

ACRONYMS

Acronym	Expansion
ALTM	Airborne Laser Terrain Mapper
ANN	Artificial Neural Network
BIRSAC	State Remote Sensing Applications Centre
BSNL	Bharath Sanchar Nigam Limited
CWC	Central Water Commission
DEM	Digital Elevation Model
DfID	Department for International Development
DMD	Disaster Management Department
DRM	Disaster Risk Management
EMIS	Embankment Management Information System
FMIS	Flood Management Information System
FMISC	Flood Management Information System Cell
GoB	Government of Bihar
GoI	Government of India
GUI	Graphical User Interface
IMD	India Meteorological Department
LISS	Linear Imaging Self Scanning
MoWR	Ministry of Water Resources
NCMRWF	National Centre for Medium Range Weather Forecasting
NIC	National Informatics Centre
NRSA	National Remote Sensing Agency
SOI	Survey of India
SRTM	Shuttle Radar Topography Mission
WRD	Water Resources Department
WALMI	Water and Land Management Institute

Index to Report

	Page
Executive Summary	
Acronyms	
1. Project Background	1
2. FMIS Development Objective	4
3. FMIS Phase I Overview	6
4. FMIS Knowledge Base	10
5. Flood Website	14
6. Community Outreach	19
7. Training and Stakeholder Workshops	22
8. Improved Flood Forecast Modeling	24
9. Upgrading Flood Management Manuals	26
10. Plan for Upgrading Hydrologic Measurements and Telemetry	30
11. Operational Flood Mapping in 2007 Monsoon Season	34
12. Next Steps	36
13. FMIS outputs, outcomes and sustainability	37
Annexure 1.FMIS Development Stages –Outcomes, Outputs and Activities	
Annexure 2 Log Frame	
Annexure 3. Flood Characterization and Hydrologic Analysis of focus area	
Annexure 4 Mapping First Flood in 2007 Monsoon Season	
Annexure 5. Flood maps in 2007 Flood Season	
Annexure 6. Maximum flooded Area in 2007 flood season	
Annexure 7. First Monthly Bulletin in English	
Annexure 8. Daily Bulletin 25th August 07	
Annexure 9. Cost_Table of FMIS Phase-II	
Annexure 10. Bihar Flood Management Strategy	

LIST OF FIGURES AND TABLES

Figure 1. River Basins of North Bihar and in Focus Area

Figure 2. FMIS Coverage of Flood Cycle Phases

Figure 3. Districts covered in FMIS Phase I

Figure 4. Inter-Agency Linkages

Figure 5. Home Page of Flood Website in English and in Hindi

Figure 6. Bagmati Basin

Figure 7. River Basins in Focus Area for Upgrading Hydrologic Network

Table 1. River Basins in Focus Area

Table 2. Implementation Status

Table 3. FMIS Database Structure

Table 4. Schedule of District-level Workshops

Table 5. Geographic Coverage of FMIS Phase II Components

EXECUTIVE SUMMARY

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)**, 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 Technical Assistance under the World Bank-DFID Trust Fund covering the first stage of FMIS development, initiated in May 2006 and scheduled to close by June 30, 2008, aims to improve the technical and institutional capacity of the State of Bihar for flood management, by introducing extensive use of modern information technologies to develop and implement a comprehensive Flood Management Information System [FMIS] in the most flood-prone areas of the State. While the Water Resources Department (WRD) is the implementing agency the FMIS will address the information needs for early warning and emergency response of three key agencies of WRD, Disaster Management Department (DMD) and Agriculture. The FMIS will benefit flood management in north Bihar through strengthening of flood knowledge base and analysis, the dissemination and outreach of operational flood management information, improvement of flood preparedness and training.

FMIS will improve the flood forecasts through a suite of appropriate models, develop a focal point in an institutional (Flood Management Information System Cell) framework and information setting, as well as improve information flow and sector preparedness. In the short term, FMIS aims at new technological approaches to improve the decision process before, during and after the flood events and the use and allocation of available

resources, along with a substantive effort of planning the development and rehabilitation of the flood and drainage control infrastructure.

The current and first stage of FMIS focuses on flood hazard characterization and analysis, improved flood forecast modeling, flood website, updated flood control manuals, plans for upgrading hydrologic measurements, telemetry and FMIS, and training. Community outreach and stakeholders' workshops and training would improve effective utilization of information products. The FMIS in the first stage covers the focus area from Burhi Gandak river in the west to Kosi river in the east in 11 districts of North Bihar¹, that is most flood prone.

The project design takes note of the flood management functions and information needs of the three key agencies of Water Resources, Disaster Management and Agriculture in Government of Bihar, as well as community needs. Under inter-agency agreements, the India Meteorological Department (IMD) in GOI is providing 3 day rainfall forecasts, while NRSA is developing the FMIS and associated analysis software, sharing its database, implementing and maintaining FMIS in Patna, and providing operational flood inundation maps during the flood season, as also supplying required additional satellite data in near-real time on commercial basis. Survey of India (SOI) is providing digitized topographic maps, while Central Water Commission and Ganga Flood Control Commission of Ministry of Water Resources (MoWR) in GOI are actively involved in the development and operation of FMIS. Consulting firms, individual consultants, and academic institutions are supporting FMIS development and operation through consultancy studies. The Water Resources Department in Government of Bihar is implementing FMIS, and contributing towards infrastructure and operational expenses. The Bihar State Remote Sensing Applications Centre (BIRSAC) provided initial facility support. The FMIS is designed to take note of complementary initiatives in DMD under the GoI-UNDP Disaster Risk Management (DRM) programme in 169 most vulnerable districts of 17 States in India, including Bihar. The FMIS operation is also synergetic with the national level Disaster Management Support (DMS) programme lead by the National Remote Sensing Agency in the Department of Space (DOS).

A Flood Management Information System Cell (FMISC) has been created within the WRD institutional framework to develop, implement, and operate FMIS. Infrastructure consisting of office equipment and special purpose hardware and software and support peripherals including power support for 24x 7 operations was operational in the 2007 flood season. Linkages have been established with national and state agencies for data and information flow. FMIS development is supported by an Advisory Committee, providing policy guidance and inter-agency coordination, and a Technical Committee, which meets more frequently to resolve technical issues and to monitor project progress for mid-course corrections. Additionally, frequent inter-agency meetings are held to resolve urgent bilateral issues.

¹ Districts of East Champaran, Sitamarhi, Sheohar, Muzaffarpur, Madhubani, Darbhanga, Samastipur, Begusarai, Khagaria, Saharsa and Supaul

The FMIS characterizing the flood hazard in the focus area aims to integrate the already existing database with National Remote Sensing Agency (NRSA) with the additional datasets to be generated by another consultancy firm. NRSA under an MOU signed in early May 2007, has implemented the existing database and the first version of a user-friendly customized GIS application software for data visualization, analysis and product generation in FMISC. The application has been upgraded in January 2008, and the complete version is planned before project closure. For final integration in FMIS, a seamless ortho-corrected Cartosat I satellite image mosaic at 2.5 m spatial resolution, Shuttle Radar Topography Mission (SRTM) based DEM at 90 m spatial resolution and about 5 m vertical resolution, and selected digital topographic map layers from Survey of India in 1:50,000 scale have been procured. Inundation maps in 2007 flood season were operationally and in near-real time provided by NRSA and additionally processed in FMISC, from RADARSAT and optical Indian satellite imagery. Historic inundation maps since year 2000 are under processing in NRSA.

Three classes of flood forecasting models are being evaluated by Indian Institute of Technology, Delhi under a consultancy study for possible improvements to increase the lead-time and to forecast flood stage at any location in gauged rivers in the selected basin, using currently available hydrologic, hydraulic and topographic data. The India Meteorological Department (IMD) is supplying customized three-day rainfall forecast at 45 km grid spacing and 6 hourly interval under an MOU (covering the whole of Nepal and the entire north Bihar), and plans to upgrade to 5 km grid spacing in the 2008 flood season. Decadal data on river stage/discharge and rainfall have been procured from IMD and Central Water Commission (CWC). Another key input would be the detailed digital elevation model of flood plain topography using SRTM data. Use of observed rainfall and water level in Nepal portion when available in real-time would further enhance the model. .

Five FMISC staff have received hands-on training in digital image processing and GIS techniques, and the capacity is further enhanced through in-house training. Stakeholder workshops for the three key GoB agencies are being planned through a consultancy study. Initial training on FMIS application software has been provided by NRSA in January 2008 after implementation of second version of software in FMISC office, and would be followed by third training after final implementation before project closure. Training on flood forecast modeling and hydrologic network design would be provided by the respective Consultants before project closure.

Operational information products include: i) Actual and predicted inundation maps customized for the key user agencies with required overlays, in near real time, ii) Pre-season river configuration map, iii) Post-season river configuration map showing possible locations for anti-erosion control measures before next flood season, iv) Seasonal flood maps including extent-duration-frequency of inundation, and v) Flood hazard map showing area affected by different flood frequency. Actual inundation map and seasonal flood maps have been generated for the 2007 flood season. All other products excluding the predicted inundated map and the flood hazard map would also be ready prior to 2008 flood season.

The information products are to be disseminated through institutional nodal points, a flood website, a community outreach programme, and periodic bulletins. The institutional linkages have been established, web site has been developed and hosted by National Informatics Centre, daily and monthly bulletins have been issued through the 2007 flood season, and community outreach modalities have been recommended by a consultancy study.

The community outreach consultancy has evaluated alternate communication modalities (public news media, mobile phone, police wireless network, etc.), community focal points, and type and content of alert, within the socio-economic context (institutional arrangements, information flow, community structure), and technology (power, computer and Internet penetration and skills, telecommunication) constraints in the focus area. The final report will recommend the alert type and contents and communication modalities for implementation in the next phase of FMIS implementation. Stakeholder workshops targeting the key GoB agencies were designed and implemented for better institutional awareness and preparedness. Detailed training plan and training material were prepared. The stakeholder workshops for more than 400 institutional staff at district and sub-district level and State-level were conducted in April-May by the WRD's Water and Land Management Institute (WALMI). Existing flood manuals in the key Bihar agencies have been updated under a consultancy contract, to support effective institutionalization of FMIS information product dissemination and use during the flood season. Supplementary sections to existing manuals have been prepared, covering actions to be taken on receipt of flood alerts and maps from FMIS, feedback from the key departments to FMIS for continued fine-tuning of information products, and archival of relevant flood impact data within agencies and transmission to FMISC for updating flood hazard characterization. A consultancy study has evaluated existing data collection networks and proposed plans to suggest improvements in hydrologic observation network and communication modalities to improve time-effective ground measurements and reporting, and enhance forecast reliability and lead-time. Upgrade requirements (spatial and temporal coverage and time-effective reporting) address optimal rainfall and flood forecast model requirements. Satellite telemetry and other alternate communication modalities have been evaluated. The report on optimal observation network (location, type, observation frequency, etc) and telemetry (type, transmission frequency, time of transmission, etc), along with a first-cut cost estimate, will enable planning implementation in the subsequent phases of FMIS.

Twenty six flood inundation maps were produced in the 2007 flood season, and disseminated by email to focal officers in Water Resources, Disaster management and Agriculture departments, and District Magistrates of affected districts. The Department of Agriculture is regularly collecting flood information through a Nodal Officer appointed for liaison with FMISC for use in contingency planning. The Disaster Management department requested daily e-bulletin published from FMISC through fax on daily basis. The District Magistrates and Special District Magistrates in charge of flood management are also receiving the daily bulletin, for better ground preparedness. The inundation maps and statistics have been used in Chief Minister's Aerial Survey of flood affected areas, as

well as used by DMD for appraising the Chief Minister on the flood status. Special District Magistrate, Darbhanga requested for positional verification of specific places for air-dropping of relief materials, which was provided by FMISC, Bihar based on inundation maps. The inundation maps have also been field validated by FMISC teams. FMIS has also provided large scale satellite mage maps to Flood Monitoring wing of WRD for planning anti-erosion control schemes prior to 2008 flood season.

Seasonal flood maps have been generated, based on individual flood maps, showing the maximum extent of inundation, frequency and duration of inundation, impact of embankment breach, and sustenance of breach plugging, etc have been generated. An Annual Report describing flood events in 2007 season has been produced. Six e-Bulletins in English and Hindi languages and at monthly frequency have been issued by the FMIS Cell. Daily bulletins describing the current and predicted hydrologic status have been regularly issued starting July 12, 2007 in the 2007 flood season.

Outputs in the first phase of FMIS are a functional FMIS, issuing time-effective and targeted information products, customized for key government agencies, for improved flood management; early warning of actual inundation status; increased awareness of stakeholders and institutionalization through updated flood manuals to promote effective use; improved information dissemination through institutional linkages, website and community outreach; and follow-up with key agencies to sustain FMIS operation. The project outcomes are improved flood management preparedness of key agencies (Water Resources Department, Disaster management department and Agriculture department), and improved flow of critical flood information, resulting in reduced flood damage to society.

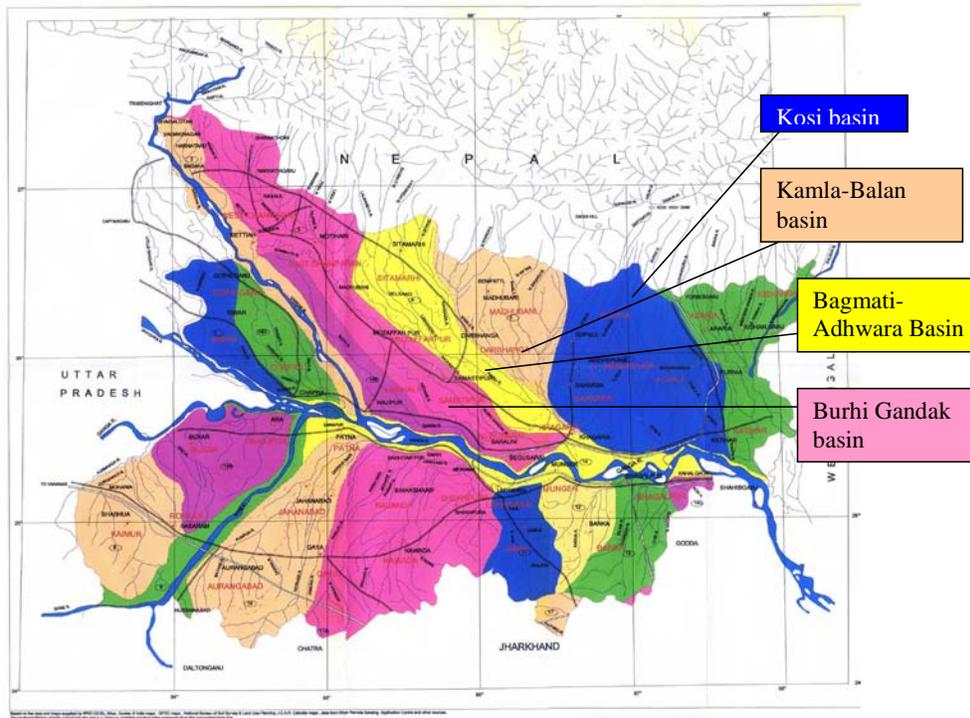
Currently the WRD proposes to convert the FMIS under Plan budget, demonstrating its commitment for sustainability in the short and medium term. Mainstreaming of FMISC is being facilitated through regular interaction with the Flood Monitoring office in WRD and presentations to WRD staff and providing analysis support with multi-year satellite imagery for flood management functions. FMIS information products are increasingly demanded by the key agencies both at headquarter level and in field offices, and used in flood management. As an indicator of sustainability WRD is funding the continued operation of FMIS during the 2008 flood season, after the closure of World Bank funded technical assistance by June 30, 08.

The second and next phase of FMIS is planned at an estimated outlay of about US \$ 3.03 millions (Rs.13.11 crores), with the following inter-related elements: a) develop a comprehensive Embankment Management Information System (EMIS) to sustain protection to flood-prone areas; b) upgrade knowledge base on flood hazard; c) upgrade timely and appropriate flood information generation and delivery systems for better institutional and community preparedness; d) facilitate sharing of international knowledge and experience in developing appropriate FMIS; and e) develop FMIS upgrading strategy and road map to support medium and long-term management interventions. An overall flood management strategy and framework has been developed to guide the different Bank initiatives to assist flood management in Bihar State.

1. Project Background

Bihar accounts for 16.5% of the flood-prone area and 22.1% of the flood-affected population in India. The flood prone area in Bihar accounts for 73 percent of its geographical area, and 76 percent of North Bihar, while the area protected by structural interventions is only 43 percent of Bihar area, and 68 percent of North Bihar area. Flood damage is about 30 to 40 percent of all India damages. The plains of Bihar, adjoining Nepal, are drained by a number of rivers that have their catchments in the steep and geologically nascent Himalayas. Torrential rains in the Nepal Himalayas have made these rivers - Ghaghra, Gandak, Buhri Gandak, Bagmati, Bhutahi Balan, Kamala, Kosi and Mahananda - carry high discharge and very high sediment load¹ down to the plains. Once the rivers enter the plains much of the silt begins to settle, raising the beds of the rivers², shrinking their channels, and blocking flow. The rivers cut fresh paths through the sediment in the subsequent monsoon season. In the past three to four decades, the population has grown rapidly and human occupation of the flood plains of the river has reached alarming proportions, resulting in increasing damages.

Fig 1. River Basins of Bihar State and in Focus Area



¹ Monsoon silt load can be as much as 99 million tones in Burhi Gandak river, and ranges from 76 to 95 million tones in other rivers

² 2 meters on an average, based on measurements from 1989 to 2006 at Benibad site in Bagmati river

Table 1. River Basins in Focus Area

River Name	Catchment Area in sq. km			Length of River in km			Bed Slope in m/km		Flood prone area (sq km)
	Outside Bihar	Within Bihar	Total	Outside Bihar	Within Bihar	Total	Outside Bihar	Within Bihar	
Kosi	72349	21006	93355	208	260	468	1.4-0.45	0.11	10150
Kamla Balan	2744	4488	7232	208	120	328	3.4	0.2 - 0.1	3700
Bagmati	7884	6500	14384	195	394	589	8.98	0.14 - 0.04	4440
Burhi Gandak	2350	19150	21500	-	320	320	4.72	4.72 - 0.06	8210

The flood are caused by a multiplicity of factors such as inadequate carrying capacity and over-bank flow in un-embanked rivers, gaps in embankment or manmade or natural embankment breaches, inadequate waterways in rail and road bridges, non-operation of sluice gates during floods, concurrent floods in main river and tributary, silting and change in river course and avulsion, drainage congestion behind and between embankments, drainage congestion between embankments of main river and tributaries, and impeded natural drainage and waterlogging caused by micro-relief.

