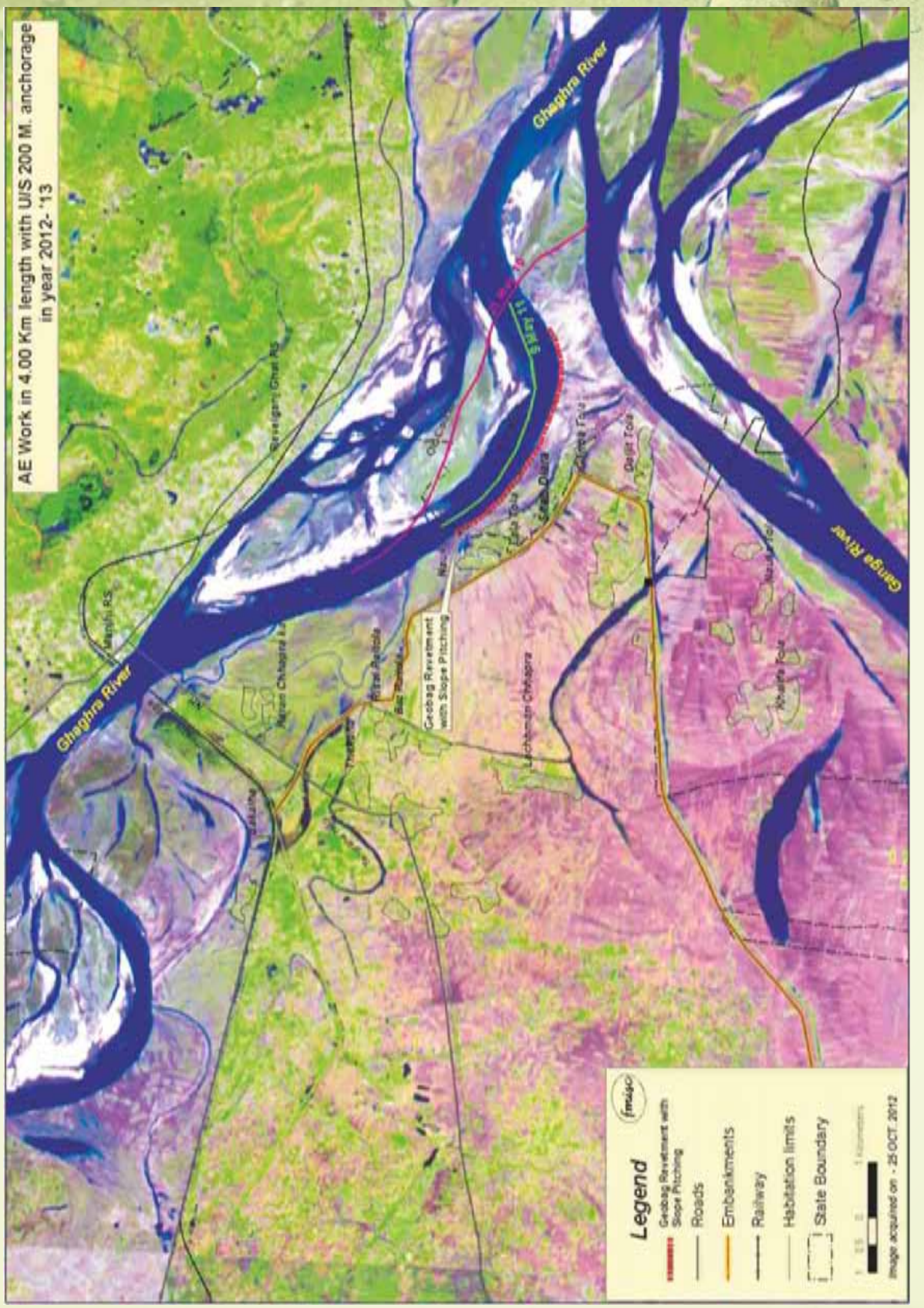
Map 5.4.1.1 Inundation map customized for WRD part of north Bihar showing district boundaries (based on Radarsat-2 Satellite image dated 8th Aug. 2012)

Other customized products:

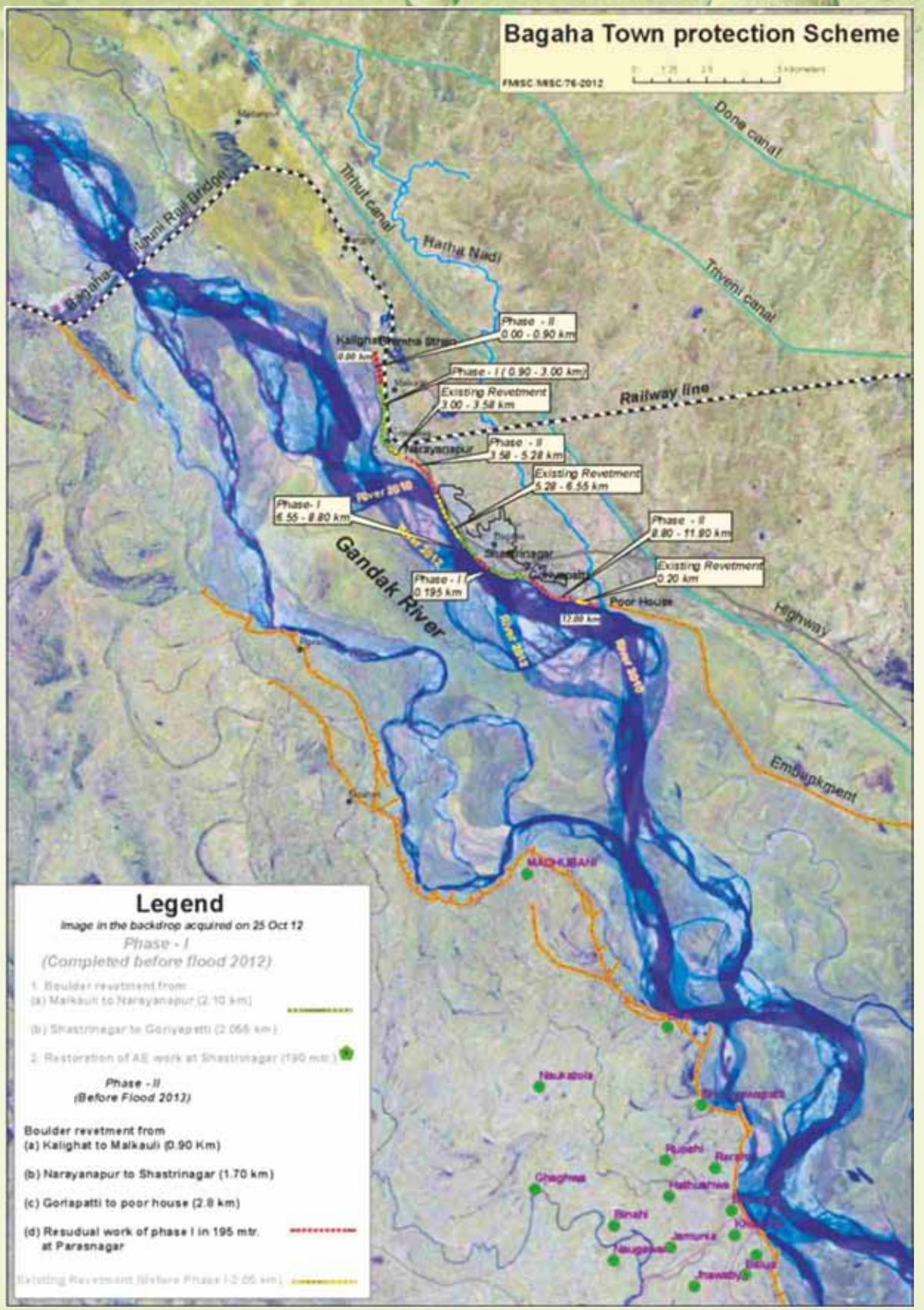
- Based on Moderate Resolution Imaging Spectroradiometer (MODIS) satellite data: We are regularly monitoring the river status with the help of MODIS satellite data of "during flood" and "post flood" also. This data is basically used for the over view of the big area, showing the river system of the North Bihar



Map 5.4.1.2 Map showing overview of North Bihar Rivers based on MODIS data acquired on 7th Aug. 12