It has been estimated that, from 1999 to 2005, the flood damages reached Rs. 2655 crores (USD 531 millions). The capital expenditure on flood protection and drainage works each year amounts to Rs. 64.43 crores (USD 13 millions), and Rs. 108.54 crores (USD 21.5 millions) in revenue expenditure. The flood in 2007 was again very destructive affecting more than 19 districts, causing 32 embankment breaches, affecting more than 14 million people (3 million households), and destroyed 7 million hectares of crop, apart from the loss of assets, mainly of the poor, totally estimated at Rs. 33191 millions. The GoB requested for immediate central assistance of Rs. 5210 millions to restore the damaged systems.

Currently, the Central Water Commission (CWC) provides flood forecasts (8 to 24 hours in advance) for the main stem of the rivers in the focus Area. The lead time for



community preparedness however is almost zero, since inundation impact from the forecasted river stage at a few fixed sites along the main river is currently not modeled. The use of rainfall forecasts (Quantitative precipitation forecasts at basin level) available from India Meteorological Department (IMD) till now, and the experimental spatially and temporally distributed forecasts up to 3 days from

National Centre for Medium Range Weather Forecasting (NCMRWF) and from India Meteorological Department (IMD), and global forecast providers is very limited. Although the National Remote Sensing Agency (NRSA) does produce maps, under a national programme, of actual inundated areas on opportunistic basis, their use in emergency response has been limited due to the limitations of the data capturing process. Although many sector agencies have emergency plans, these would be further strengthened with improved flood information availability and flow.

The Government of Bihar has identified improvement of flood control as a priority area for World Bank engagement in the State. The World Bank partnership matrix agreed with Bihar (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. Improved flood management will protect the poorest farmers and tribal groups located in the low value lands in the flood plains, in line with the Bank/DFID partnership policy of extending Bank's support to state reforms that could lead to lasting poverty reduction. The **Flood Management Information System (FMIS)** is designed to provide 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.

2. FMIS development objective

The long-term objective is to develop and implement a comprehensive Flood Management Information System (FMIS) to effectively support flood control and management in the flood prone areas of Bihar State. 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 (Annex 1). The technical improvements in flood forecasting, inundation warning, and embankment management are also coupled with expanded institutional and community linkages, and expanding geographic coverage from the 11 most flood-prone districts in north Bihar in the first stage to the priority flood prone basins in the second stage, and to further technical intensification and expansion to the whole north Bihar 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 developing regional management plans.

Flood Disaster Cycle and FMIS Phases

Within the six-stage disaster cycle, the FMIS is currently focused on improved flood preparedness through early warning, and emergency response. At the final development stage the FMIS would support flood management through the entire disaster cycle. It will move the State from disaster response to improved disaster preparedness, improve the flood forecasts, develop a focal point in an institutional (e.g. a multi-disciplinary Flood Management Information System Cell) framework and information setting, as well as improve information flow and sector preparedness.

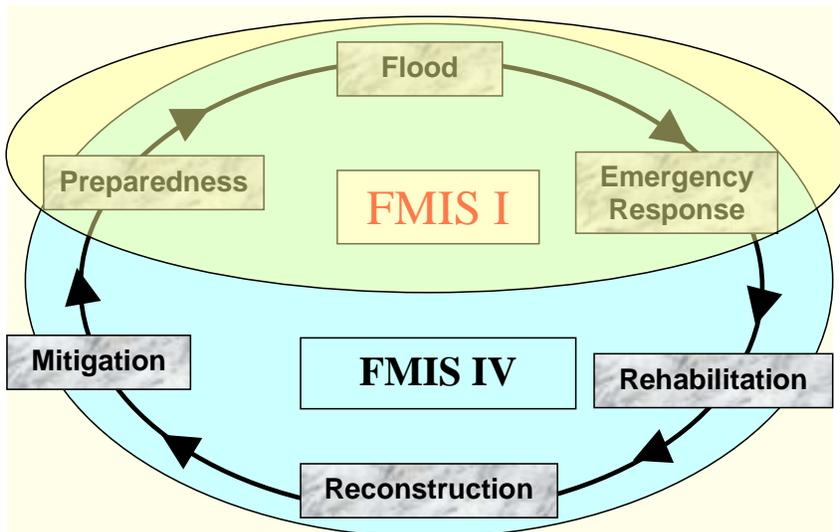


Fig 2. FMIS Coverage of Flood Cycle Phases

In the short term, FMIS aims at new technological approaches to improve the decision process before, during and after the flood events and the use and allocation of available resources, along with a substantive effort of planning the development and rehabilitation of the flood and drainage control infrastructure. The later stages of FMIS would cover flood management in its entirety.

Government of Bihar, as well as community needs in improving the flood preparedness and emergency response.

Inter-Agency Linkages

Synergy between central and state agencies involved in flood management in Bihar is identified as the key to successful development and sustained operation. The Water Resources Department (WRD) in Government of Bihar is implementing the FMIS, and contributing towards infrastructure and operational expenses. The Bihar State Remote Sensing Applications Centre (BIRSAC) provided initial facility support till FMISC operations shifted to its own office. Under inter-agency agreements, the India Meteorological Department (IMD) in GOI is providing 3 day rainfall forecasts, while NRSA is sharing its database, developing the associated analysis software, implementing and maintaining FMIS in Patna, and providing operational flood inundation maps during the flood season, as also supplying required additional satellite data in near-real time on commercial basis. The Survey of India (SOI) is providing digitized topographic maps, while Central Water Commission and Ganga Flood Control Commission of Ministry of Water Resources (MoWR) in GOI are actively involved in the development and operation of FMIS. Consulting firms, individual consultants, and academic institutions are supporting FMIS development and operation through consultancy studies. The FMIS is also designed to take note of complementary initiatives in DMD under the GoI-UNDP Disaster Risk Management (DRM) programme in 169 most vulnerable districts of 17 States in India, including Bihar. The FMIS operation is also synergetic with the national level Disaster Management Support (DMS) programme lead by the National Remote Sensing Agency in the Department of Space (DOS), GOI.

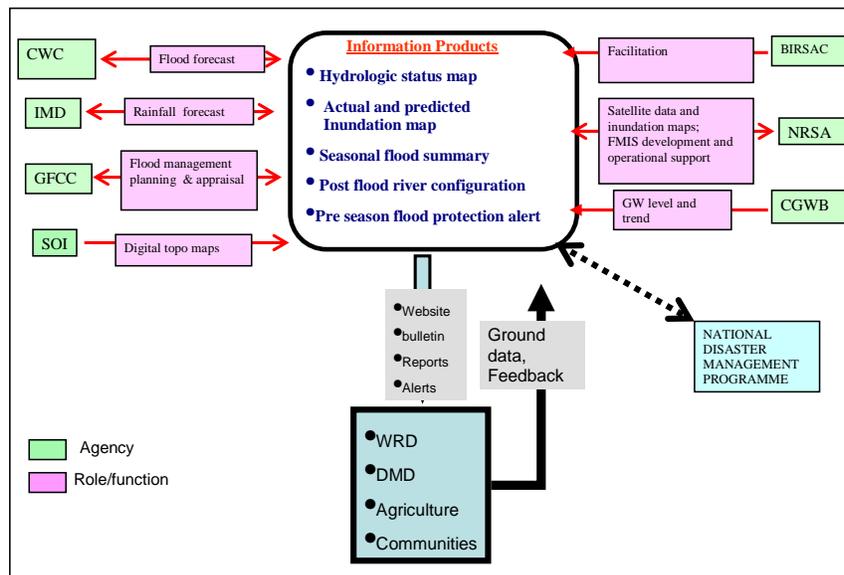


Fig 4. Inter-Agency Linkages

Project Implementation Arrangements and Schedule

The GoB submitted a proposal to the Department of Economic Affairs (DEA) in GOI in February 2006 for Technical Assistance under the World Bank-DfID Trust Fund programme, and received approval in May 2006. The delayed conclusion of the Letter of Agreement on August 24, 2006 resulted in the rescheduling of project closure to 31st October 2007 in order to include at least one operational flood season for validating the proposed Flood Management Information System (FMIS). The project closure was extended till Feb 29, 08 in view of the delayed approval of the GoB Cabinet only on Jan 22, 07, resulting in delay in some critical activities. The project closure was subsequently extended to June 30, 08 to ensure stabilization of FMIS operations and full preparedness before the 2008 flood season.

A Flood Management Information System Cell (FMISC) has been created within WRD to develop, implement, and operate FMIS. A Project Director provides overall leadership while an Executive Engineer provides day-to-day technical guidance. Linkages have been established with national and state agencies for data and information flow. The FMIS development is supported by an Advisory Committee chaired by the Commissioner and Principal Secretary, WRD, GoB, providing policy guidance and inter-agency coordination, and a Technical Committee, chaired by Engineer-in-Chief (North), WRD which meets more frequently to resolve technical issues and to monitor project progress for mid-course corrections. Additionally, frequent inter-agency meetings are held as needed to resolve urgent bilateral issues.

Current Implementation Status by Project Components

The outcomes of the TA are the strengthening of flood knowledge base and analysis, dissemination and outreach of operational flood management information, improvement of flood preparedness, and future flood Management Improvement. The project components and detailed activities are shown in Table below.

Table 2. Implementation Status

Project Components	Activity	Status
1. FMIS Knowledge Base	1.1 Preparation of Cartosat data mosaic of focus area	Completed
	1.1.a. Preparation of additional Cartosat mosaic	Completed
	1.2 Generation of processed historic Radarsat and optical satellite data	Completed
	1.3 Generation of processed 2007 flood season Radarsat and optical satellite data (as needed basis)	Completed
	1.4 Developing additional database for integration in FMIS	Nearing Completion
	1.5 Topographic map digitization as per FMIS specifications	Completed
	1.6 FMIS facilitation	Completed
	1.7 Develop modalities for community outreach, preparedness, and flood management	Completed
	1.8 Computer for remote sensing and GIS software (2 Nos)	Completed

	1.9 HP Designjet 500 PostScript printer (42 inch)	Completed
	1.10.1 UPS + Battery	Completed
	1.10 .2 Diesel generator	Completed
	1.11 Remote sensing (ERDAS Imagine) software	Completed
	1.12 GIS (ArcGIS) software	Completed
	1.13 Oracle RDBMS (1 license), Windows XP Professional SP2 + MS Office suite 2003+ Antivirus software (enterprise version), Visual C++ (2 licenses), Visual Basic (2 licenses)	Completed
	Develop integrated FMIS database , develop and integrate application software, implement in Patna, and maintain for 1 year	Improved version under development
2. Flood Website	2.1. Hiring consultants for operational support	Completed
	2.2 Flood website development, hosting and maintenance	Completed
3. Training	3.1 Plan Stakeholder workshops, meetings and training at Hqs and up to field office, and community level for support to conduct of workshops, meeting and training	Completed
	3.2 Implement programme & plan of 3.1	Completed
	3.3.1 Training in satellite data processing and GIS 3.3.2 Training on procurement Procedures for the World Bank aided projects	Completed
4. Improving flood forecast modeling	4.1 Development of DEM	Completed
	4.2 Generation of customized rainfall forecasts	Completed
	4.3 Develop models for improved flood forecasting, and predicted inundation mapping	Nearing completion
	4.4 Innovative inundation modeling	Dropped ³
5. Developing a plan for upgrading hydrologic measurements, telemetry and FMIS	5.1 Develop plan for strengthening hydrologic network, telemetry, etc	Nearing Completion

³ Due to non-availability of historic inundation maps prior to project closure

4. FMIS Knowledge Base

The FMIS knowledge base characterizing the flood hazard in the focus area aims to integrate the already existing database with National Remote Sensing Agency (NRSA) with the additional datasets to be generated by another consultancy firm. NRSA under an Memorandum of Agreement (MOU) signed in early May 2007, has implemented the existing database and the first version of a user-friendly customized GIS application software for data visualization, analysis and product generation in FMISC. The user friendly Graphical User Interface (GUI) helps to visualize the Geospatial database and generate specific flood data products with minimum GIS expertise. The application has been developed using Arc Objects 9.1 in Visual Basic 6.0, which runs on Windows operating system. The application has been upgraded in January 2008, and further improvement is planned before project closure. Continuous upgrading is made possible through close interaction between FMISC and the NRSA team. It is also planned to web-enable the application in the next phase of FMIS for improved access to the application software for customized analysis by stakeholders, and for updating the database.



The FMIS also integrates a seamless precision-corrected Cartosat I satellite image mosaic at 2.5 m spatial resolution, Shuttle Radar Topography Mission (SRTM) based DEM at 90 m spatial resolution and about 5 m vertical resolution, and selected digital topographic map layers from Survey of India in 1:50,000 scale. Inundation maps in 2007 flood season were operationally and in near-real time provided by NRSA and additional imagery from RADARSAT and optical Indian satellite imagery procured and processed in FMISC. About 30 historic inundation maps since year 2000 are under processing in NRSA. FMIS will integrate all historic and current season inundation maps. Infrastructure consisting of office equipment and special purpose hardware and software and support peripherals including power support for 24x 7 operations was operational in the 2007 flood season.

Table 3. FMIS Data Base Structure

Module/Theme/Feature	Elements and Attributes	Source
A. Administrative/hydrologic context		
Administrative units - District, subdivision, block and village boundaries (Current)	Class code, Name, Geographic area, population and occupation, land utilization class, area and year of data (as per Revenue classification), Total cropped area and area under major crops in each season; sowing, heading/flowering and harvesting period of each major crop in kharif and rabi seasons	Census 2001; GOB WRD; Agriculture Department
Hydrologic units – basins (Current)	Class code, name, geographic area	GOB WRD; updated from drainage/DEM layers
Satellite Image base (current)	Precision corrected Cartosat I mosaic	NRSA Data Centre
Archival satellite imagery (from 2003 till 2007)	Precision corrected Pre- and post season LISS III imagery	NRSA Data Centre
Topographic maps (Current)	SOI Digital Maps in 1:50,000 scale	SOI
B. Infrastructure		
WRD flood offices (Chief Engineer, Superintending Engineer, Executive Engineer, Asst. Engineer, Junior Engineer) (Current)	Class code, office name, location (district/sub division, block, village), jurisdiction (embankment code, name of embankment, reach, name of sluice gate/village), name of person, address, flood management function code	GOB WRD
Storage/diversion structures (Current)	Class code, ID, name, location, purpose, structure type, structural details, year of construction, FRL, MWL, Annual reservoir level at beginning of each month and capacity,	GOB WRD
Command area (Current) Tirhut command (Gandak) and Kamala command (under development); part Kosi command	Code, geographical area, gross and net command area, etc.	RRSSC map (2002-03) ⁴ , GOB WRD
Canal network (Current)	Class code, canal ID, name, starting and end points, length, command area ID, river ID, etc.	GOB WRD + Cartosat I mosaic
Flood management works (Current)	Embankments, afflux bunds, ring bunds, spurs, sluice gates- class code, ID, name, river ID, length, start and end year of construction, structural details, maintenance history, vulnerable reaches, past breaches (year, breach date, breach location on embankment, breach length, flood level, reason for breach, breach impact, when plugged, etc)	GOB WRD + Cartosat I mosaic
Urban and rural settlements – both polygon and point (Current)	Class code, District code, geographical area, population, occupation	SOI Map data + Cartosat I mosaic
Communication network (Current); upto village road, and rail	Roads upto village roads, railway line (available for above districts)	SOI Map data + Cartosat I mosaic
C. Natural Resource Profile		
Land cover-use, upto second	Land cover/use code, area	LISS satellite imagery

Comment [asdf1]: monthly rainfall – min/mean/max daily values, monthly total, seasonal and annual totals

⁴ Map in 1: 775,000 scale, showing waterlogged and salt affected areas in the commands of all major and medium irrigation projects in Bihar using satellite remote sensing, prepared by Regional Remote Sensing Service Centre, Jodhpur, using for Central Water Commission, Ministry of Water Resources, Government of India (using LISS III data of Nov 202 and April 2003)

level in general, and third level in Agriculture category including seasonal crop lands (Most recent after 2002)		
Soil (Current)	Soil type code. area	NBSSLUP maps, Second Bihar State Irrigation Commission report (1:50000 scale in BIRSAC)
Depth to ground water table – pre and post-monsoon (Current, and past years)	Contours and value	CGWB
D. Flood Hazard Characterization		
Flood plain Geomorphology (Current)	Class code (Natural levees, oxbow lakes, abandoned channels, paleo channels, etc.), area	LISS III imagery+ Cartosat I mosaic
River survey data	River ID, Reach ID, Site ID, location ID ⁵ , hydraulic data	WRD
River configuration and bank line (for major rivers) (Current, and past years)	Annual post monsoon status- bank line, active channels, stable and unstable reaches, shoals, actual and potential bank erosion location and severity, drainage block location and type, etc	Cartosat I mosaic
Contours and spot heights (Current)		SOI digital maps
Digital Elevation Model (DEM) (Current)		SRTM DEM
Drainage (Current, and past years)	River ID, basin ID, name, length, seasonal or perennial flow, , connected to, etc.	Cartosat I mosaic
Rainfall – Normal isohyets – 12 monthly, 4 seasonal, 1 annual (Current)		GOB WRD
Hydrometeorological observation site (Current site specific and historic attribute data)	Station ID, station name, location (lat-long, or place name), basin and river ID, District ID, type (manual/automated-type), influence area, Theisson polygon weight, measured variables, operational status, operating agency, observation periodicity, start and end period of record, intermittent/ continuous record, statistical descriptors (monthly, seasonal, annual rainfall, quantity and no. of rainy days), current year daily observations	GOB WRD, IMD
Hydrological (surface and ground water) site (Current site specific and historic attribute data)	Station ID, name, location, type (HO or FF), measured variable/s (G, DG, GDQ, GDSQ), catchment area, basin and river ID, District ID, operating agency, operational status, observation periodicity, start and end period of record, nature of (intermittent/continuous) record, statistical descriptors of past stage or/and discharge (monthly total/mean/min/max flow; annual summary indices (flood flows, calendar period and duration, extreme floods & return periods), current year daily stage/discharge and hydrologic status (low flow, normal flow, flood/rising flow, major flood flow)	GOB WRD, CWC

Comment [asdf2]: gauge and gauge/discharge sites, monthly mean/min/max flow, annual flood flows

Comment [asdf3]: GW level

⁵ Along crosssection

	GW level- pre and post monsoon	
Rainfall forecasts	Grid ID, location, forecast period and value,	Global and national sources
CWC Flood forecasting stations (Current site specific and historic attribute data)	Location, address, type (water stage/inflow), start of operation, period of operation, annual summary of past flood forecasts and actual flood observations Current forecast- water level/inflow, time of occurrence, lead time	CWC
IMD Flood Meteorological Offices (Current site specific and historic attribute data)	Location, address, type (daily manual reporting/automated), start of operation, period of operation, annual summary of past rainfall forecasts and actual rainfall observations Current precipitation forecast, time of occurrence, lead time	IMD
Flood inundation maps (Current, and past years)	Year, flood date, satellite data date, satellite sensor, dissemination date	FMISC/NRSA
Flood damage (Current, and past years)	Year, flood date and duration, Inundation extent, extent in area units and districts/tahsils, duration, damage to crops, livestock, public utilities; frequency of impact within season	GOB DMD
Flood risk zones (Current)	Admin unit - flood characterization – return period and magnitude, frequency and duration within season Hydrologic unit - flood characterization – return period and magnitude, frequency and duration within season	To be derived later
Flood management zone (Current, and past years)		To be derived later

Information Products: Operational information products include:

- Actual and predicted inundation maps customized for the key user agencies with required overlays, in near real time
- Post-season river configuration map, showing possible locations for anti-erosion control measures before next flood season
- Seasonal flood maps showing extent-duration-frequency of inundation,
- Flood hazard map showing area affected by different flood frequency

The information products are to be disseminated through institutional nodal points, a flood website, a community outreach programme, and periodic bulletins.