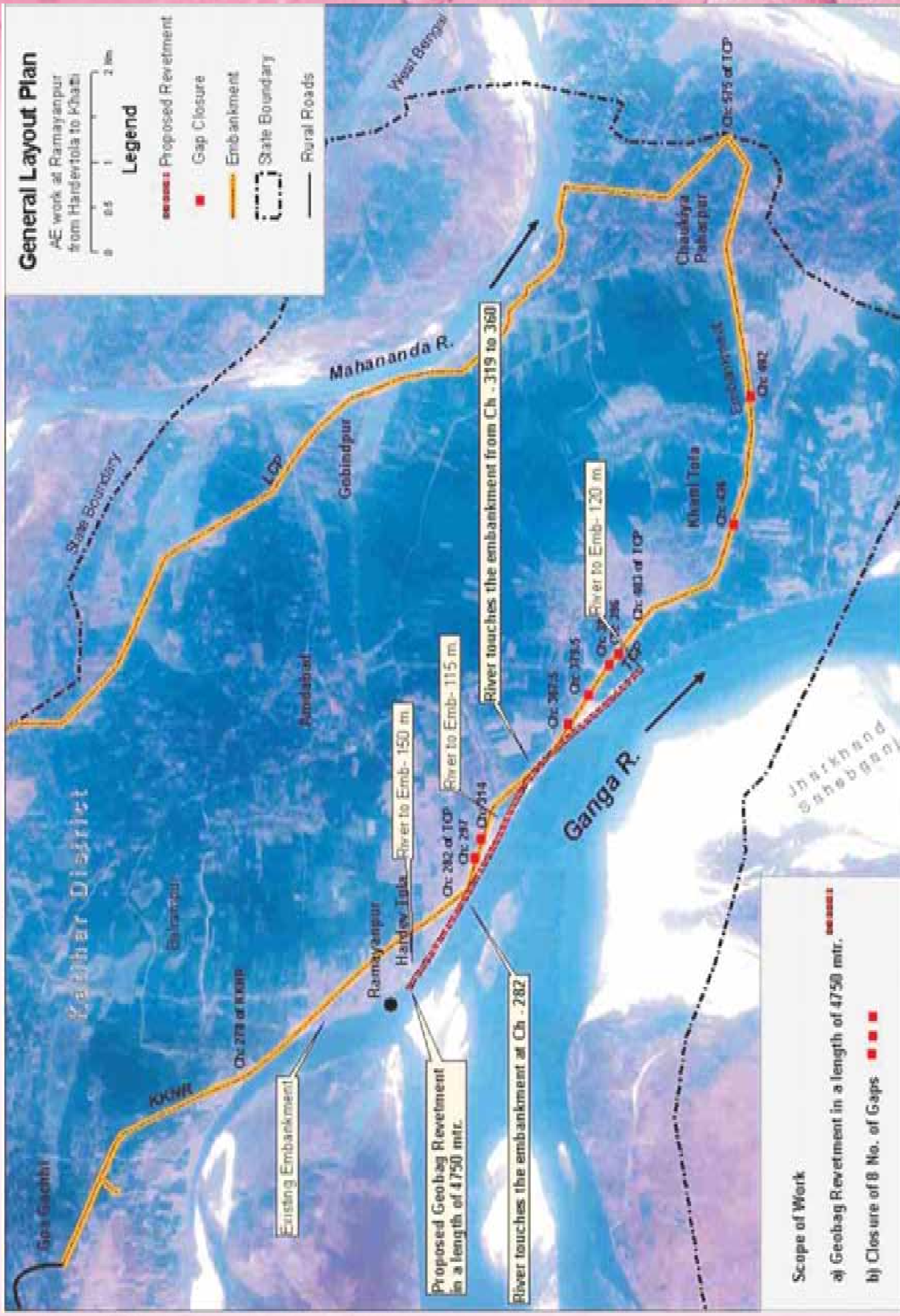


Map 5.4.1. 3 Map showing change in bankline over years near Sitab Diara. Such maps are prepared to help make better decision in AE works.



Map 5.4.1.4 A map showing changing River course near Bagaha Town. This type of image based analysis helps in judicious Anti erosion work planning and monitoring.

Map 5.4.1.5 Map showing probable inundation in case of a likely breach near Dhanaha . These maps are helpful in preparing for relief and rescue operation in case of a sudden flood due to breach in Embankment.



Map 5.4.1.6 Map showing details of proposal for restoration of flood protection structures along left bank of Ganga in Katihar.

6.0 OBJECTIVES AND FEATURES OF BIHAR FMIS PHASE-I AND PHASE-II (TF 096841)

6.1 Aims and Objectives

The Government of Bihar has identified improvement of flood control as a priority area for World Bank engagement in the State. The World Bank – Government of Bihar Partnership Matrix (2006) prioritizes the improvement of the institutional capacity for delivering better flood management and drainage services, as a key action for accelerating agriculture productivity in north Bihar. **The Flood Management Information System (FMIS) now Flood Management Improvement Support (FMIS),** identified for entry-level and short-term bank engagement in Bihar, is designed to generate and disseminate timely and customized information to move the sector agencies from disaster response to improved disaster preparedness and to effectively support flood control and management in the flood prone areas of the State of Bihar. Improved flood management that will protect the poorest farmers and tribal groups located in the low value lands in the flood plains, is also in line with the Bank/DFID partnership policy of extending Bank's support to state reforms that could lead to lasting poverty reduction.

The development of FMIS is planned in four stages: Flood hazard characterization & emergency response; improved flood preparedness and community participation; Flood hazard mitigation; and Integrated flood management. The technical improvements in flood forecasting, inundation modeling and warning, and embankment management are also coupled with expanded institutional and community linkages and expanding geographic coverage (from the most flood-prone 11 districts in north Bihar in the first stage to the whole flood prone area in the third stage). The fourth stage aims to develop integrated flood/drainage/irrigation management through upgrading FMIS into a Water Resources Information System, implementing operational community based flood management and operationalizing regional flood knowledge base and management plans.

The first module has been implemented and made operational during 2007 flood season, with focus on flood hazard characterization and operational flood management information products, supplemented by improved flood forecast, a flood website for public dissemination and access, updated flood control manuals, plans for upgrading hydrologic measurements and telemetry, and training. Providing and disseminating information tools has moved sector agencies capacity from disaster response to improved disaster preparedness and to effectively support flood control and management in the flood prone areas of the State of Bihar. The FMIS in the first stage had covered the focus area from Burhi Gandak river in the west & Kosi river in the east in north Bihar which has most flood prone area in the State presently.

The subsequent stages of FMIS development would cover substantially enhanced functions and products, supported by improved hydrologic observations and telemetry, more reliable and longer term rainfall forecasts, enhanced flood forecast and inundation prediction with better models,

Airborne Synthetic Aperture Radar (ASAR) surveys for real-time inundation information during floods, close-contour surveys of the flood plain, mapping flood plain geomorphology including micro-relief to understand and improve drainage, improved communication links and information flow, risk and vulnerability analysis, institutional and community outreach mechanisms, and real-time flood data dissemination. The fully upgraded FMIS would support preparation of master plan for flood control and drainage, irrigation improvement, and overall water sector development in Bihar State.

6.2 FMIS Phase–I Objectives

FMIS Phase-I objectives were: To move from disaster response to improved disaster preparedness, to improve the lead time of the forecasts, develop a focal point in an institutional (e.g. a multi-disciplinary Flood Management Information System Cell) framework and information (e.g. a web-portal for Bihar Flood Management) setting, as well as improved information flow (e.g. bulletins, improved use of email/internet/cell phones) and sector preparedness (by updating flood manuals).

Along with a substantive effort of planning the development and rehabilitation of the flood and drainage control infrastructure, in the short term, there is a compelling need for adopting new technological approaches to improve the decision process before, during and after the flood events and the use and allocation of available resources.

In the short-term FMIS would help strengthen existing institutional capacity and arrangements for flood management in the state and make extensive use of modern technology (e.g. satellite remote sensing, Geographic Information System [GIS], Internet, forecast models, etc.). Relevant outcomes of the technical assistance are the strengthening of flood knowledge base and analysis, the dissemination and outreach of operational flood management information and the improvement of flood preparedness.

6.3 Activity Completion Report for Phase I

The project components included:

i) Development of FMIS

ii) Improved flood forecasting

iii) Bihar Flood Information Website

iv) Updated flood control manual

v) Training

vi) Plan for upgrading hydrologic measurements and telemetry.

The 'Activity Completion Report' received from the World Bank mentions that FMIS has been set up. FMIS website has been developed and **hosted**. The website **(http://fmis.bih.nic.in)** is

operational providing public access to flood data. FMIS officers have been trained. The FMIS has addressed information needs for early warning and emergency response of three key Departments: Water Resources Department, Disaster Management Department and Agriculture Department. The Central and State Agencies linkages (linkage between WRD, GOB, and NRSC/ IMD / SOI/ CWC and GFCC) have been strengthened. In nut shell, almost all the project activities have been successfully completed and the project outputs and outcomes have been substantially realized with the disbursement to the tune of about 93 percent of the total project cost. The Bank has expressed its pleasure over the WRD's commitment for sustaining the FMIS by supporting continued operation with substantial augmentation of systems and staff.

6.4 FMIS Phase II

A proposal for FMIS Phase II for the Grant of nearly Rs 11.92 crore (3.03 million US $) with extended focus area covering whole of North Bihar, with the objective of improved flood forecasting and early spatial warning etc was submitted to the Bank via Department of Economic Affairs, Ministry of Finance, Govt. of India in June 2008. The Bank took up preparation of the project through its mission in April 2009 and extensive consultation with stakeholders & field visits were conducted by the Bank in this process. In the meantime DEA in April 2009 (letter no- F. No. 16/03/2008-FB-II dt 17.04.2009, serial no 5) downscaled the Grant request to US $ 1.5 million only with assurance to scale it up to the original request of 3.03 million US $ if the recipient shows good disbursement at a faster pace during project implementation. The project was then restructured by reducing the scope/ geographic coverage area of many activities to accommodate within this limited budget. The agreement for TA (Technical Assistance) of 1.5 Million US $ (nearly Rs. 675 lac) DFID, UK Grant was signed between DEA (Department of Economic Affairs), GOI and the World Bank on 31.05.2010 and administrative approval of Bihar Cabinet was received on 18.01.2011. Initially it was planned to end on 31.12.2012 which has recently been extended till Nov' 2014.

Funding / Financing of the FMIS Ph –II Project

The total cost of the development of the project is estimated as Rs 825.00 lac out of which Rs. 675.00 (nearly US $ 1.5 million) would come from Technical Assistance (TA) from the World Bank and rest Rs. 150 lac would come from state contribution to the project. The State contribution includes Rs. 130.15 lac already disbursed from 01.07.2008 to 31.07.2010 to continue the functioning of the FMISC and Rs. 19.85 lac has been kept to obtain various satellite data from NRSC and for other miscellaneous expenditure.