5. Flood Website

A FMIS website has been created and hosted by National Informatics Centre (NIC) that provides access to current and historic flood data by flood management specialist, research workers and the population affected by floods.. The website has been designed and implemented in-house by FMISC to host data that would include rainfall forecasts from India Meteorological Department (IMD), flood level/inflow forecast from Central Water Commission (CWC), flood inundation maps from National Remote Sensing Agency (NRSA), and data sets from global information providers. The flood website In addition to hosting flood related data, will also provide a forum for feedback and ground data reporting by communities. The website is planned in both English and Hindi.

Website Statistics

- FMIS Site address : <http://fmis.bih.nic.in>
- Designed, developed & Maintained by : FMISC, Patna
- Hosting Agency : National Informatics Centre
- Size of the site : 55MB (Approx)
- Number of text Pages : 52 (as on 18/03/2008)
- Number of Maps : 60 (as on 18/03/2008)
- Number of Database Table : 2 (as on 18/03/2008)
- Number of External links : 11 (as on 18/03/2008)

Technical Specification

- Operating System : Windows / Linux compatible.
- Web Scripting Language : JavaScript, ASP
- Web Site Designing (Tool)
 - Dreamweaver
 - Flash
 - Photoshop
 - Adobe Acrobat
 - DHTML JavaScript Menu tool
 - Flash plug-ins
 - MS-Access

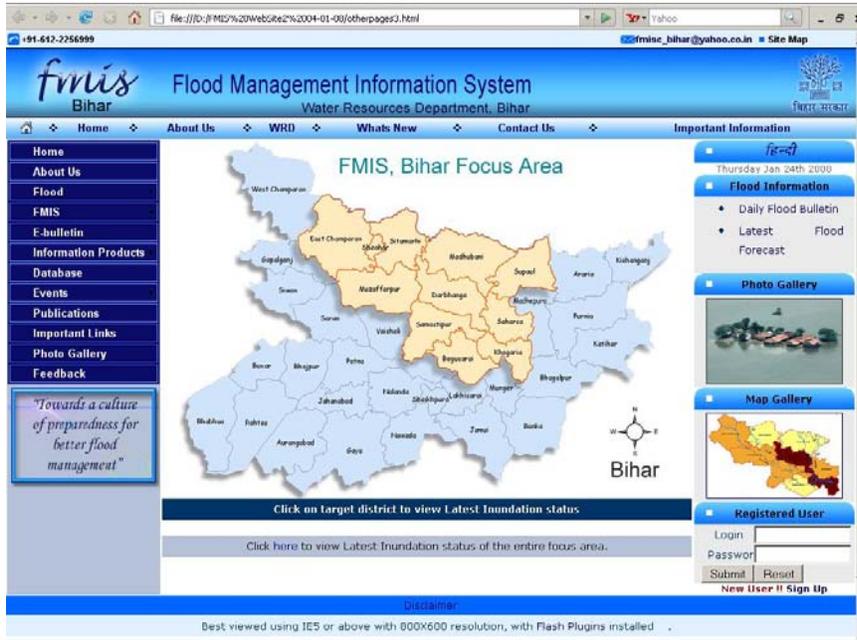
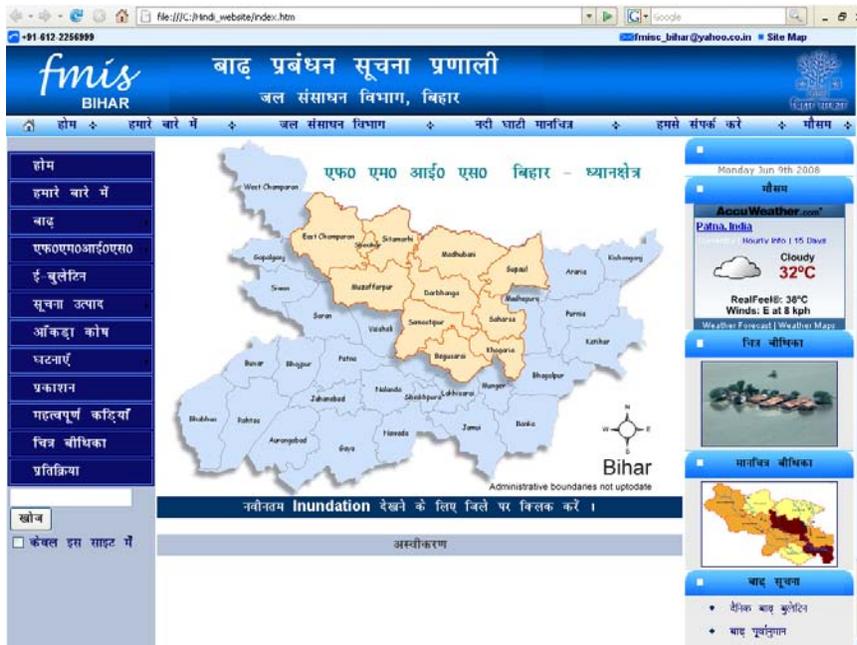


Fig 5. Home page in English and Hindi, with dynamic Weather Data



Navigation

Navigation through the pages of the site can be done using the horizontal bar just below the banner at the top of the page or using the buttons on the left side of the page.

Home	What is FMIS
About Us	Technical Concept
Flood	Technology
FMIS	Goals & Objectives
E-bulletin	Phases
Information Products	Timeline
Database	FMIS Setup
Events	
Publications	
Important Links	
Photo Gallery	
Feedback	

The home page of the site shows a map of the state of Bihar with the focus area high lighted. Each district of the focus area provides a link to a view of the inundation status of that district with the optional block & village boundary layers. The maps may be zoomed for details.

Click the option buttons to select the specific layers



Use the arrow keys or click for panning across the image.



Click to zoom in (Shift-PgUp) & zoom out (Shift-PgDn)



The Hindi version of the website is being developed & would shortly be available.



Currently, Hourly Information as well 15 days forecast weather information.



Information regarding the Daily Flood Bulletin brought out by FMISC & the flood forecast (would shortly be available).



In future though the website will be available to general public, but some of the enhanced features will be restricted for the departmental users. The authorized users would be informed about their login id & password by email.

The home page of the site shows a map of the state of Bihar with the focus area high lighted. Each district of the focus area provides a link to a view of the inundation status of that district with the optional block & village boundary layers. The maps may be zoomed for details. Navigation through the pages of the site is done using the horizontal bar just below the banner at the top of the page or using the buttons on the left side of the page. Dynamic weather data and forecasts are shown based on links o international weather sites. The Hindi version of the website is being developed & would shortly be available. In future though the website will be available to general public, but some of the enhanced features will be restricted for the departmental users. The authorized users would be informed about their login id & password by email.

Future enhancements would include:

Database related

- GIS Map server solution for updated maps for realtime analysis
- Access to database, reports and thematic and FMIS maps
- Thematic and non-spatial queries
- Acquisition of SMS response from communities and database updation
- Interactive generation of thematic map

Web Administration & Site Control

- Tools for updation of News & events
- User access control
- Security modules for protected database access.

Web Site Designing

- Improve interface for content editing and page customization
- Templates for dynamic web pages.
- Automated near real time generation of customized FMIS product
- Development of interfaces to analyze visitor profile to fine tune the network according to the priority group

Dynamic updating of weather data and forecasts

6. Community Outreach

Objectives

The consultancy focused on an evaluation of alternate communication outreach modalities, to ensure that critical flood information reaches vulnerable communities in time and in suitable format for effective ground preparedness. The objectives are:

1. To evaluate alternate communication modes and to recommend the most effective means to directly disseminate localized flood alerts to communities, considering current status of communication modes, infrastructure at community level, absorption capacity and support facilities like electrical power
2. To interact with recommended 'alert service providers' for establishing feasibility and draft agreements
3. To recommend the nature and contents of the community alerts, which is demand driven and maximizes use in effective flood management, compatible with the recommended community communication solution and the community level Disaster Management Plans that may have been developed.

Methodology

- Interact with selected communities based on a sample survey to assess the communication infrastructure at the community level, functional status and efficiency, community skill sets, and readiness of community to absorb new technological tools and information.
- Review existing institutional mechanisms in the key Government departments of Water Resources, Disaster Management and Agriculture, and use of rural kiosks established or proposed by the private or Government sector agencies.
- Review possible innovative and cost-effective communication solutions for community outreach.
- Take note of other initiatives and programmes based on discussions with key departments of Disaster Management and Agriculture.
- Take note of disaster management plans at the community level prepared by Disaster Management Department.
- Consult NGOs working in the project area on disaster management.
- Review international experience.
- Recommend appropriate communication solution and suggest the content and format of community alerts.
- Interact with Consultants undertaking complimentary studies.
- Identify service providers and establish feasibility and draw up draft agreements.

Sample Survey

The field survey is based on household and community surveys using separate structured questionnaire for institutional and individual respondents, selected based on a sound statistical sampling design (covering one randomly selected village in each randomly selected block (18 most flood-prone blocks, 9 moderately affected blocks and 9

marginally affected blocks, representing different flood preparedness level, randomly selected out of 169 blocks in the 11 districts covering the focus area, based on flood severity and frequency). The household survey covered 10 people in each village, with half the respondents from SC/ST communities, ensuring that all socio-economic groups are covered in this survey and the vulnerability aspects of everyone is accounted for. Since all the villages have been divided in two parts, i.e., a) Main Village and b) Satellite Village (inhabited by the marginal and most poor people); 72 community schedules were circulated across the 36 villages. A common village schedule was also used in Focused Group Discussion to further supplement the primary data collection. This primary data was supplemented by information about the village from secondary sources. NGOs and voluntary organizations working in the area on flood management were consulted and their experience reviewed. The efficacy of the existing system of information dissemination was gauged at the ground level, supplemented by identification and interaction with other government and private service providers.

Conclusions and Recommendations

The study evaluated i) alternate communication modalities (public news media such as print media and All India Radio and television, mobile phone, police wireless network, etc.), ii) reviewed possible community focal points for dissemination and mobilization, and iii) type and content of alert, within the socio-economic context (institutional arrangements, information flow, community structure), and technology (power, computer and Internet penetration and skills, telecommunication) constraints in the focus area.

Field survey indicated that in the main village about 70 % of respondents owned radio, while ownership for TV and mobile is 31 and 44 %, with ownership in the satellite village at 45 %, 12 % and 15 %. Landline connectivity is very poor. Due to power problems battery operated radio is a common sight. Most respondents reported radio as a main source of external news.

The infrastructure for community outreach is very weak, with computer and internet penetration almost non-existent in the surveyed households. Currently all district headquarter offices are computerized, and connected to the State headquarters with broadband. Their use is generally very limited, due to poor computer skills. The situation at block level is even weaker. Under ongoing Governmental schemes all Block Resource Centres have been provided computers, but remain unutilized due to lack of skills, erratic power supply, and other factors. Though in principle most blocks can access Internet through dial-up connectivity at a maximum speed of 50 kbps, in none of surveyed blocks this is happening. Significant infrastructure improvements are expected in the future, with many proposed Government initiatives and in the private sector due to overall economic development of the State. Under the Draft IT Policy of 2008 the state government aims to create world class IT infrastructure and connectivity for e-Governance linking its offices from the State HQs down to districts and blocks; to ensure connectivity for panchayati raj institutions; to facilitate setting up of broadband digital networks and encourage National Long Distance Operators (NLDOs) to build robust fiber optic network in the State; efforts are afoot for connecting all the departmental offices across Bihar to the nearest Bihar State Wide Area Network (BSWAN) PoP through Horizontal Connectivity. The

Bharath Sanchar Nigam Limited (BSNL) indicated that of the current strength of their 1200 exchanges across the state roughly 250 to 275 are covered through broadband connectivity and in the next six months it is planned to bring additional 500 exchange under broadband connectivity, thus covering more than three-fourth of the total exchange. Apart from this the BSNL-Bihar has also launched Data-One services that will provide broadband internet connection in the form of data-card. It is important to note here that Reliance, Airtel and Tata-Indicom are already providing the facility of data card/modems, however supporting connectivity only to a maximum speed of 256 kbps with average speed much lower.

The current communication system is highly inadequate to reach out the affected people, suffering from last mile connectivity to the vulnerable communities. In the absence of a well structured system of information flow the communities have evolved an indigenous and informal mechanism, particularly in the area bordering Nepal. Many people living in these areas share marital as well as other socio-economic relations with the people living in Nepal. Their own telephonic communications with such associates and relatives keep them informed about the levels of danger from the rivers originating in Nepal. The radio news transmitted by OXFAM GB located in Janakpur in Nepal with a reach in majority of the places in the focus area and also the flood news broadcast by All India Radio (AIR) were able to alert people in some of the cases.

This study explored alternate community nodes and communication networks, within the current infrastructure and socio-economic context, for effective dissemination of community based alerts. The study has identified voice or text (in graphical format) alert through mobile and police network, awareness building through AIR, use of community level institutions (postal service and Aanganwadi Sevikas), groups and individuals (NGOs, Village-level Disaster Preparedness Committees, Panchayat Sevaks and SHG's). Though PRI functionaries were rated high by the respondents for information on government schemes and welfare activities, Aanganwadi Sevikas came a close second, and scored even better in the poorer satellite villages.

Airtel seems to be the dominant mobile service provider (75 %) followed by BSNL and Reliance networks. Efforts are underway to reach to an understanding with all of these on the possible modes through which they can carry the alerts provided to them by the cell and other logistic aspects. The police wireless network has penetration at every village level and contact with a number of people in every village and has the ability to work in most extreme conditions. The postal service, Aanganwadi Sevikas, Village-level Disaster Preparedness Committees, Panchayat Raj Institutional functionaries and Self Help Groups (SHG's) would be the potential community nodes to receive the flood alert and to mobilize follow-up action. The field survey indicates that roughly 70 percent of these potential information carriers are already equipped with mobiles. The content of the alert has to be, short (not exceeding 10 words or 100 characters), simple and direct, be in Hindi, and ideally graphical to be comprehensible to the illiterate user. These alerts should not be couched in technical terms, for example, release of water in cusec and measuring water flow in depth. The sample survey indicated that verbal messages are more effective than the SMS, and may need to be free or subsidized.

7. Training and Stakeholder Workshops

Training

Five FMISC staff has received hands-on training in digital image processing and GIS techniques at NRSA and at Centre for Spatial Information and Technology in Hyderabad. The external training has been enhanced through in-house training by contract remote sensing and GIS professionals recruited to the Cell. Initial training on FMIS application software has been provided by NRSA in January 2008 after implementation of second version of software in FMISC office, and would be followed by third training after final implementation before project closure. Training on flood forecast modeling and hydrologic network design would be provided by the respective Consultants before project closure.

Stakeholder Workshops

Stakeholder workshops targeting the key GoB agencies (WRD, DMD and Agriculture) have been designed for better institutional awareness and preparedness. The workshops aim to support effective use of FMIS generated information products by the departmental units at different hierarchical levels for effective emergency flood management. The consultant interacted, based on a sampling strategy, with the agencies at multiple hierarchical levels to understand the existing institutional hierarchy, information and decision flow, communication networks, reporting modalities from field formations and hierarchical level flood management functions. Detailed training plan and training material were prepared for use in the stakeholder workshops conducted in 11 districts during April 2008 by the WRD's Water and Land Management Institute (WALMI). The district level workshops were preceded by a TOT training and State level workshop in WALMI in Patna. A Directory has been prepared of key department offices to which flood information products would be sent. The use of NGOs for awareness generation in the focus area was explored.

Approach to Planning Stakeholder Workshops

The planning of workshops started with an interaction with the functionaries associated with flood management in the three key departments of WRD, DMD and Agriculture, which helped in identifying the existing mechanism for flood related information dissemination at various levels in the state. Actual functioning of the existing institutional hierarchy, information and decision flow, communication networks, reporting modalities from field formations and hierarchical level flood management functions was reviewed through field visits to one Chief Engineer zone out of the six such zones in North Bihar, in the WRD context. Sitamarhi district in Muzaffarpur Chief Engineer zone was selected for field work for detailing the functioning of DMD and Agriculture departments at various levels. The existing institutional mechanism through which flood related information and decision flow from the district, block and village levels was reviewed, . .

Workshop Implementation

Training of Trainers: One day Training of Trainers (TOT) of 14 Resource Persons, selected from among the members of academic faculty of WALMI, was organized at WALMI on March 21, 08, to equip Resource Persons with knowledge about FMIS, and FMIS products and their utility in emergency flood management. Master Trainers from the FMIS Cell and the workshop planning consultant trained the TOT trainers. At the end of the training the trainers were aware of the significance of flood management in the broader context of disaster management, understood the application and utility of FMIS information products in flood management. A folder containing resource materials (hardouts, write-up maps and charts etc.) was given to each Trainer to be used as ready reference during down-the-line stakeholders workshops.

Stakeholders Workshops at State Level: The Workshop was organized by WALMI in WALMI Campus on May 16, 08, and inaugurated by Minister for Water Resources, GoB, and chaired by Secretary, WRD. Sixty three officers from the three departments of WRD, Agriculture and DMD participated.