In course of implementation it has been observed that the available Grant is not sufficient enough to complete all the taken up activities. Therefore additional Grant for nearly 0.8 million US $ has been requested for, from the Bank through DEA & MOF of GOI.

Ph –II Project Components

The Technical Assistance has the following three components:

Component A: Institutional Strengthening for Flood Management

This component includes support for the institutional strengthening of FMIS Centre essential to achieve and sustain the aims of the project. The centre would also act as focal point on flood information and analysis in the Water Resources Department (WRD), as well as links to stakeholder agencies (in particular, the Disaster Management Department). The support to be provided for strengthening would be setting up emergency flood control rooms, including office and equipment upgradation, improved connectivity, video conferencing facility, as well as training and other capacity building and moving to a comprehensive strategy for modernizing policy, institutional, and technical aspects of flood management in Bihar. A Panel of Experts will be constituted to help improve quality of the entire project, as well as special studies and international training. The two proposed focus areas are:

A1. Capacity Building and Training

i) This includes support for improving flood management through strengthening of FMIS Center by recruitment of specialist staff, office upgrading, equipment including connectivity upgrading, and incremental operational expenses, building on the current FMIS Centre, as a focal point to provide state-of-the-art flood information and analytical services to flood-related departments of GoB.

ii) Strengthening the Hydrology Directorate of Water Resources Department, through recruitment of specialist staff, office upgrading, equipment including connectivity upgrading, and incremental operational expenses, to improve their current activities and interface with the FMIS Center. In addition, WRD offices will be strengthened, including higher-level offices in flood-affected areas, and field offices in the targeted area of Bagmati-Adhwara basin through office and equipment upgrading including connectivity, critical specialist staff and incremental office expenses.

A2. Flood management strategy and planning

An Integrated Flood Management Plan will be developed for the Bagmati basin by considering flood issues with other interlinked water resources management issues. In addition, this activity would support special studies to upgrade flood management manuals and outline larger-scale institutional strengthening for the Water Resources Department.

Component B: Development of Flood Management Information Systems

This Component includes support for the development of a modern flood management information system for Bihar, with an initial demonstration in selected areas of the Bagmati-Adhwara basin. This also includes support for improving the spatial knowledge base for flood management, developing and using models for forecasting flood flow and inundation, and the establishment of a much-needed embankment asset management system. Support also provides for

associated consultancies, surveys, satellite imagery and other data procurement, and related operating expenses. The proposed focus areas are:

B1. Improve Knowledge Base for Flood Management

This sub-component supports following activities to strengthen the knowledge base to improve flood management:

i) Support for critical topographic and other surveys (e.g. cross-sections/ longitudinal sections of embankments and river) in the focus areas of the Bagmati-Adhwara basin.

ii) Support will be provided to immediately upgrade the inadequate and very outdated monitoring network for precipitation, flood flows, and sediment by setting up RTDAS (Real Time Data Acquisition System).

iii) Support will also be provided for the development of a satellite imagery-based spatial database covering flood-prone north Bihar.

B2. Improve Modeling/Analysis for Flood Warning
This activity supports

i) Flood Forecasting and Inundation Modeling in the Bagmati-Adhwara basin (enhancing the present system of stage-level warnings based on gauge-to-gauge correlation). Both traditional and innovative modeling approaches will be attempted.

ii) Studies on river course migration and analysis of flood hazard/risk/vulnerability.

B3. Establish an Embankment Asset Management System

The embankment system in north Bihar is extensive, but suffers from extensive problems of inadequate maintenance, exacerbated by the lack of any systematic inspection programs and techniques and data to assess current embankment status or prioritize embankment investments. This activity will support the development of a systematic Embankment Asset Management System (EAMS) for Bagmati-Adhwara basin supported by detailed modern surveys of the embankment status in the Bagmati-Adhwara basin that is partially embanked and where substantial investments for new embankments are planned. WRD is currently considering the use of limited number of PC Tablets for capturing inspection data using Inspection Check List. The EAMS would be developed in such a way so as to have capability to incorporate these data for integrating into the Embankment Database using Levee Inspection System (LIS) developed by US Army Corps of Engineers (USACE).

Community participation for embankment surveillance and to update embankment safety information in the EAMS will be piloted.

Component C: Community-Based Flood Risk Management in Targeted Areas

This Component will include support for the planning and implementation of community-based flood management in selected areas of the Bagmati-Adhwara basin. This will include support

for consultancies, communication systems, and associated operating expenses. The proposed focus areas are:

C1. Planning Community Outreach for Flood Management

This sub-component will support the planning for community outreach for effective flood management, focused on the situation on the ground in the targeted areas of the Bagmati-Adhwara basin. Technical assistance will be provided to develop strategies to improve community awareness, preparedness, and response, including institutional arrangements and tools for improved early warning communication and dissemination and for community reporting of flood problems.