District level Workshops: District, sub-division and Block level officials of Agriculture and DMD and Divisional and sub-divisional level engineers of WRD participated in the half-day session earmarked for each department. Around 400 field level officials of the three key departments were trained. The seven WALMI teams, each comprising two trained resource persons, conducted the district level workshops on fixed dates and venues in each district between April 1 to 30, 2008 (Table 4) . Feedback from the workshops indicated specific areas for improving the utility of FM,IS information products.

Table 4. Schedule of District level Workshops

Sl. No.	Date	District	No. of Participants	Sl. No.	Date	District	No. of Participants
1.	1-2 April	Saharsa	42	6.	8-9 April	Begusarai	35
2.	3-4 April	Supaul	39	7.	10-11 April	Khagaria	41
3.	3-4 April	Darbhangha	41	8.	16-17 April	East Champanan	51
4.	3-4 April	Muzaffarpur	45	9.	16-17 April	Sitamarhi	17
5.	8-9 April	Sheohar	21	10.	16-17 April	Samastipur	43
				11.	29-30 April	Madhubani	33

8. Improved Flood Forecast Modeling

The complex flood regime in the focus area, in which floods are caused by a multiplicity of factors, calls for innovative approaches rather than pure classical hydrologic and hydraulic modeling. Three classes of flood forecasting models (Unit Hydrograph model, ANN based model and SWAT process model) are being evaluated by Indian Institute of Technology, Delhi, under a consultancy study for possible improvements to increase the lead-time and to forecast flood stage at any location in the Bagmati river basin, using currently available hydrologic, hydraulic and topographic data and data flow to the modeling centre. The differing basin characteristics and data availability from Nepal calls for a suite of models⁶ rather than a single basin-wide model. The current forecasting approach is based on gauge-to-gauge correlation, limiting warning time to 8 to 24 hours, and at selected forecasting sites along the main river.

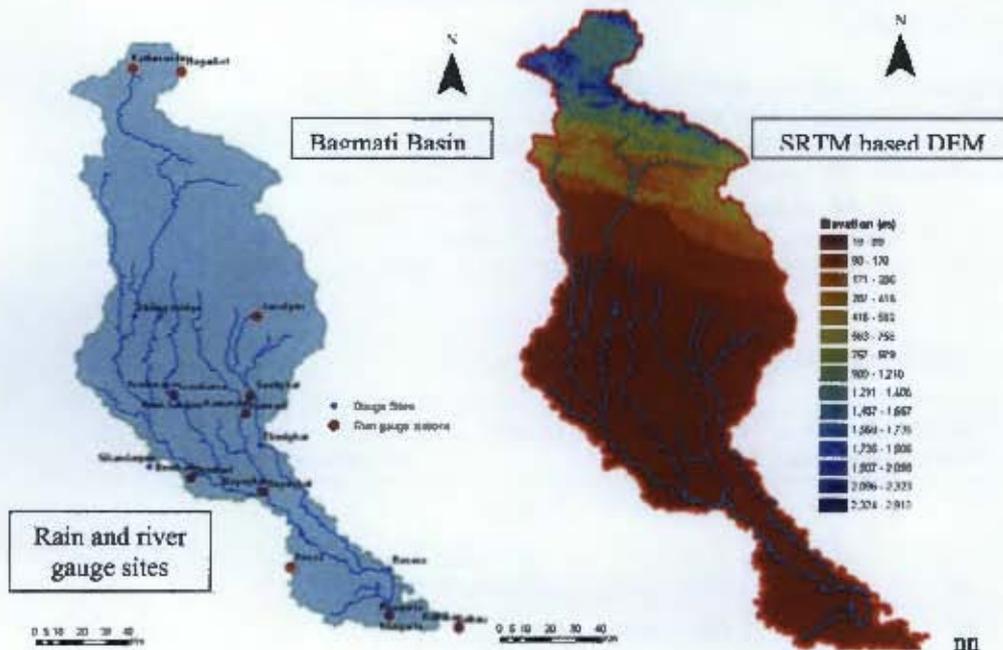


Fig 6. Bagmati Basin

The unit hydrograph approach models the basin response to rainfall input based on historical scenario. The Artificial Neural Network (ANN) model is recommended when real time problems of nonlinear relationship between the rainfall and runoff process is to be modeled. The use of ANN in real time flood forecasting is of very recent origin and shall be used on the Bagmati basin. The Soil and Water Assessment Tool (SWAT) model is a distributed parameter and continuous time simulation model, to predict the response

⁶ For example, ANN, unit hydrograph or rainfall-runoff models would be applied to Nepal portion of river basin, while gauge-to-gauge correlation or routing models may operate in Bihar portion of basin.

to natural inputs as well as the manmade interventions on water and sediment yields in un-gauged catchments. The model (a) is physically based; (b) uses readily available inputs; (c) is computationally efficient to operate and (d) is continuous time and capable of simulating long periods for computing the effects of management changes. The major advantage of the SWAT model is that unlike the other conventional conceptual simulation models it does not require much calibration and therefore can be used on ungauged watersheds. Decadal data on river stage/discharge and rainfall, including hourly rainfall and stage data for selected storms, have been procured from IMD and Central Water Commission (CWC) for model development, since daily data has been found inadequate to simulate the basin response. An SRTM based DEM has been developed to develop drainage details, flow directions, flow accumulation, sub-basin units, slope, etc. for use in model development. The process model would use soil and land use information produced in another consultancy. The model, or suite of models applicable in different portions of river system, will be validated using historical data, and implemented in FMISC office in Patna. The model forecasts will be dynamically integrated in the FMIS knowledge base.

Model integration of observed rainfall and water level in Nepal portion of north Bihar river basins in real-time, currently not available to FMIS, would enhance the forecast lead time. The planned approach would also consider the output of the Meso-scale MM5 model or global climate models of India Meteorological Department (IMD) for the pilot area in the form of precipitation forecasts of up to 3 days for formulating the flood forecasts and mapping expected inundation. Global sources of rainfall estimates and forecasts are also to be evaluated for possible model integration. The India Meteorological Department (IMD) supplied customized three-day rainfall forecast at 45 km grid spacing and 6 hourly interval under an MOU (covering the whole of Nepal and the entire north Bihar) in 2007 flood season, and plans to upgrade to 5 km grid spacing in the 2008 flood season. Initial validation of 3 day forecast for selected periods in 2007 monsoon season indicates need for further improvement in regard to location, time and duration of heavy rainfall events. IMD expects improvements in model accuracy and reliability with use of improved models, computing capacity and increase in spatial resolution. Integration of medium term rainfall forecasts in the flood forecast model will further improve the lead time.

Development of flood forecast model in Bagmati basin has been delayed due to delayed supply of hourly rainfall data from IMD and hourly stage data by CWC. It is expected that a prototype model may be available by project closure.

Alternate inundation mapping approaches based on Artificial Neural Network (ANN) models using variables including observed or forecasted rainfall and river stage in the upstream basin, embankment breach, and inundation extent was explored in the absence of close-contour topographic data⁷. This initiative however had to be dropped since historic inundation maps were not available from National Remote Sensing Agency prior to project closure.

⁷ Close-contour survey planned in next phase of FMIS

9. Upgrading Flood Management Manuals

Objectives

Existing flood manuals in the key Bihar agencies are being updated under a consultancy contract, to integrate FMIS information products with departmental decision-making process and incorporating in flood management plans and manuals etc.

The main objectives are :

- To review the existing manuals and action plans of the three key departments i.e. Water Resource (WRD), Disaster Management (DMD) and Agriculture (DOA), and to identify the prescribed flood management related information flow prior to, during and post-flood season.
- Identify the flood management related information currently used, and indicate how FMIS can enhance information content and timeliness.
- Identify nodal units within each key departments who should be receiving the flood information from FMISC, and revise the manuals and action plans for actions to be taken on receipt of alert , reporting feedback on action taken , structuring information flow within the institution , performing end-of-season evaluation of FMIS product use, and offering suggestions for further improvement.
- Conduct stakeholders' workshops to discuss possible revisions.
- Prepare a supplementary (in Hindi and in English) to the manuals and action plans for adoption by concerned key departments.

Methodology

To achieve the objectives of the present assignment both primary and secondary data sources have been explored. This starts by reviewing the available literature on flood situation in Bihar and its management. The flood forecasting components (including the product quality, dissemination methodology and utility of the product etc.) has been given due consideration, while doing this preliminary literature survey. This helps in identifying the problem associated with flood management in the state and suggested solutions by different authorities. Based on this preliminary assessment of the situation, the government documents available with main key departments have been reviewed to understand the existing mechanism of flood management and identifying the key gaps. Based on this information bank compiled through secondary data analysis, including literature survey, the primary information has been gathered through interaction, interviews, focus group discussions (FGDs) etc.

Secondary Data Collection

To have the first hand idea about flood management system prevailing in Bihar, available secondary information/data have been collected before and during the field activities. The main source of the secondary data information have been as follows-

- The research papers/ articles/ research thesis available in public and college libraries. (Number of studies have been carried out regarding the flood situation in the state by many scholars). This literature has been very informative and helped in identifying the actual need of the community to manage the floods in more effective manner and also the kind of products it all requires. The main source of such information were- from Sinha Library, Patna; Khudababsh Library, Patna; Patna University Library, Patna; National Institute of Technology- Patna, Library, Patna and also the documentation centres of the key departments.
- The internet exploration has been other main source of collecting secondary information. The web sites of main institutions (national and international both) dealing with flood management were explored to get most update information. The main emphasis has been on websites of different state disaster management departments, where quality work was carried out in the field of flood management.
- The CWC and IMD are the main role players, as far as the flood forecasting is concerned. During the first phase of data compilation, a detail analysis was carried out of information available with these institutions,. This helped in understanding the flood information flow system at national and regional level and plan of action of these focal departments to update/ modernise the existing system. The state level offices of these departments were also contacted for getting some other relevant information.
- At state level there are three main role players/ users of flood forecasting information i.e. Department of Disaster Management (DMD), Water Resource Department (WRD) and the Agriculture Department. The manuals/ action plans and other information available with them, (mainly related to flood forecasting information dissemination methodology), and utility by the user groups- including the community were analysed and efforts made to identify the gaps.

Primary Data Collection

With this basic information in hand, the process of primary data compilation initiated. This process concentrated on the objective of the FMIS project and specifically on assignment objectives. The main objective of the primary data/ information compilation is to confirm / cross check the findings of secondary data and enrich this with the primary information input. The specific objectives of this exercise have been-

- *To identify the needs of the user group in flood forecast-* This includes the needs of state level main line government departments and district administration (including various district and local level government departments i.e. agriculture, forestry, urban development, police, fire brigade), Community Based Organisations(CBOs) etc., and the community.
- *To identify gaps in the existing flood forecast system i.e. information available and actual need and its utility-* The information for flood forecast is used by various groups for different purposes. But in most of the cases this information generated is not of much use, because it is not translated in the form it is needed

by that particular section/ group. The primary data collection emphasises to know these gaps, so that appropriate strategy may be suggested to make the final product of more practical utility.

- *Identify gaps in the communication /dissemination of the forecast-* The present system of compiling raw input information for weather forecast and dissemination final product to the user does not seem to be very effective and of much use. There seems to be many gaps in the existing system of communication of flood forecast. Efforts have been made to pin point these gaps by gathering relevant information through interviews, discussions and meetings with different stake holders and user groups. The relevant information has been collected both from state level and regional/ local level groups.

In order to ensure the participation of the different stakeholders, various options were used consisting mainly of – Interviews, Meetings, Focus Group Discussion etc.

- *Transact Walk and Physical Observations*

To have the first hand idea about the pilot sites, the visit were made to the selected areas before starting the actual process of data collection.. During these visits, informal discussions were held with cross sections of people from the areas.

- *Focus Group Discussion (FGD)*

The method Focus group discussion (FGD) were used to involve a large number of grass root people who have practical experiences to face the floods. The larger number of stakeholders, as well as geographical location covered under this method.

- *Meetings*

Number of meetings held mainly with the concerned officials of the key departments (i.e. Disaster Management, Agriculture and Agriculture Departments) to discuss various issues related to flood forecasting and its dissemination.

- *Key Informant Interview (KII)*

While carrying out the above exercise, different sections of the community were made representative. Special attention was paid to the most vulnerable groups and their specific needs in context of flood forecast.

The main resources for the primary information collection have been-

1. *The policy makers at state level-* Including the Central Water Commission(CWC), India Meteorological Department(IMD), Department of Disaster Management (DMD), Agriculture Department, and Water Resource Department(WRD) officials. The interviews were conducted mainly with the middle/ level officials, who are dealing with the information compilation, generation and dissemination.
2. *The NGOs and CBOs-* In Bihar, number of good NGOs (both national and international) are working for flood mitigation and response. The key persons of such NGOs, dealing with flood management were interviewed to identify the real

needs and problems in flood forecast information generation, dissemination and use. In the changing administrative scenario, the Panchayats and other CBOs have to play a very effective role in all aspects of activities, including the floods management. The panchayats and other main Community Based Organisations (CBOs) members were consulted to give their suggestion for making the flood forecasting system more effective and user friendly.

3. *District and local level Administration-* In the present set up of Disaster Management, the District Magistrate is the nodal person to look after the disaster management. The real problems faced by district administration in using the flood forecast were tried to be explored by discussion with officials dealing with the issue. Necessary issues about the communication and dissemination of the forecast information were also discussed.

Analysis

The information compiled both from secondary as well as primary data were analysed in perspective of the assignment's expected out put i.e. updating the flood management manuals/ action plans (focussing mainly on- identifying needs of the user groups, the gaps/ shortcomings in the existing flood forecast system and its dissemination and utility for the user groups). Along with identifying the gaps, the analysis also took care of the options to fill these gaps so that the real need of the customer groups are fulfilled in appropriate manner and in right time. The analysis was continuously discussed with the FMIS team, including other consultants undertaking complementary studies. Following the analysis and necessary feed back, extensive flow charts were prepared discussing organisational structure in flood management, the flood information flow, action taken at various steps and feed back mechanism. While making these suggestions/ recommendations; special attention was given to the availability of the final expected product/ flood alerts of the FMISC. Necessary suggestions/ recommendations were made to make the mechanism of flood forecast information flow (starting from generation point to the end user) more effective and user friendly. Necessary suggestions are made to update the flood management manuals / action plans of the three line departments so that the information flow is more smooth and quick. These suggestions also include, wherever necessary, the changes in the institutional framework. The suggestions and different options for the key departments were discussed with the main concerned officials of the departments and necessary feed back are received.

Outcome

Supplementary to the manual of each key GoB department has been prepared in Hindi, covering actions to be taken on receipt of flood alerts in different phases of flood hazard, feedback from the key departments to FMIS for continued fine-tuning of information products, and archival of relevant flood impact data within agencies and transmission to FMISC for updating flood hazard characterization. Nodal points in the key agencies have been identified to receive and disseminate the FMIS products within each agency, and to build capacity of the key personals in the departments.

10. Plan for Upgrading Hydrologic Measurements and Telemetry

Overview

A consultancy study is evaluating existing data collection networks and proposed plans to suggest improvements in hydrologic observation network and communication modalities to improve time-effective ground measurements and reporting, and enhance forecast reliability and lead-time. Existing network covers state agency operated rain gauge and stage/discharge sites as well as those operated by central agencies. Existing and proposed hydrologic data collection and flow from Nepal portion of river basins would also be considered. Upgrade requirements (spatial and temporal coverage and time-effective reporting) would address optimal rainfall and flood forecast model requirements. Satellite telemetry and other alternate communication modalities will be evaluated. The report on optimal observation network (location, type, observation frequency, etc) and telemetry (type, transmission frequency, time of transmission, etc), along with a first-cut cost estimate, will enable planning implementation in the subsequent phases of FMIS.

Methodology

The Shuttle Radar Topographic Mission (SRTM) DEM of 90 meter resolution was used to delineate the basins and generate the drainage network. The data processing and analysis was carried out in ILWIS software. The first step was to place the rain gauge stations received from different sources (CWC, DSO and Nepal-India Flood forecasting Plan 2003) at their respective spatial locations; this was achieved by creating a table with the rain gauge and their latitude-longitude. Further this table was used to create spatial point map showing the rain gauge locations. Interpolation technique was applied to develop Thiessen polygons for the point location of the various rain gauge stations, which gave the weights and area of influence for each rain gauge locations. WMO recommends a minimum density of one rain gauge for every 575 Sq. Km. for flat regions and 250 Sq. km. for mountainous regions. The optimal network of rain gauges was identified based on these recommendations. This analysis was undertaken separately for each of the three systems. Ordinary rain gauges already exist in the three river systems. The sites have been identified keeping in mind the access by a vehicle. These stations are chosen to identify the minimum network. Stations which reduce the density below the recommended value are eliminated provided they do not increase the influencing area of the adjacent stations. It is recommended that Automatic Recording telemetric rain gauges (Micro processor based) be set up at these stations and data from the stations be made available to the forecast model. The influencing area of some of the stations is higher than the WMO recommended values. Once the rainfall runoff models are identified, calibrated and are operational, more rain gauges to reduce the influencing area be set up to reduce the error in the determination of average input to the model.

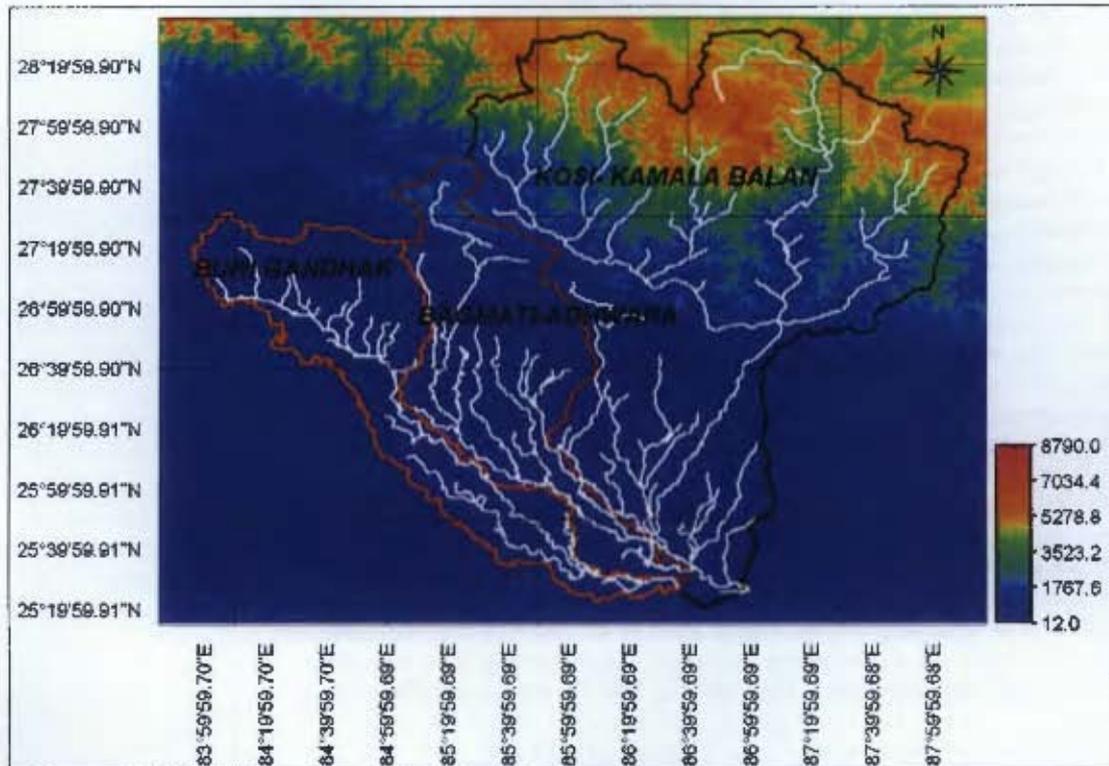


Fig 7. River Basins in Focus Area for upgrading Hydrologic Network

Current status of observation network and data transmission

The two components of the observation network are the meteorological network and the hydrological network. The data requirement depends on the use of observed data for hydrologic analysis, as for instance the requirements by the forecasters to convert the information available from the network to formulate the yield or peak flow forecasts. Presently, CWC issues forecasts in the focus area on the basis of Gauge to gauge correlations/coaxial correlation graphs. The lead time for these forecasts which is 8 to 24 hours, depends on the travel time of the flood wave to the forecast station from the nearest station used as a dependent variable in the correlation. CWC maintains wireless stations for communicating data (rainfall, gauge, discharge) observed at specific periodicity in real-time.

The data on current non-recording rainfall network in Nepal and Bihar portions of basins has been compiled. Daily rainfall data from select rain gauge sites and 8 hourly stage observations from all hydrometric stations and hourly stage observations from select hydrometry sites are transmitted in near Real time through Wireless/Telephone/Messenger. Though some Self recording rain gauges(SRG's) exist in

the focus area but none of the installed SRG's were functional as per the 2006 appraisal report of CWC. Though a few automated rainfall gauges are maintained by IMD the data is transmitted with delay. The adequacy of current network to capture rainfall and runoff variability across the basin has been evaluated using the WMO guidelines and analysis of concurrent hydrologic data, and a minimum network recommended. The desirable network eliminates stations which cover less than 250 Sq.Km in hilly portion and less than 575 Sq. Km. in plain portion . The desirable network gives priority to stations which are already functioning as non-recording raingauges in Nepal, IMD/CWC stations in India and DSO stations in Bihar. WMO recommendations are used and the sites for non-recording rain gauges are analyzed to obtain the network for each basin. In some cases the area nearest to the rain gauge is more than the WMO recommended area for plains and hills. In these cases additional rain gauges need to be provided to reduce the influencing area. The network design has been discussed with the modeling group at IIT Delhi. It emerges from the discussion that the proposed network would be suitable for the modeling work provided these gauges are updated to ARGs (Automatic rain gauge stations) and hourly data are available in real time at the forecast centers.

The requirement by IMD for assimilation in the rainfall forecast model is observed data at 50 Km grid points. The real time observed data can be analyzed to obtain the interpolated values at 50 Km grid points.. The proposed sites are easily accessible as non-recording rain gauge stations are already functioning at the proposed sites. Once the models are calibrated to issue the forecast, the xx steps in section 4 of the report can be used to define key stations where two sensors can be provided to improve the availability of data if one of the sensors malfunctions. This can only after the models start functioning in the area.

CWC flood forecasting manual defines the criteria of choosing Gauge and Gauge-Discharge stations in Indian basins. The stations chosen by CWC and agreed to in the Nepal-India Plan 2003 are recommended.

CWC is currently using wireless for transmission of rainfall and water level data. Three networks are used for the purpose: CWC Wireless network, Customs and central Excise Deptt. Wireless network, and Bihar Police Wireless network In addition telephone, telegrams and special messenger is used to transmit the information.

The observation systems are still manual in the focus area and depend on the CWC communication network for daily raingauge information to develop synoptic charts. Synoptic approach is normally used by the IMD offices to develop Quantitative Precipitation forecasts. National center for medium range weather forecast centre on the other hand uses sophisticated models such as MM5 for Medium range forecasts. MM5 Model for issuing QPF in the focus area is also presently operational and daily forecasts up to three days are being issued by IMD New-Delhi.

CWC is in the process of Modernization of Flood forecasting Network in the XI th Plan. The modernization envisages satellite based transmission system from automatic raingauge and water level sensors . It is expected that by the end of eleventh five year

plan there will be about 1415 telemetry stations covering most of the basins in India. In phase one which is proposed to be implemented during 2008-2009, two forecasting base stations are proposed to be updated in Bagmati, two in Adwara group and two in Burhi Gandak . In the XI the plan two stations each in Bagmati and Adhwara Group and 4 in Burhigandak are proposed to be installed. The commission also plans to integrate the data collection and transmission system with that of the state governments/Project authorities . The Lower Ganga Basin Organization of CWC is developing a mathematical model (Mike-11)

IMD plans to install 550 Automatic weather stations and 1350 Automatic rain gauges in the country. Some of these stations will be in the focus area and can be used in conjunction with realtime forecasting models to formulate forecasts. The likely approach for Transmission is through INSAT (Time Division Multiple Excess)TDMA Technology. All (Data relay transponders) DRT channels in INSAT are administered by IMD..

The existing real-time flood forecasting systems, which generate the most reliable forecasts, are sophisticated, use real-time data as input, and are expensive. These systems use automatic recording rain gauges for measuring rainfall. Data can be transmitted from a remote site to a central base station through several available communication systems. The choice of the appropriate communication system depends on factors such as the size of the watershed, the time of data transmission, and the costs.

The consultant has estimated the rough cost of two master stations, software and 168 ARG's, and the other accessories including civil works, training and 10% spares at Rs. 100 to 120 million (US \$ 2.5 to 3).

11. Operational Flood Mapping in 2007 Monsoon Season

The detailed protocol for FMISC operations prior to, during and post-monsoon season and in normal period was developed prior to the 2007 flood season. The protocol called for effective flood watch each day, with review of rainfall forecasts, reported rainfall, water levels (current, trend and forecasted) and ground reports received from different agencies. Procedures for NRSA interaction, additional satellite data acquisition, processing and dissemination were implemented. Staff schedule for 7 day-week operations was put in place, and necessary facility support for un-interrupted power supply was ensured.

First Flood Map: The first flood episode in 2007 flood season occurred in the Bagmati basin, due to over-topping along a length of 60 m at about 47.3 km along the Bagmati Left embankment near Pachnuar village, which was reported at midnight of 15 June. Subsequent field reports indicated that extensive areas in four blocks in Muzzaffarpur and Sitamarhi districts were inundated. The first cloud-free satellite data was available from IRS 1D satellite's Linear Imaging Self Scanning (LISS) III sensor coverage of 17 June 2007, and was ordered by FMISC, generated by NRSA Data Centre in 6 hours and uploaded to its ftp server, and downloaded in Patna through the high speed internet connectivity in FMISC. The satellite data was processed overnight, and the inundation map and statistics of villages affected in each of four blocks were generated (Annexure 4). These were provided to the Disaster Management Department in the State and used for appraising the Chief Minister. Subsequently, FMISC received the inundation maps produced from RADARSAT data of 20 June on 22 June 2007. Inundation map based on satellite data of 17 June 2007, two days after flooding, indicated about 1,25,444 ha affected in four blocks in the two districts. Water had not evacuated from about 31, 468 ha even 5 days after flooding. .

The first flood episode was analyzed to draw lessons and to tighten up the protocols of data flow between different stakeholders, and within FMISC, and follow-up actions for flood monitoring.

Dissemination and Outreach: Twenty six flood inundation maps were produced in the 2007 flood season, and disseminated by email to focal officers in Water Resources, Disaster management and Agriculture departments, and District Magistrates of affected districts (Annexure 5). The Department of Agriculture is regularly collecting flood information through a Nodal Officer appointed for liaison with FMISC for use in contingency planning. The Disaster Management department is also receiving on request the rainfall Forecast in the form of daily e-bulletin published from FMISC through fax on daily basis. The District Magistrates and Special District Magistrates in charge of flood management are receiving the daily bulletin which is used for better ground preparedness. The inundation maps and statistics have been used in Chief Minister's Aerial Survey of flood affected areas, as well as used by DMD for appraising the Chief Minister on the flood status. Special District Magistrate, Darbhanga requested for positional verification of specified places for air-dropping of relief materials, which was provided by FMISC, Bihar based on inundation maps. The inundation maps have also been field validated by FMISC teams.

Seasonal flood maps have been generated, based on individual flood maps, showing the maximum extent of inundation (Annexure 6), frequency and duration of inundation, impact of embankment breach, and sustenance of breach plugging, etc have been generated. An Annual Report describing flood events in 2007 season has been produced. Six e-Bulletins in English and in Hindi languages and at monthly frequency have been issued by the FMIS Cell (Annexure 7). Daily bulletins describing the past, current and predicted hydrologic status have been regularly issued in the 2007 flood season (Annexure 8).

12. Next Steps

Preparing for 2008 Flood Season

With the closure of World Bank assisted FMIS Phase I project closing on June 30, 08 the WRD of GoB would be sustaining the project operations in 2008 flood season (June 15-Oct 15, 08) with its funds. Sanction has been provided for additional staff and systems for two-shift operations during the flood season. Operational protocol for FMIS operation has been updated for 2008 season. Funds for need-based satellite data has also been sanctioned.

FMIS Phase II

The second and next phase of FMIS is planned at an estimated outlay of about US \$ 3.03 millions (Rs.13.11 crores), with the following inter-related elements: a) develop a comprehensive Embankment Management Information System (EMIS) to sustain protection in select priority river basins; b) upgrade knowledge base on flood hazard and extend to all flood prone districts of North Bihar, c) upgrade timely and appropriate flood information generation and delivery systems for better institutional and community preparedness in selected river basins; d) Improve community participation and outreach, and e) facilitate sharing of international knowledge and experience in developing appropriate FMIS (Annex 9).

The strategy in Phase II would be to build upon the achievements in the earlier phase, with expanded geographic coverage and technical enhancements. Horizontal expansion would vary with the sub-component.

Table 5. Geographic Coverage of FMIS Phase II Components

Component	Geographic coverage
1.1 Expansion of spatial database	Whole north Bihar
1.2 Surveys	Bagmati basin
	Bagmati, Kamla and Burhi Gandak basins
	Bagmati, Kamla and Burhi Gandak basins
1.4 Improved predictive models	Bagmati, Kamla and Burhi Gandak basins
	Bagmati basin
	Bagmati, Kamla, BurhiGandal and Gandak rivers
1.5 Embankment Management System	Bagmati, Kamla and Burhi Gandak basins
2.1 Strengthening community outreach, ground data collection/reporting	Bagmati basin
2.2 Community participation for embankment protection	Pilot in Bagmati basin

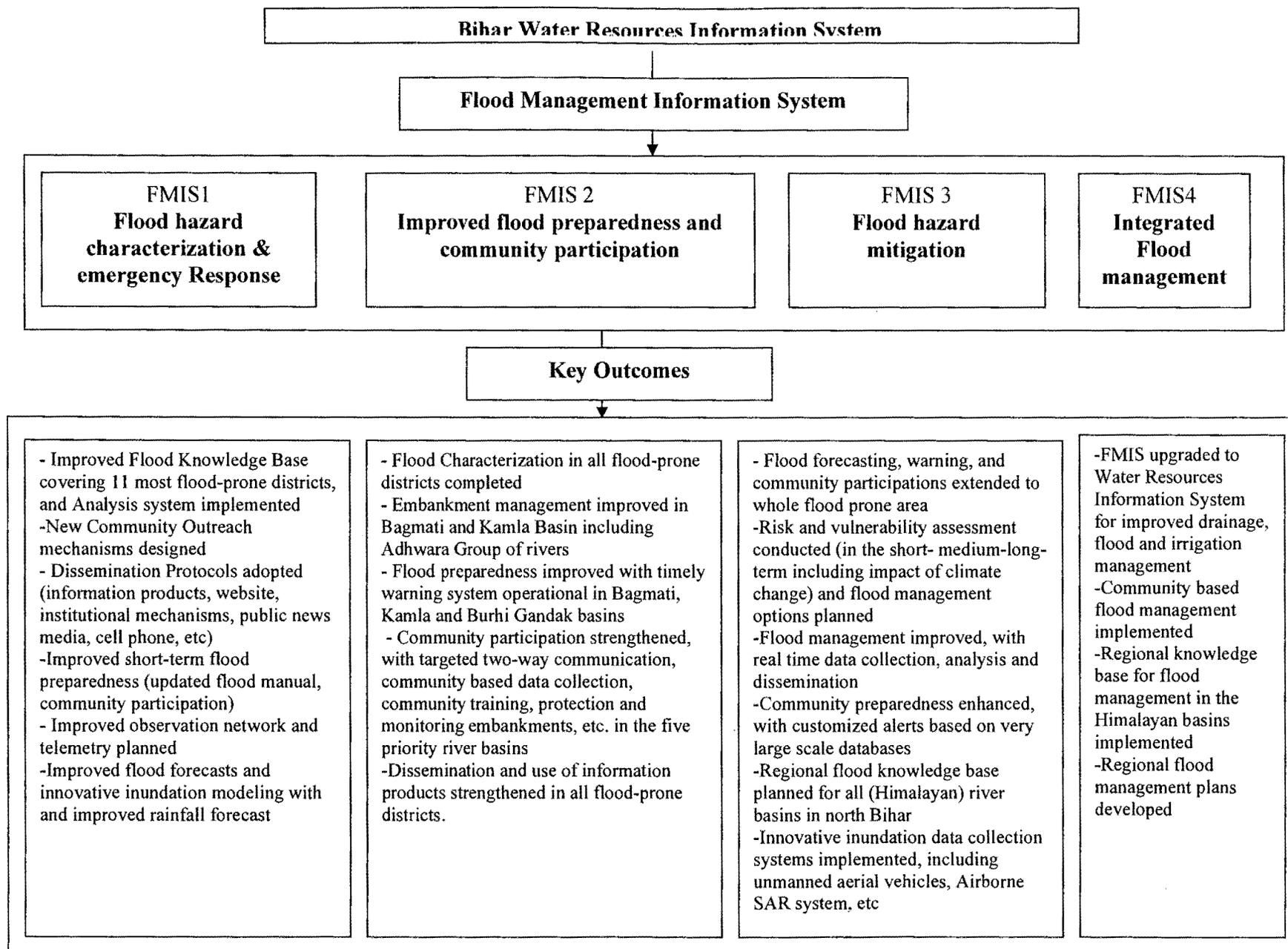
13. FMIS outputs, outcomes and sustainability

Outputs in the first phase of FMIS are a functional FMIS, issuing time-effective and targeted information products, customized for key government agencies, for improved flood management; increased lead-time of warning from current 8 to 24 hours to 3 days for better ground preparedness; spatial warning of expected flood inundation, hitherto not available, for locale specific emergency management; increased awareness of stakeholders and institutionalization through updated flood manuals to promote effective use; improved information dissemination through institutional linkages, website and community outreach; and follow-up with key agencies to sustain FMIS operation. The project outcomes are improved flood management preparedness of key agencies (Water Resources Department, Disaster management department and Agriculture department), and improved flow of critical flood information, resulting in reduced flood damage to society.

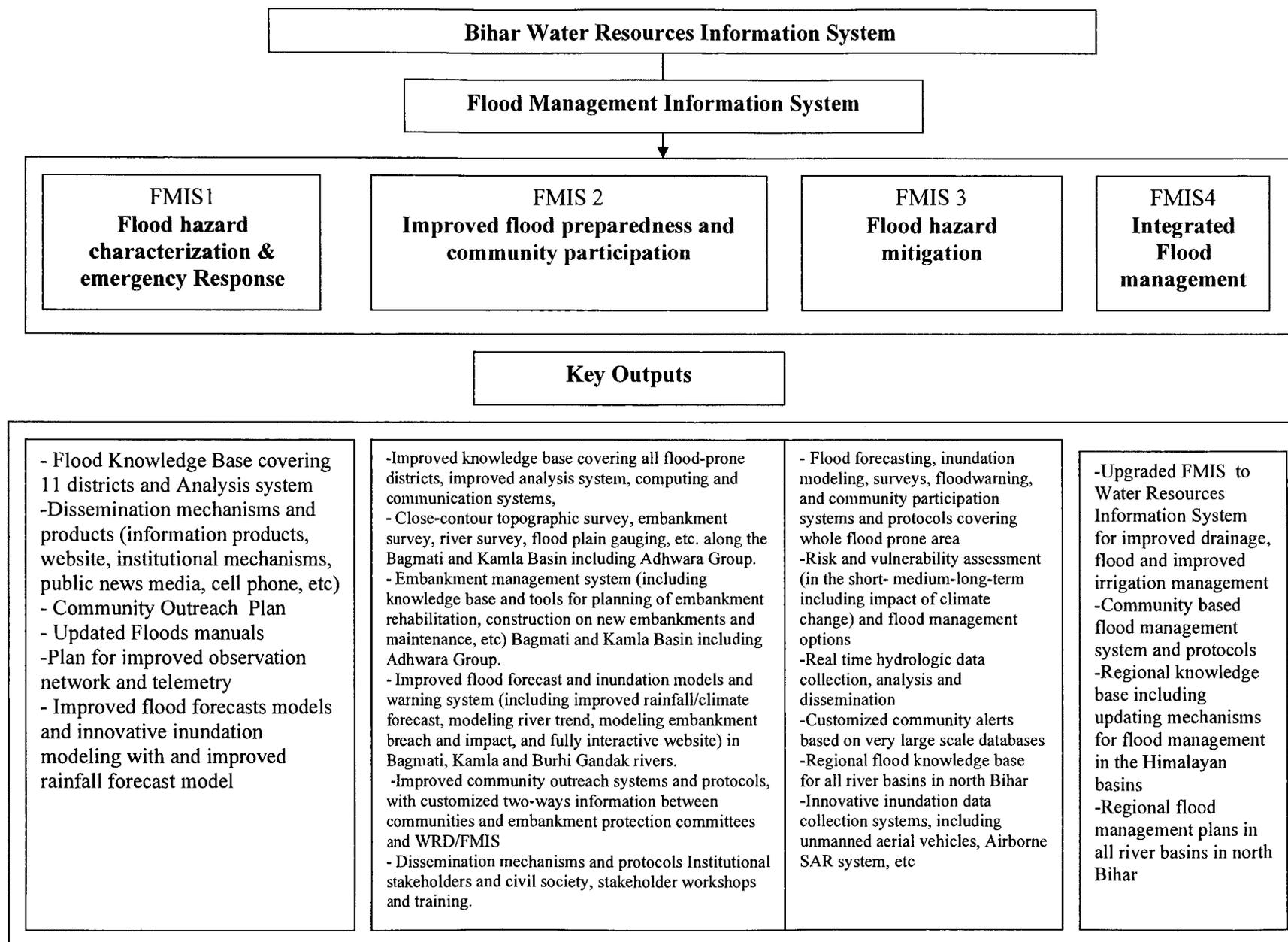
The critical agreement with NRSA, IMD and other national agencies, achieved after extensive interaction, would lead to sustainability of FMIS after the Bank withdrawal. Mainstreaming within WRD is already under way, with frequent interaction between FMISC and the Flood Monitoring office of WRD, and by providing services to WRD for planning/strengthening flood management schemes. The demand for services by stakeholders at state headquarters and at district level is continuing which is a positive sign.