C2. Enhancing Community Participation for Flood Management

This sub-component will support the implementation of efforts to improve community participation for selected flood-prone areas of the Bagmati-Adhwara basin. This will include support for technical assistance, communication tools, and community participation to demonstrate the "last mile" connectivity and involving the WRD, Disaster Management Department, District administration, and other institutions. Synergies with the existing Bank-financed Bihar Livelihoods Project are also being explored.

6.5 Capacity Building

Under Capacity Building activity of the FMIS Phase- II project, a study tour to USA was undertaken by four officers of WRD from 20th June to 2nd July 2012 under leadership of Joint Director on the invitation of FMIS Phase- II Task Team Leader Dr. Winston Yu of World Bank. The purpose of the tour was to study the know-how of maintenance and up-keeping of embankments in USA, and the tools used for this purpose, like Levee Inspection Tools, Levee Screening Tools, National Levee Database etc and the activities undergoing in United States Army Corps of Engineers (USACE) and United States Geological Survey (USGS), both lead organizations engaged in the flood management activities in USA. The experiences were rich enough and some recommendations have been made to the department based on these experiences. Like National Database of embankments in USA, a similar database of embankments in Bihar also needs to be prepared. We are contemplating this activity under EAMS activity of FMIS Phase II.

6.6 Current Status of FMIS Phase II:

As per the World Bank guidelines, to implement the project a Procurement Plan was prepared in which the major components have been sliced into easy executable activities/ sub activities called packages. The detailed description about the status of ongoing key activities is as below:

- Most of the works involved in office & equipment upgradation have been completed. Under its package Pk-13, to support day-to-day activities of FMISC, professional staff have been hired who are satisfactorily rendering their services in FMISC. Rest linked with a particular

consultancy (IT Specialist, Embankment Specialist, Instrumentation Specialist and Remote Sensing/ GIS Assistant) services are being hired.

- MoU for Development of DEM (Digital Elevation Model) by LiDAR (Light Detection and Ranging) for delineated 1800 sq km in Bagmati-Adhwara basin was signed with NRSC. As per the MoU, payment was made to NRSC and data has been received and being used in the Flood Forecast & Inundation Modeling study under Pk.29.
- For activity Conducting River Cross Section and Embankment Asset Survey in Bagmati –Adhwara Basin, Technical Evaluation Report has been approved and consultants are being ranked on basis of QCBS. The award is expected by April 2013.
- For Real Time Data Acquisition System (RTDAS) for Bagmati and Adhwara group of rivers basins in Bihar: After rejection of all the three bids received during 1st IFB due to non-responsiveness, fresh Bid Document has been prepared. The World Bank's approval is being awaited.
- Contract for 'Development of Flood Forecast and Inundation Modeling System in Bagmati-Adhwara basin' was signed on 01/03/2012. Inception Report & Design report has been received & approved. Also the proportionate payment has been made to the consultant, DHI, New Delhi. Initial model is expected by April, 2013.
- Contract for 'Development of Spatial Database and Application for Bihar Flood Planning Management' - was signed on 06/07/2012. Inception Report & priority dataset has been received & approved. The proportionate payment to the consultant SCIENCE, Dehradun is under progress. Next report is expected in June 2013.
- The contract for consultancy services for River Behavior Analysis (Gandak, Burhi Gandak & Bagmati) has been signed. Inception Report has been received and being reviewed.
- For activity Embankment Asset Management System, Technical Evaluation Report has been approved. Financial bid is to be opened on 19.03.2013. Contract is expected to be awarded by April 2013.
- ToR/ EoI to develop approach, protocols and mechanisms for "Community Participation in Embankment Surveillance and Piloting in Select Communities" has been approved by the Bank. EoI has been received. Shortlisting is in progress.

6.7 Financial Progress :

Allotment received : 6.5 crore
(2.5 crore in 2010-11+ 2.0 crore in 2011-12+ 2.0 crore in 2012-13)
Disbursed till 14.03.13 : 3.462 Crore

fmis e-bulletin

Flood Management Improvement Support Centre
Water Resources Department
Bihar

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Contents

"Towards a culture of preparedness for better flood management"

From the Joint Director's Desk

The flood season is gone and the festive season in Bihar is midway. As per IMD records, the overall rainfall deficit till 15th October was 20.5%. Although the rainfall this year is less than IMD's prediction, but overall there was neither acute flood nor drought like situation in Bihar. As per the report of Disaster Management Department there was loss of Rs. 4.5 crore in eleven flood affected districts during this year flood though there was no adverse effect on infrastructures and civil amenities like electricity, roads, health and communication.