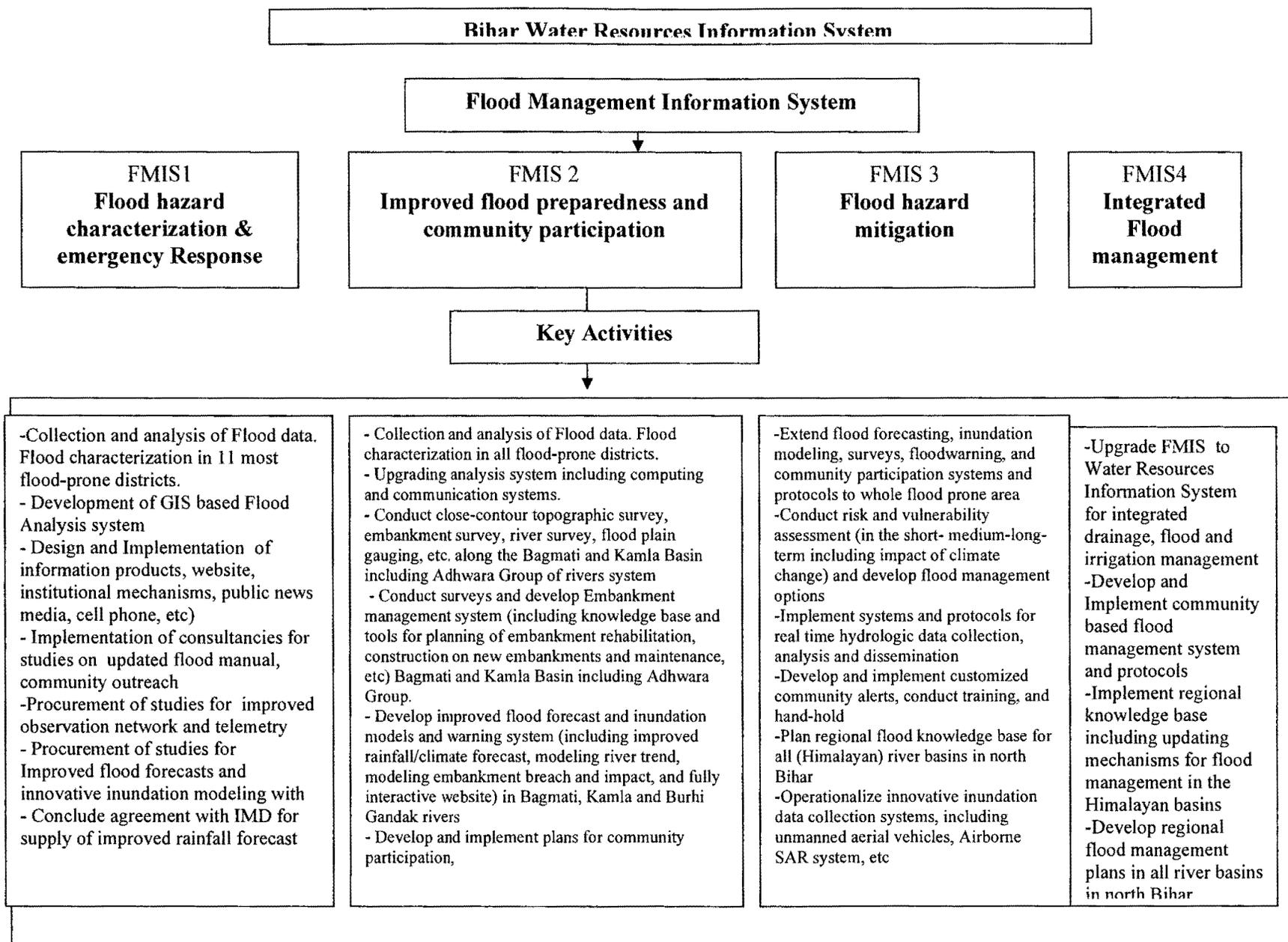
Allocation of funds by WRD for continued upgrading and operation of FMIS, and demonstrated use in flood management by key agencies would indicate sustainability in the short-term⁸. Mainstreaming FMIS within WRD, including integration in flood manual and associated actions, demand for upgrading FMIS and continued demand from key agencies would indicate medium term sustainability. Long-term sustainability would be indicated by integration in national systems, specific budget allocation, and seamless integration with all key agencies. Currently the WRD proposes to convert the FMIS under Plan budget, demonstrating its commitment for sustainability in the short and medium term. Mainstreaming of FMISC is being facilitated through regular interaction with the Flood Monitoring office in WRD and presentations to WRD staff and providing analysis support on request for flood management functions. FMIS information products were demanded by the key agencies both at headquarter level and in field offices, and used in flood management.

⁸ In a telling demonstration of sustainability, after closure of World Bank TA by June 30, 08, the WRD has allocated funds to continue operation of FMIS during the 2008 flood season.



Annexure 1a. FMIS Development Framework -Outcomes





Annexure 1c. FMIS Development Framework -Activities

Annex 2. Log frame for proposed activity

Narrative Summary	Verifiable Indicators	Means of Verification	Assumptions
<p>Goal</p> <p>To improve the institutional capacity of the GoB for delivering better flood management services as a key action for accelerating agriculture productivity in North Bihar</p>	<p>Timely response and increased flood management effectiveness of the WRD and concerned agencies leading to the reduction of annual damages and quality of public expenditure on relief operations</p>	<p>Yearly damage report of the property, loss of human and cattle lives, etc.</p>	<p>Sustained political commitment to the development and use of information for operational purposes</p>
<p>Purpose</p> <p>Development and implementation of a comprehensive Flood Management information system to effectively support flood control and management in the flood prone areas of Bihar.</p>	<p>a) Updated information applied to a more effective flood management and protection. b) Institution capacity upgraded for the implementation of a sustainable flood management and drainage control policy</p>	<p>a) Statistics of Disaster Management Department of G.O.B & Disaster Management Authority, G.O.I. b) Institutional capacity assessment.</p>	<p>a) Continuity of policy and priorities b) Timely availability of funds for developing and implementing the system. c) Access to restricted information.</p>
<p>Outputs</p> <p>(i) Strengthening knowledge Base and Analysis. (ii) Dissemination and out reach of operational flood Management information. (iii) Improvement of flood preparedness. (iv) Future Flood Management Improvement.</p>	<p>a. FMIS developed and Implemented b. Website developed and operational d. Updating of flood control Manual. e. Hydro meteorological data collection policy updated</p>	<ul style="list-style-type: none"> ▪ FMIS developed and implemented. ▪ Website for Bihar Flood Information developed and operational ▪ Flood control manual updated for use of FMIS. ▪ Plans for the improvement hydro meteorological measurements prepared. 	<p>The inter-institutional arrangements for information sharing are successfully managed in the project timeframe.</p>
<p>Activities</p> <ul style="list-style-type: none"> ▪ Analysis of historical floods ▪ Development of GIS databases ▪ Archive for remote sensing and GIS data. ▪ Improved modeling. 	<ul style="list-style-type: none"> ▪ Flood Management database and GIS completed ▪ Improved understanding of flood hazard 	<ul style="list-style-type: none"> ▪ FMIS Project Report 	
<ul style="list-style-type: none"> ▪ Review current flood information stakeholders, information flow and use arrangements. ▪ Review of modern international websites for flood management. ▪ Develop Bihar Flood Information Website. ▪ Develop with stakeholder input of Bulletins (monthly, weekly, for specific events) 	<ul style="list-style-type: none"> ▪ Flood management database updated. ▪ Information accessible for all decision makers and stakeholders. 	<ul style="list-style-type: none"> ▪ Website for Bihar Flood Information. ▪ Bulletins 	
<ul style="list-style-type: none"> ▪ Review existing flood contingency plans. ▪ Update these plans to improve use of available flood information. 	<ul style="list-style-type: none"> ▪ Updating of Flood Management Response. ▪ Manuals and Flood Contingency Plans 	<ul style="list-style-type: none"> ▪ Flood Management Contingency Plans. ▪ Manuals and procedures approved and in use in WRD 	
<ul style="list-style-type: none"> ▪ Review existing hydrometeorological and hydrological network and information flow arrangements. ▪ Develop medium-term plans to improve flood management information systems in Bihar 	<ul style="list-style-type: none"> ▪ Proposal for improving the hydrometeorological and hydrological network and information flow for Bihar flood management. ▪ Medium-term plan to improve flood management information system for Bihar 	<ul style="list-style-type: none"> ▪ FMIS Project Report. ▪ Proposal for the improvement of the information system and for hydro meteorological network 	

Annexure 3. Flood Characterization and Hydrologic Analysis of Focus Area

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 have identified 4 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 raining season, no Kharif season agriculture
- Class IV: Permanent water logging - shrinkage in area only in Feb, local rainfall, micro-relief aspects.

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. There after flood generally comes in River Burhi Gandak 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. A peculiarity of this year's flood is regarding the river Bagmati in which flood remained high even during the month of September –October.

Flood History

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 pressures of industrial activities and other development works 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 Resourced Department Annual Flood Report in chronological order during (1997-2006) is given as follows:

1997 - During this year rainfall in the catchments of all the river basins was generally normal. Gandak, Kosi, Bagmati and Mahananda rivers experienced floods from first week of July. In the mid of July maximum discharge caused tremendous pressure to the embankment/ structures resulting in wide spread damage. Bagmati right embankment at Kothia village, Bagmati afflux bund at Mausurha closure, right embankment of Burhi Gandak at Beria Thorai, Govindpur and Paharpur, Kamla Balan river at 65.5 Km, were partially damaged. Afflux bund and main eastern Kosi embankment were damaged at few places which were protected by undertaking flood fighting works. Besides these few places at Burhi Gandak, Bagmati, Kamla and Kosi, river embankments faced severe erosion which was protected by flood fighting works.

1998- In 1998 rainfall started by the first week of July and extended up to end of September. The rainfall was by and large normal but the length of flood period was extended. Maximum discharge in the first week of July in most of the river in North Bihar caused excessive pressure on the embankment along the rivers resulting in damages at several places which were encountered by doing flood fighting works. Burhi Gandak right embankment at Beria Koral, Govindpur, Ahok Ghat Sikhaul, Rampurwa Burhi Gandak Left embankment at Enerwa , Seuri, Aolapur, Mainpurwa, Bagmati right Embankment at Surgahi, Kothia, Mausaura closure bund Bagmati left embankment at ch. 101-405 near Belsund were partially damaged which were successfully repaired by timely flood fighting. Kamla Balan right embankment at 73.6 km was breached in a length of 15 ft. and at 42.75 km, 65 km were cut by the anti social elements. Also Khiroi embankment at 17, 18, 9.25 km were damaged by anti social elements. Badlaghat Nagar Para embankment at Malpa, Lalpur, Prayani, Karachin Badlaghat embankment at Chatar, Amni, Saidpur were damaged at some places. Adhwara right embankment at ch. 16, left embankment at ch. 140 breached due to high pressure which was controlled by flood fighting works. Right and left Brandi embankment at ch. 165 and 400.75 km. respectively were cut by anti social elements. Eastern Kosi embankment, afflux bund and western embankment at few places were damaged which were protected by flood fighting works.

1999-This year rainfall in June was more than normal rainfall. In July Bagmati basin experienced more than normal rainfall. In August no significant rainfall observed in month of October the rainfall was more than normal rainfall in the focus area. Due to more than normal rainfall the spur in Kosi river experiences threat throughout the flood season. But timely flood fighting kept the river within the embankment. In the Burhi Gandak the right embankment at Suratpur, Sikhaula and at left embankment at Tatitola, Pehsara, Bihulia, Mirzapur, Rajhwara, Bore-Jairam, Satmalpur, Begumpur and Balapur were threaten by flood water but timely flood fighting kept the embankment safe. In Bagmati river right embankment at Kothia and Surgahi site felt high pressure similarly at left embankment at ch. 314 to 329 and ch 397 to 405. Right embankment was kept safe by flood fighting but for the left embankment retire bund was constructed to keep the river safe from flooding the area. In Kamla-Balan right embankment 8 to 10 km., 12.7 to 13.5 km and 58.6 km felt high tension and pressure which was overcome by flood fighting. In October due to excessive rainfall 55.5 km the embankment breached in 215 ft length. Same way Kamla-Balan left embankment at 27 km, 31 to 42 km, 44.7 km 46 km 49.6 km 57 km 59.42 to 61.25 km 62 km, 65.4 km 66.6 km, 67.5 km and at 82 km it was under threat which was overcome by flood fighting but the villagers purposely cut at 60 km 63.5 km 65.3 km 78.5 km 82 km and 86.75 km so that they could allow the river to gush in the fertile silt into their field. Buthi-Balan at 8 km the right embankment breached and caused loss to the area. And at left embankment at 16 km. great pressure was overcome by flood fighting.

2000- Bagmati left embankment at chain 273 near village Madhkaul was cut by villagers. 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 villager. Incident of embankment cut have been reported earlier also. This was done to bring silt to raise land by the villagers. Kamla-Balan and Bhuthi-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 was 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, expert from head quarter camped at the site and brought under control. Sikarhata Majhari Bund of western Kosi embankment between Km 6-7 was damaged in the night of 13/8/2000 but saved by doing flood fighting work. Heavy pressure on Spur at km 78.30 of Eastern Kosi embankment was overcome by undertaking flood fighting work.

2001- Left bank of river Burhi Gandak at Rampurwa Pulwar, Pakridayal, Enarwa Gaht Mainpurwa and right embankment at Bihkhiya, Chakarniya, Bairiya, Koral, and Balochak was experiencing pressure but was saved by timely flood fighting. Burhi Gandak left embankment at 69-70 km at village more the bed wall which was earlier constructed damaged due to heavy local rainfall and pressure over embankment. Burhi Gandak at right embankment at 98-99 km at village Phulwaria anti social element cut the embankment on 17.9.2001. The Right embankment of Bagmati River at Kothia and Surgahi and at 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. 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. Western Kosi embankment at 2.25 km the D-part of spur nose was damaged. Bhuthi-Balan right embankment breached due to overtopping at 20.91 Km, 21.01 km, 21.4 km 22 km, and 60.7 km in first week of October.

2002-Kamla Balan left embankment at km 81.20 (Bugras) was cut by villagers in a length of 30 m which increased to 50 m. Overtopping 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 Pipra ghat, 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 villagers, piping and 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 the embankment was breached due to overtopping. Bagmati left embankment between ch. 145 to 149 was cut by villagers on 23.7 02. Kiroi left embankment at 7 km at village Masartharia and 5.25 km near Maasma and Kiroi right embankment at 12 km near Belwara Milki village and at 3 km near Bagwasa village it breached due to overtopping on 24.7.02. Western Kosi embankment at 29 to 30 km below Kasba Barda was cut by villages at 2 places.

2003- Maximum discharge of 389000 Cusec passed through river Kosi where as 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 through the river 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 antisocial elements cut Kamla Balan right embankment at km 66.50 in a length of 50 ft. Status of flood in other rivers except Ganga, Gandak remain normal. In river Ganga the HFL at Bhagalpur surpassed the 1978 record of 34.18 and was 34.20 level and at Patna at Ghandhighat the HFL level of 1994 (50.27) was observed as 50.12 in 2003 due to 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 in much respect 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 year which was the maximum flood producing year. 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 it self speaks about the fury of flood in year 2004. Many places in the embankment of North Bihar were breached resulting in flood inundation in a vast area of North Bihar area. Unprecedented flood in river Bagmati, Burhi-Gandak, Kamla and Bhuthi-Balan and Adhwara groups of river breached the embankments at many places and there was loss of life and property in a large scale. In river Kosi situation by and large remained normal and a maximum discharge of 286375 cusecs passed on 10.7.04.

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

2006- The flood situation during 2006 was normal. Where there was 52 numbers of breaches during 2004 flood, this year only 1 breach occurred. Left embankment of Kamla was breached near village Asma at km 75.70 by antisocial elements but fortunately there was no loss of life or property. Flood situation in other places remained normal by and large.

Flood Characteristics of Focus Area

FMIS focus area comprises of Muzaffarpur, East Champaran, Sitamarhi, Sheohar, Saharsa, Supaul, Darbhanga, Madhubani, Khagaria, Samastipur and Begusarai. A study has been made with the help of data obtained from DMD to see the flood events that took place in the development Blocks of these districts in term of inundation during 1987 to 2006 (20years). A summary of the findings is given below

Sl. No.	Name of Districts	No. of Blocks affected more than 11 years out of 20 years	No. of Blocks affected 5 to 11 years out of 20 years	No. of Blocks affected less than 5 years out of 20 years
1.	Muzaffarpur	5	5	6
2.	East Champaran	2	14	13
3.	Sitamarhi including Sheohar	9	5	4
4.	Madhubani	3	12	9
5.	Darbhangha	6	10	4
6.	Supaul	5	2	5
7.	Samastipur	3	5	14
8.	Saharsa	5	1	3
9.	Begusarai	1	5	10

10	Khagaria	6	1	-
	Total	45	60	68

The table indicates that there are as many as 45 blocks of FMIS focus area which are chronically flood affected in terms of flood inundation.

2.9 Loss Of Public Property In Last 10 Years

Year	Number of Affected									Crop Damaged	House Damaged		Public Property Damaged (in Rs. Lac.)	Deaths	
	District	Blocks	Village	(in Lac)		Area (in Lac. ha.)					Total	Value (in Rs. Lac.)		Human	Animals
				Human	Animal	Agriculture	Non Agriculture	Total	Cropped						
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	6.01	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	5.14	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	14.45	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
1999	24	150	5,057	65.66	13.58	6.79	1.66	8.45	3.04	24,203.88	91,813	5,384.95	5,409.99	243	136
1998	28	260	8,347	134.7	30.93	17.59	7.53	25.12	12.84	36,696.68	199,611	5,503.70	9,284.04	381	187
1997	26	169	7,043	69.65	10.11	12.46	2.25	14.71	6.55	5,737.66	174,379	3,056.67	2,038.09	163	151

Source: Disaster Management Department

(<http://disastermgmt.bih.nic.in/>)

Hydrologic Analysis of 2007 Flood Season

The focus area receives flood waters from vast areas of Nepal through four main streams viz Burhi Gandak, Bagmati, Kamla and Kosi. The FMIS Cell received daily rainfall / river water level data of some stations falling in these basins whose details are as follows.

Sl. No.	Name of measuring station	Location		Maintained by	Type of data	Mode of data acquisition
		Basin/River	(Nepal/ Bihar)			
1	2	3	4	5	6	7
1	Simara	Burhi Gandak	Nepal	GoN	Daily Rainfall	Web site ²
2	Kathmandu	Bagmati	Nepal	GoN	Daily Rainfall	Web site ²
3	Nagarkot	Bagmati	Nepal	GoN	Daily Rainfall	Web site ²
4	Garuda	Bagmati	Nepal	GoN	Daily Rainfall	Telephone ³
5	Janakpur	Kamla	Nepal	GoN	Daily Rainfall	Web site ²
6	Sindhuli	Kamla	Nepal	GoN	Daily Rainfall	Telephone ³
7	Okhaldunga	Kosi	Nepal	GoN	Daily Rainfall	Web site ²
8	Taplejang	Kosi	Nepal	GoN	Daily Rainfall	Web site ²
9	Dhankutta	Kosi	Nepal	GoN	Daily Rainfall	Web site ²
10	Biratnagar	Kosi	Nepal	GoN	Daily Rainfall	Web site ²
11	Dharan	Kosi	Nepal	GoN	Daily Rainfall	Web site ²
12	Lalbegiaghat	Burhi Gandak	Bihar	CWC, GoI	DRF & RS ¹	Email ⁴
13	Sikandarpur	Burhi Gandak	Bihar	CWC, GoI	DRF & RS ¹	Email ⁴
14	Samastipur	Burhi Gandak	Bihar	CWC, GoI	DRF & RS ¹	Email ⁴
15	Rosera	Burhi Gandak	Bihar	CWC, GoI	DRF & RS ¹	Email ⁴
16	Khagaria	Burhi Gandak	Bihar	CWC, GoI	DRF & RS ¹	Email ⁴
17	Sonakhan	Bagmati	Bihar	WRD, GoB	River Stage	Flood News ⁵
18	Dubbadhar	Bagmati	Bihar	WRD, GoB	River Stage	Flood News ⁵

19	Kansar	Bagmati	Bihar	WRD, GoB	River Stage	Flood News ⁵
20	Benibad	Bagmati	Bihar	CWC, Gol	DRF & RS ¹	Email ⁴
21	Hayaghat	Bagmati	Bihar	CWC, Gol	DRF & RS ¹	Email ⁴
22	Kamtaul	Bagmati/Khiroi	Bihar	CWC, Gol	DRF & RS ¹	Email ⁴
23	Sonbarsa	Bagmati/Khiroi	Bihar	CWC, Gol	DRF & RS ¹	Flood News ⁵
24	Saulighat	Bagmati/ Darbhanga Bagmati	Bihar	CWC, Gol	DRF & RS ¹	Flood News ⁵
25	Ekmighat	Bagmati/ Darbhanga Bagmati	Bihar	CWC, Gol	River Stage	Email ⁴
26	Jainagar	Kamla	Bihar	WRD, GoB	River Stage	Flood News ⁵
27	Jhanjharpur railpul (u/s)	Kamla	Bihar	WRD, GoB	River Stage	Flood News ⁵
28	Jhanjharpur railpul (d/s)	Kamla	Bihar	CWC, Gol	DRF & RS ¹	Email ⁴
29	Basua	Kosi	Bihar	CWC, Gol	DRF & RS ¹	Email ⁴
30	Baltara	Kosi	Bihar	CWC, Gol	DRF & RS ¹	Email ⁴
31	Kursela	Kosi	Bihar	CWC, Gol	DRF & RS ¹	Email ⁴
32	Birpur	Kosi	Bihar	CWC, Gol	DRF & RS ¹	Flood News ⁵

¹ Daily Rainfall and River stage,

² www.mfd.gov.np,

³ from CWC

⁴ from CWC,

⁵ Daily flood News of Water Resources Dept. GoB

Rainfall

The first monsoon rainfall is received before the formal beginning of the monsoon season i.e.; 15th June. Heavy rainfall was registered on 15th (142.20 mm at Simara in Nepal) and 16th June (126.40mm at Sikandarpur, 144.00mm at Kamtaul, 116.40mm at Jhanjharpur, 231.00 mm at Baltara and 105.00mm at Kursela all in Bihar). July has been the wettest month having maximum rainy days. August seems to have received three isolated storms. In September some of the stations recorded extremely high rainfall. For example, Sikandarpur in Bihar received 453.00mm cumulative rainfall in 24 hours on 26th September. This station observed 150.60mm on 25th and 151.00mm on 27th September. Thus, it forms the maximum 24-hr, 48-hr and 72-hr cumulative rainfall observed this year in the AOI. Second maximum 24-hr cumulative rainfall was observed at Simara in Nepal (312.00mm) on 5th September. The monsoon season came to the end in the beginning of October with only a few millimeter cumulative rainfalls observed at most locations in this month. Exceptionally, Sikandarpur observed 449.60mm in October up to 18th. The following Table compiles monthly / monsoon rainfall as well as number of rainy days observed at different stations falling in the concerned basins. This compilation is based on the daily rainfall data received from local Division of Central Water Commission and the Nepal website www.mfd.gov.np.

Monthly / monsoon rainfall (mm) observed in the river basins of AOI flood 2007

River Basins	Rain-Gauge Stations	Monthly Rainfall					Monsoon 2007		Normal Monsoon Rainfall
		June (from 15th)	July	August	September	October (up to 18th)	Total	No. of rainy days	
1	2	3	4	5	6	7	8	9	10
Burhi Gandak	Simara	291.60	862.20	665.70	739.30	27.60	2586.40	64	1497.40
	Lalbegiaghat	61.10	562.40	983.90	572.60	76.80	2256.80	63	
	Sikandarpur	136.40	1023.00	1106.40	1230.08	449.60	3945.48	66	
	Samastipur	165.20	630.20	383.60	542.00	49.80	1770.80	66	
	Rosera	141.00	459.60	394.40	394.20	34.20	1423.40	62	
	Khagaria	149.40	611.50	214.60	309.50	55.60	1340.60	49	

Bagmati	<i>Kathmandu</i>	134.00	234.50	226.16	329.70	18.30	942.66	87	1125.60
	<i>Nagarkot</i>	231.40	226.80	353.35	422.60	1.20	1235.35	72	1554.30
	Benibad	125.20	620.20	323.20	530.50	103.00	1702.10	59	
	Hayaghat	46.20	640.50	379.20	691.40	85.80	1843.10	76	
	Kamtaul	193.00	528.00	448.10	422.50	148.90	1740.50	53	
	Sonbarsa	<u>216.20</u>	<u>810.80</u>	509.80	316.00	53.40	1906.20	50	
	Saulighat	NA	NA	577.80	629.60	133.70			
Kamla	Jainagar	<u>253.90</u>	<u>622.40</u>	226.00	245.00	34.60	1381.90	55	
	Jhanjharpur	133.60	544.40	593.70	428.10	25.50	1725.30	64	
Kosi	<i>Okhaldunga</i>	140.30	508.90	250.00	420.30	49.80	1369.30	88	1401.60
	<i>Taplejang</i>	109.40	456.10	323.40	305.90	116.60	1311.40	101	1404.60
	<i>Dhankutta</i>	82.10	253.00	93.20	166.00	19.80	614.10	72	722.50
	<i>Biratnagar</i>	211.80	424.10	521.80	375.80	1.60	1535.10	75	1522.50
	<i>Dharan</i>	204.50	573.40	305.50	387.60	145.30	1616.30	88	
	Basua	117.80	397.43	342.50	375.00	10.40	1243.13	64	
	Baltara	285.00	374.40	230.60	243.40	47.00	1180.40	53	
	Kursela	244.00	343.20	197.60	151.60	2.20	938.60	55	
Birpur	NA	NA	386.20	446.00	6.60				

- Notes:
1. Rain-gauge stations written in italics are located in Nepal.
 2. Monthly / monsoon rainfall have been calculated using daily rainfall obtained from CWC and Nepal web site www.mfd.gov.np. Underlined figures for Sonbarsa and Jainagar have been taken from Directorate of Statistics.
 3. Source of Normal Monsoon Rainfall is the Nepal web site www.mfd.gov.np

It is however to be noted that there have been a few days on which data was not available. Those gaps have not been filled up. So, similar information from the parent source may be a little different.

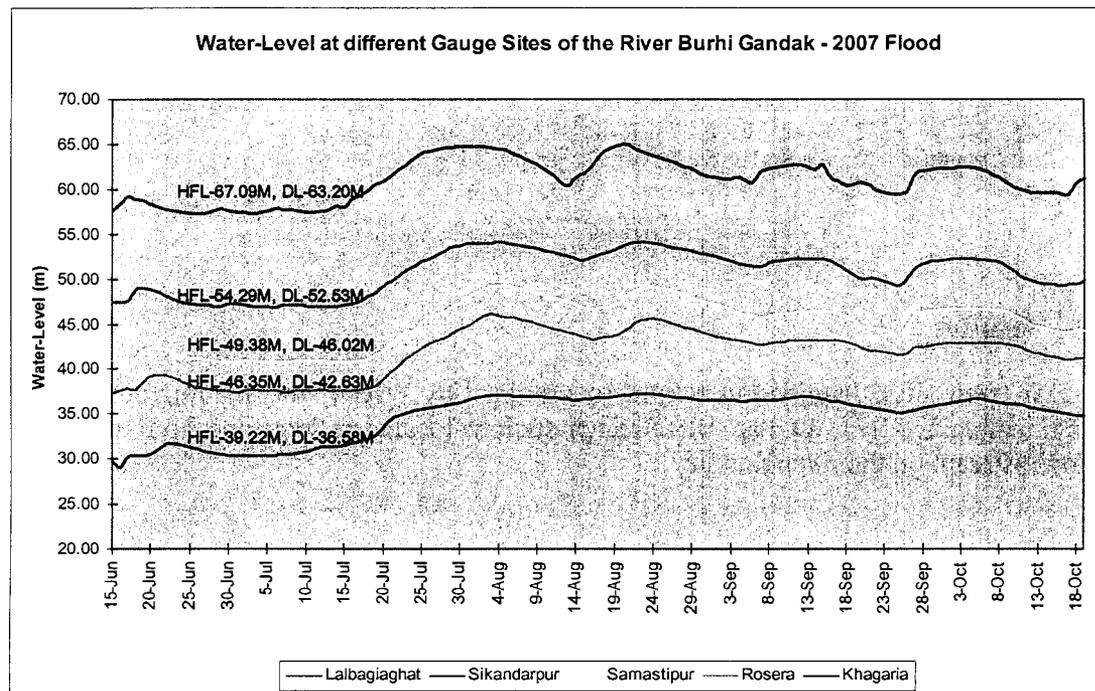
Most of the places have received rainfall on more than 50% days of the monsoon period. Taplejung in Nepal had maximum (101) rainy days. If we compare this monsoon rainfall with the Normal Monsoon Rainfall, it reveals that the monsoon has been more active in the western part of the area (Burhi Gandak basin). Eastern part (Kosi basin) received less than the Normal rainfall. Sikandarpur received 3945.00mm cumulative monsoon rainfall which is more than three times the Normal Monsoon Rainfall of the area. Below are the contours drawn with the rainfall figures given in the above Table. The June rainfall is taken from 15th of the month and the October rainfall is only up to 18th of the month.

River Stage

Daily water-levels measured (at 6:00 AM) at different gauge stations on four major rivers of the AOI have been chronologically plotted. They are discussed below.

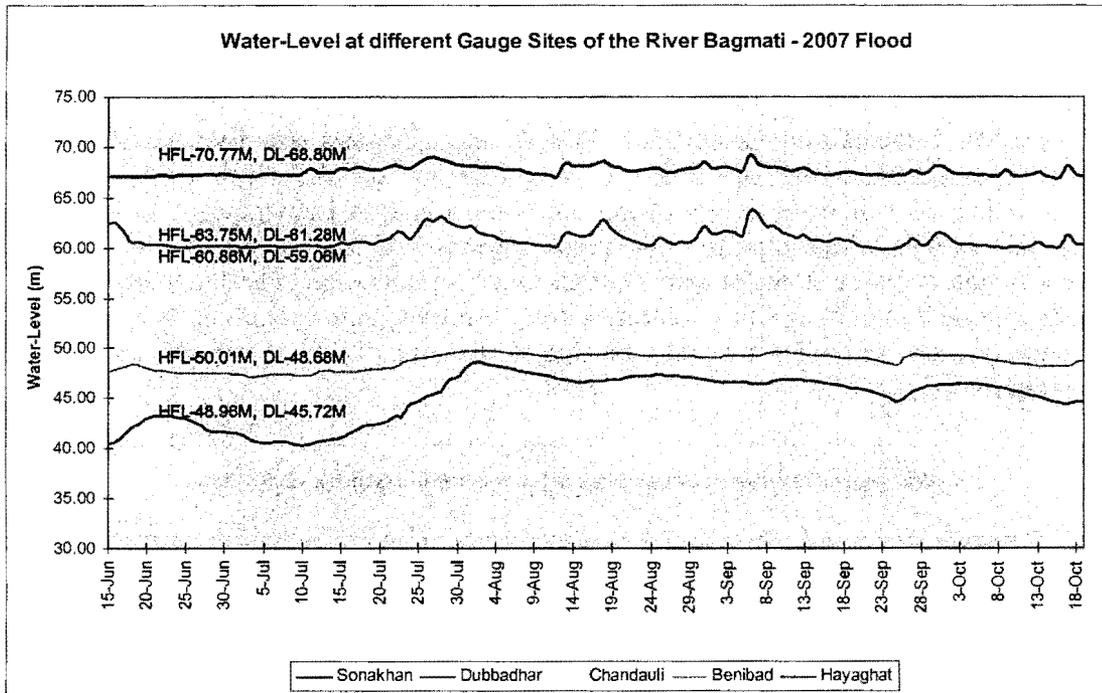
4.2.1 Burhi Gandak

Lalbegiaghat, Sikandarpur, Samastipur, Rosera and Khagaria are five gauge-stations located in sequence from up-stream to down-stream on the river Burhi Gandak. Chronological plot of water-levels at the upper-most station Lalbegiaghat shows sharp peaks and valleys which signifies the quick response of catchments at this location. Gradually the plots at down-stream stations have smoothed. Parallel pattern up to Rosera may be due to insignificant contribution of intermediate tributaries. Khagaria plot is relatively more smooth which may be due to the effect of local run-off and spill of adjoining rivers.



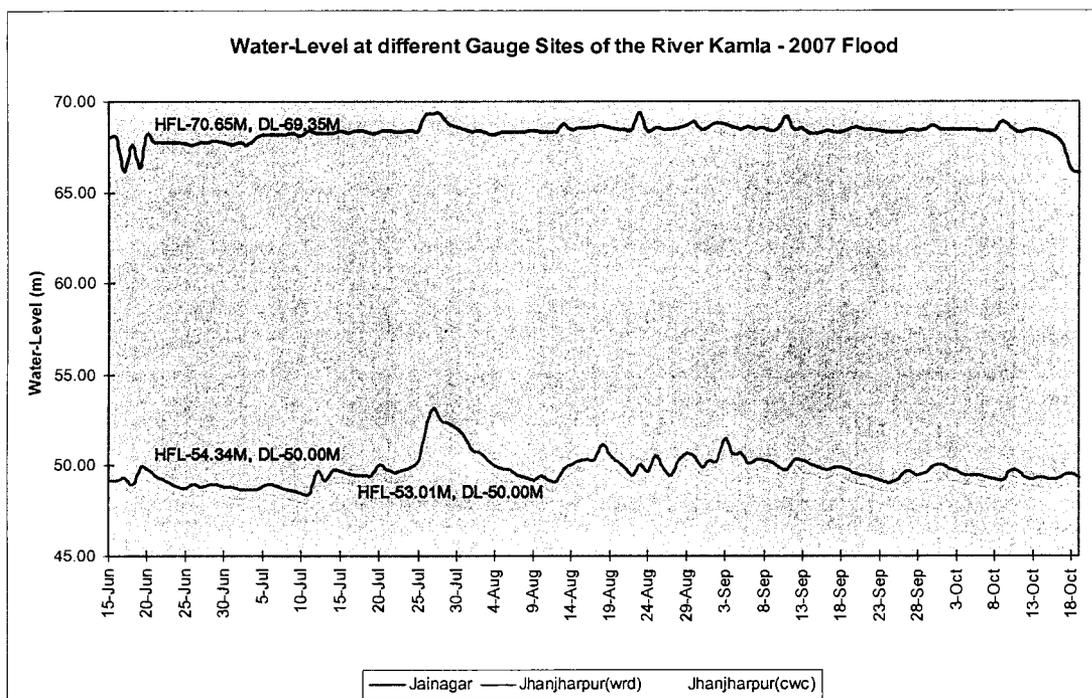
4.2.2 Bagmati

Sonakhan, Dubbadhar, Chandauli/Kansar, Benibad and Hayaghat are five gauge-stations located in sequence from up-stream to down-stream on the river Bagmati. Chronological plot of water-levels at the upper stations shows less rise and fall at Sonakhan in comparison with that at Dubbadhar and Chandauli. At Benibad plot is much smooth which may be due to the routing effect as well as run-off contribution of tributaries. The nature of Hayaghat plot is quite different which shows the effect of major tributary-Khiroi.