Bihar State is on road to progress as the Agriculture Road Map (2012- 17) was launched by Hon'ble President of India, Shri Pranav Mukherjee on 3rd October 2012. This road map is meant to target the ever growing food demands by implementing various agricultural reforms. At the same time, this will take care of farmers' interests and improve the infrastructure to facilitate for better inputs, access, supply and quality. More income generation schemes for farmers will be developed with transfer of technology and extensions and better facilities of marketing. The road map also includes disaster management programmes in which FMISC is actively associated.

The month of October this year has been full of events organized in FMISC. A delegation of senior engineers from Uttar Pradesh led by Mr. M. Maheshwari, IAS, Special Secretary, Irrigation Department visited FMISC on 5th October to have an idea of the works being undertaken in FMISC. Meetings of Technical Advisory Committee of WRD, Bihar took place between 08-27 October 2012 in FMIS Centre in which anti-erosion schemes to be executed before the next year flood were recommended to Scheme Review Committee of WRD by taking help of available satellite imageries archived in FMISC.

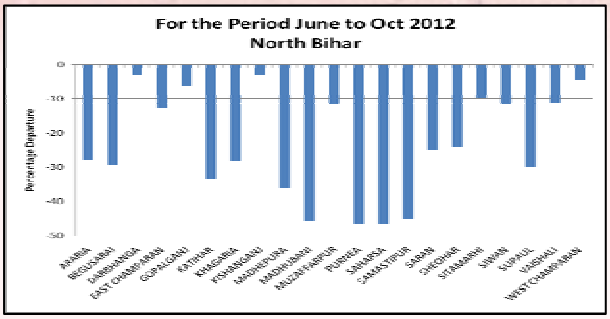
There can not be two different opinions that natural disasters can only be mitigated by taking early preventive measures which is evident from the SANDY superstorm cyclone that marred east coast of USA in the last week of October. The losses were not to the scale as compared to the magnitude of the cyclone due to advance warning. In India, too, due to very low pressure over Bay of Bengal, another cyclonic tornado named Neelam has caused heavy rain and high speed wind in Tamilnadu and Andhra Pradesh.

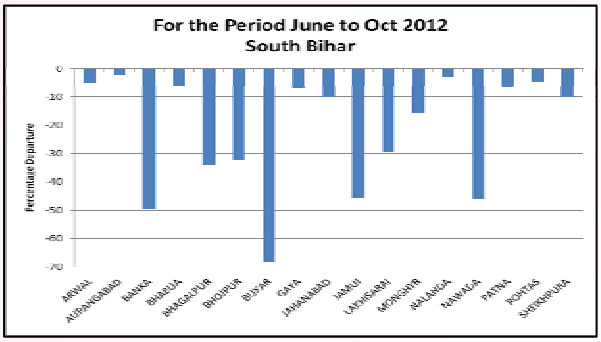
We can not fight or win over the nature, but we can certainly try to minimize the losses by scientific endeavors. Our all preparations are towards this mission for humanity...

From the Editor's Desk

There is a saying, "The full use of to-day is the best preparation for tomorrow". FMIS Centre is the apt example of the saying. The Centre remained busy during the critical four months of floods and contributed positively towards minimizing the effects of floods. Monsoon remained scanty. But for the late downpour in September and early steps taken for plantation, diesel subsidy, round the clock electric supply and above all proactive actions taken on the part of Government, the situation could have gone worse. It is said, "All is well that ends well". This flood also ended well without major desolation. We are on the move in FMISC for developing better flood information as "My interest is in the future because I am going to spend rest of my life there".

End of season rain fall summary





News and Activities

- Visitors from Uttar Pradesh, Irrigation Department to appraise with the activities of FMISC on 5th Oct'12
- Technical Advisory Committee of WRD, Bihar conducted meeting from 8 –27 Oct'12 to discuss the proposed Anti Flood schemes.
- High Level Expert Committee meeting on 18th Oct'12 to discuss Flood Forecast and Inundation Modeling Design Report submitted by Consultant M/s DHI, India

Sample Information Product

Map showing portion of Gandak River at Dhanaha Bridge based on LISS 3 dt. 26th Aug'12, 23rd Mar'12 and 4th May'11

News in Picture

UP Govt. delegation headed by Mr. M. Maheshwari, IAS, Spl. Secretary, Irrigation Deptt. along with Chief Engineers and others.

Other Information Products

- Map showing proposed raising and strengthening of embankment at Doab Lalbakeya river (Bagmati) based on LISS 3 dt. 24th Sep'12.
- Map showing Ghaghara river at Sitab Diara based on LISS 3 dt. 25th May'10, 9th May'11 and 25th Oct'12
- Map showing proposed alignment of Kamla River embankment extension up to Phuia based on Post Flood'2011 based on LISS 3 dt. 22 Nov'11
- Map showing position of Kosi river with respect to Eastern Embankment from Chakarghatti (Nepal) to Koparia (Bihar) based on Liss 3 dt. 27 Sep'12
- Map showing position of Gandak river with respect to Pipra Piprasi Embankment based on Liss 3 dt. 26 Aug'12, 23rd Mar'12 and 4th May'11

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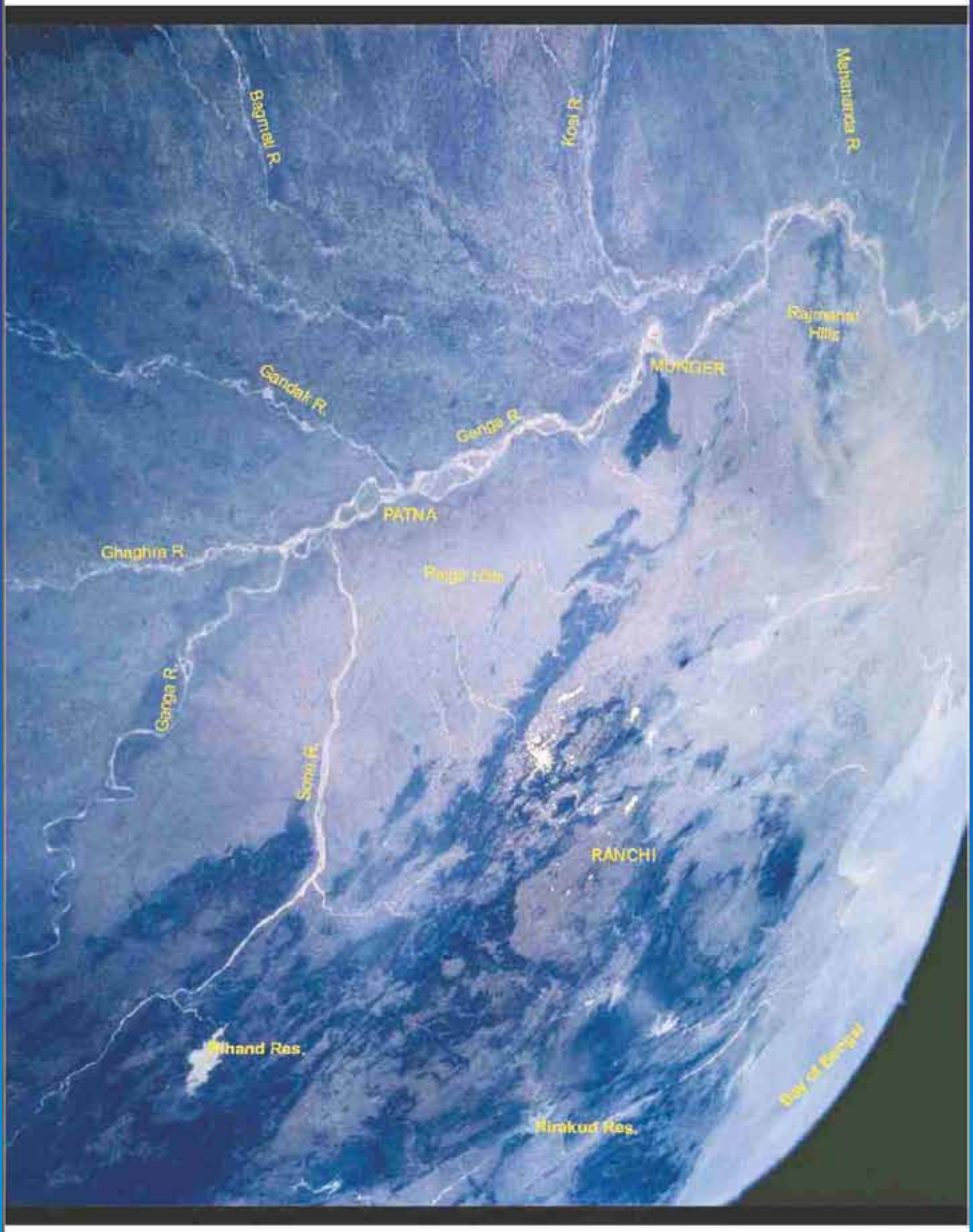
■ Designed and produced at FMISC, Patna.

Panoramic view of River system of Bihar
as seen by Astronauts onboard Space Shuttle on 24th Oct. 2012



Source : Asrtomaterials Research & Exploration Science Directorate


Month-wise distribution of Rain in different Basins
(2012 Monsoon)
N
NEPAL
Gandak
Bagmati
Kosi
Kamla
Mahananda
KATHMANDU
OKHALDUNGA
TAPLEJUNG
SIMRA
DHANKUTTA
DHARAN
Sonbarsa
Jainagar
BIRATNAGAR
ARARIA
BANMANKI
MADHEPURA
Basua
Baltara
Kursela
PATNA
BIHARSHARIF
Uttar Pradesh
West Bengal
South Bihar
Mahananda
Legend
June
July
August
September
October
Disclaimer: Basin boundaries are only indicative