4.2.3 Kamla

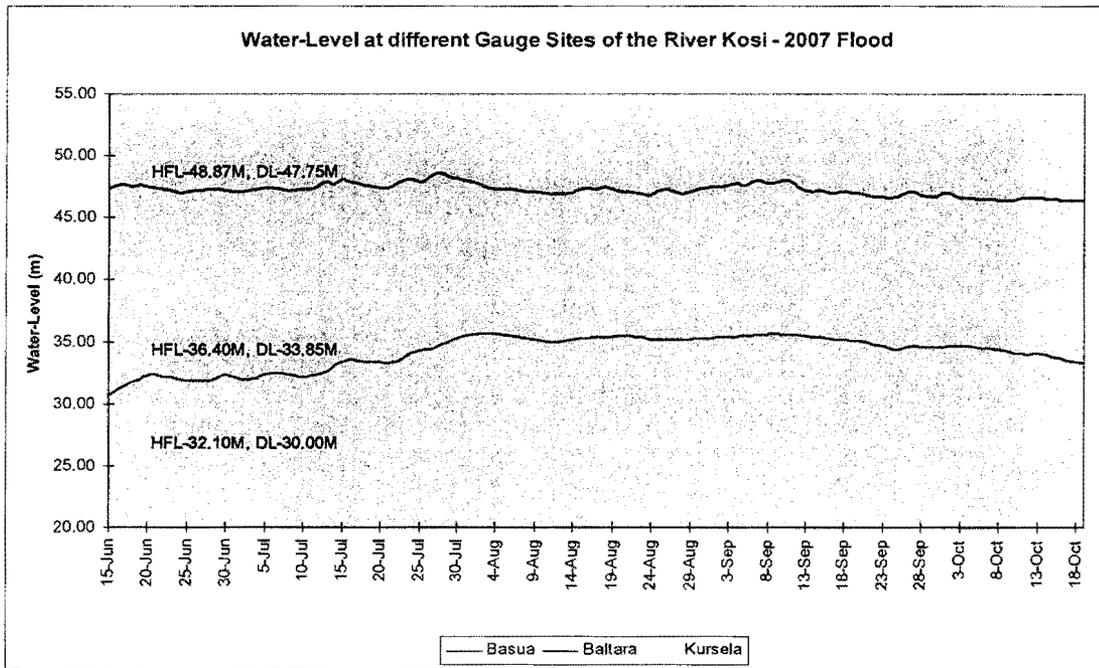
Jainagar (weir site), Jhanjharpur railpul (maintained by WRD), and Jhanjharpur (down-stream maintained by CWC) are three gauge-stations located in sequence from up-stream to down-stream on the river Kamla.



Chronological plot of water-levels at these stations shows that Jainagar plot has small rise and fall. This may be due to the effect of gate operation of Jainagar weir. Water-level pattern at u/s and d/s of Jhanjharpur railpul is quite parallel. Average afflux of 0.63m has been observed during the flood season 2007 with a maximum of 1.33m and minimum of 0.11m. Water-level fluctuation is more at Jhanjharpur than that at Jainagar which seems the effect of intermediate tributaries.

4.2.4 Kosi

Basua, Baltara, and Kursela are three gauge-stations located in sequence from up-stream to down-stream on the river Kosi. Chronological plot of water-levels at these stations shows that Basua plot is rougher in comparison with that at Baltara. The magnitude of rise and fall at Basua is less than that at Baltara. Smooth pattern of Baltara plot may be attributed to the large storage capacity of channel between Basua and Baltara. Water-levels at Kursela seem to be effected by the flow of Bagmati tributary.



4.3 Effect of rainfall in the Nepal region on the river-stages in Bihar

River gauge stations in AOI close to the Indo-Nepal border are Lalbegiaghat on Burhi Gandak, Sonakhan on Bagmati, Jainagar on Kamla and Basua on Kosi. Daily river water levels measured at these stations vis-a-vis daily average rainfall of the respective basin above these locations have been plotted on the same charts. Rain-gauge stations considered for averaging are as follows:

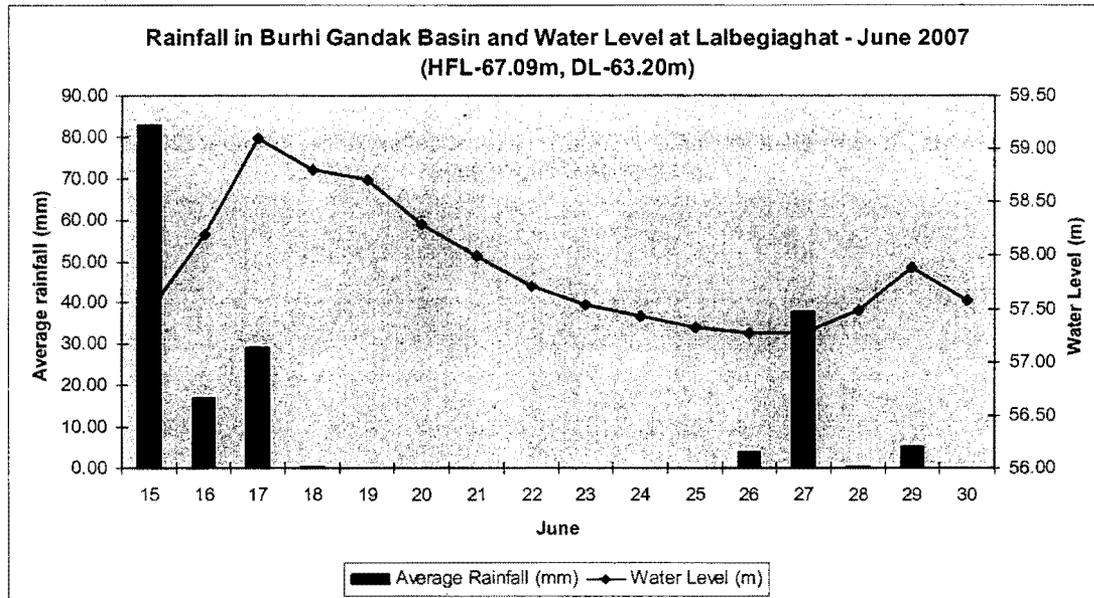
Name of basin	Part under consideration	Rain-gauge stations considered for averaging
1	2	3
Burhi Gandak	Up to Lalbegiaghat	Simara, Lalbegiaghat
Bagmati	Up to Sonakhan	Simara, Kathmandu, Nagarkot, Garuda
Kamla	Up to Jainagar	Janakpur, Sindhuli, Okhaldunga
Kosi	Up to Basua	Okhaldunga, Taplejang, Dhankutta, Biratnagar, Dharan, Basua

Number of rain-gauge stations is too less to account for the aerial variability of rainfall. Therefore, in stead of using rigorous methods simple arithmetic mean has been used for averaging the rainfall. Basin wise rainfall pattern and corresponding water level are discussed in the following paragraphs.

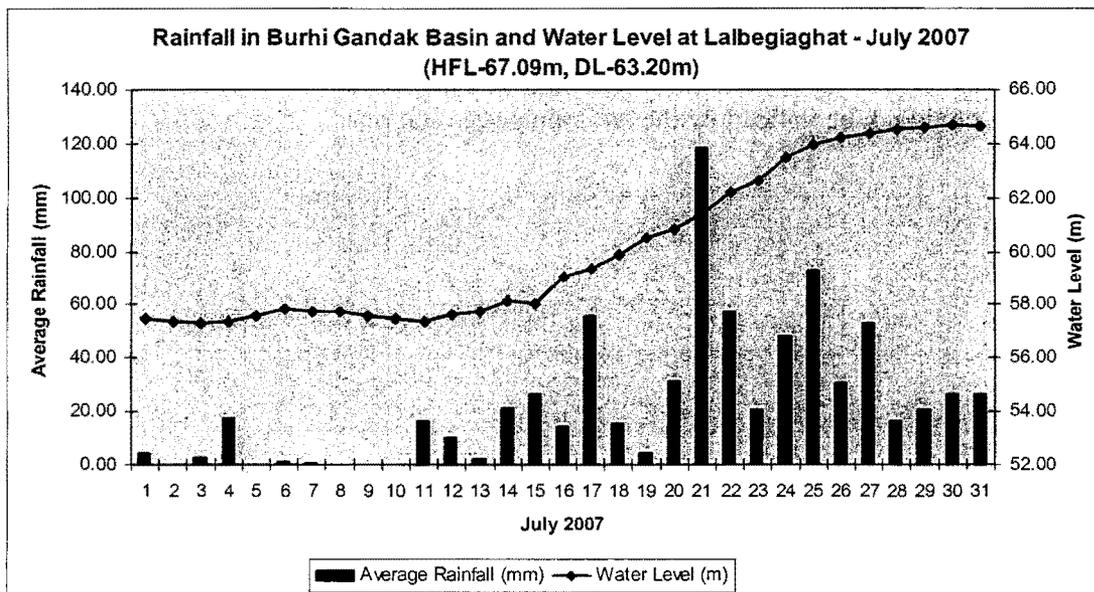
4.3.1 Burhi Gandak

Big spell of rainfall (average 82.70mm) was observed on the very first day of the flood season (15th June to 15th October). The river rose from 57.48m on 15th to 59.10m on 17th

in June. This followed continuous receding till 27th when an average rainfall of 37.60mm caused further rise for two succeeding days.

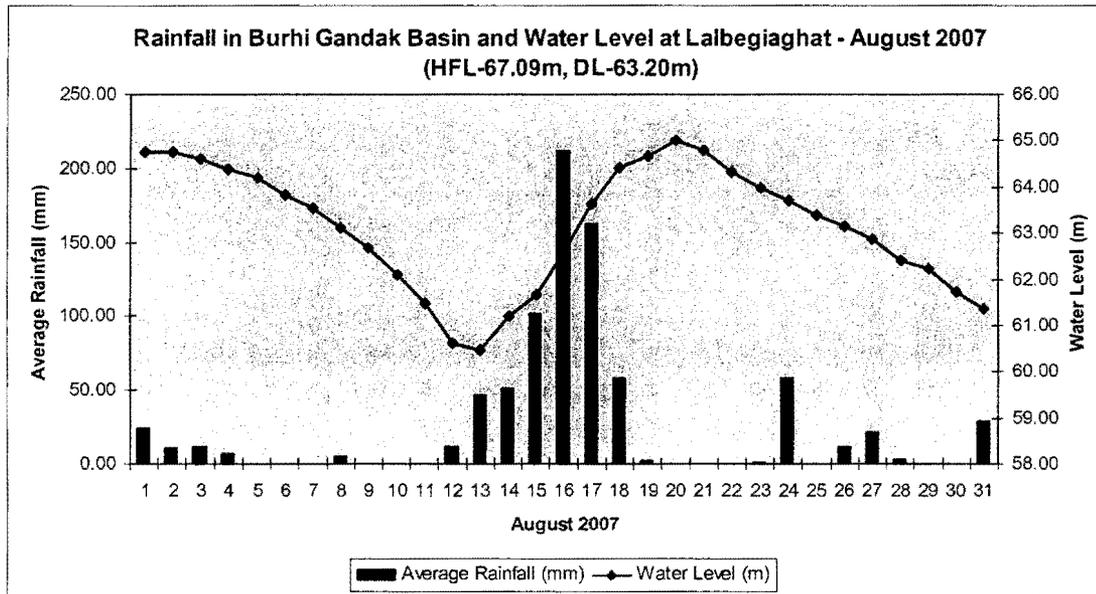


Then continuous rainfall took place from 11th July to 4th August during which river water level continuously rose from 57.34m to 64.75m. Maximum average rainfall of 118.20mm during this period was observed on 21st July. Water level started receding on 2nd August and continued till 13th August when it reached 60.46m.

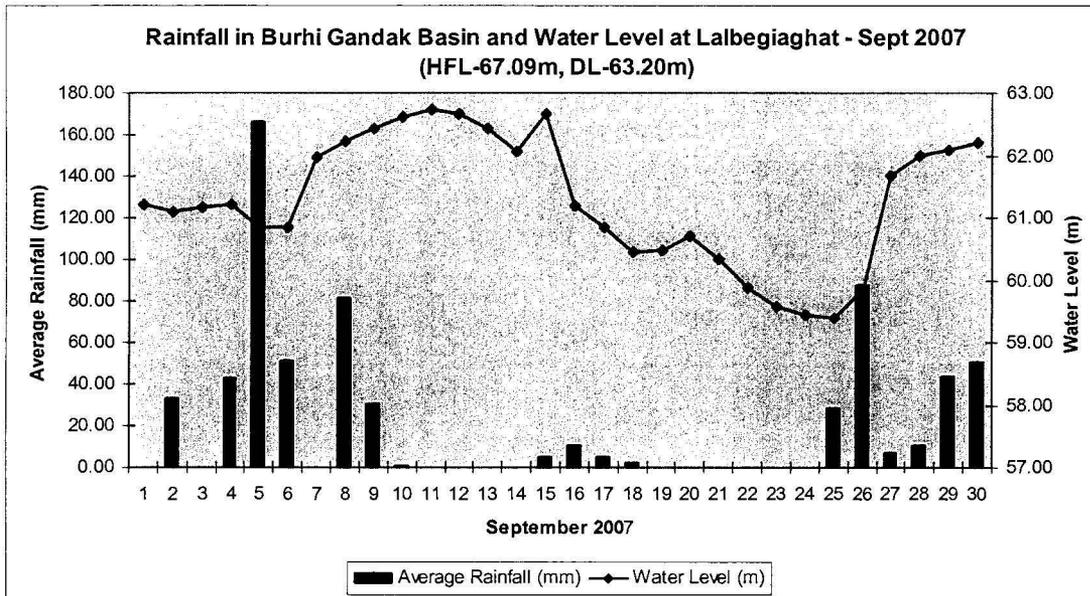


An isolated heavy storm took place between 12th to 19th August. Average value was 11.7mm on 12th August, it continuously increased and maximum of 211.40mm was observed on 16th, then started decreasing and a minimum of 2.10mm was observed on 19th. This resulted in step rise in the river water level from 60.46m on 13th to 65.01m on

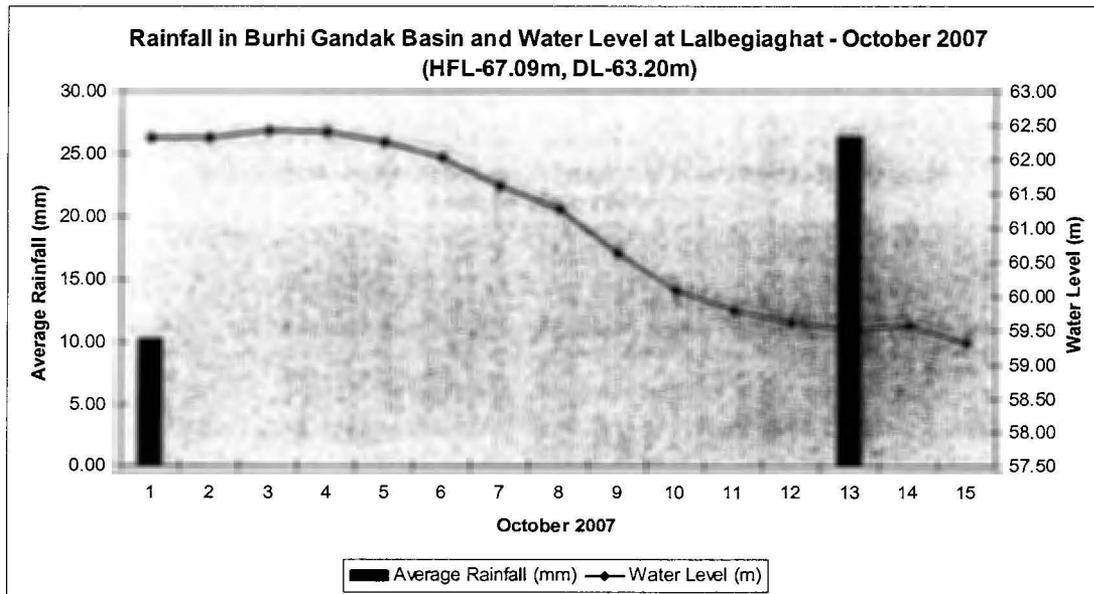
20th August. In September, three spells of rainfall of relatively low magnitude occurred when average daily rainfall was less than 100mm except on 5th September (when it was 166.10mm). This caused several rise and fall in river water level. Maximum was 62.73m on 11th and minimum 59.40m on 25th September.



Three steep rises were marked on 6-7, 14-15 and 26-27 September. A steep fall was also observed on 16-17 September. It is difficult to justify the steep rise of 14-15 as the rainfall on the preceding days is nil. There might be a high rainfall concentrated in small area which could not be noticed by the two rain gauge stations.



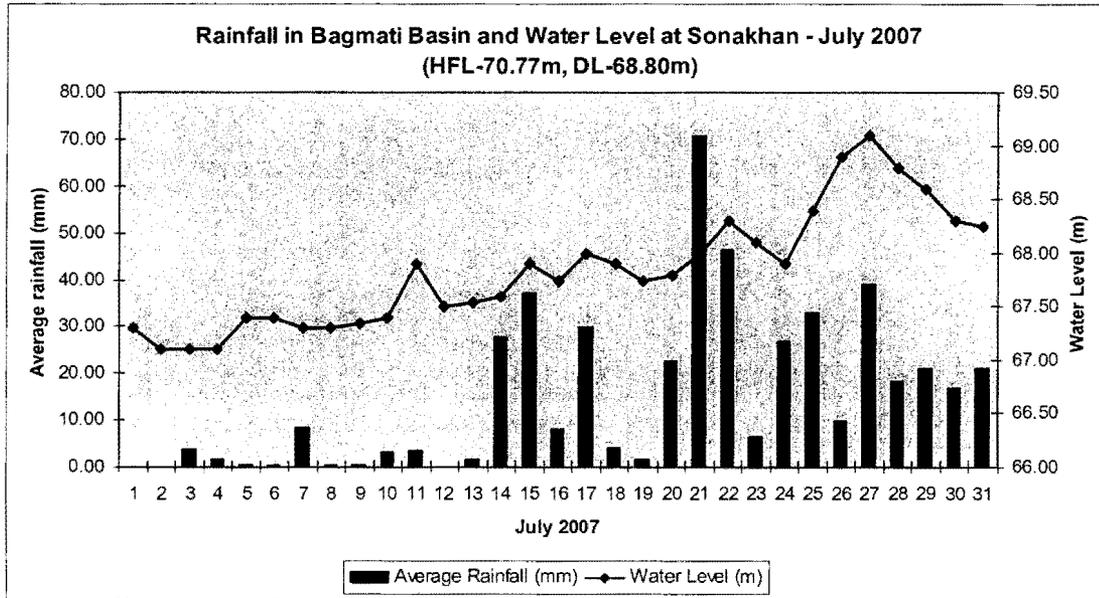
Last of three spells ended on 1st October. Thereafter only one rainy day on 13th was observed till 15th October. This did not have any noticeable effect on the river water level. Water level observed on 15th October was 59.31m.



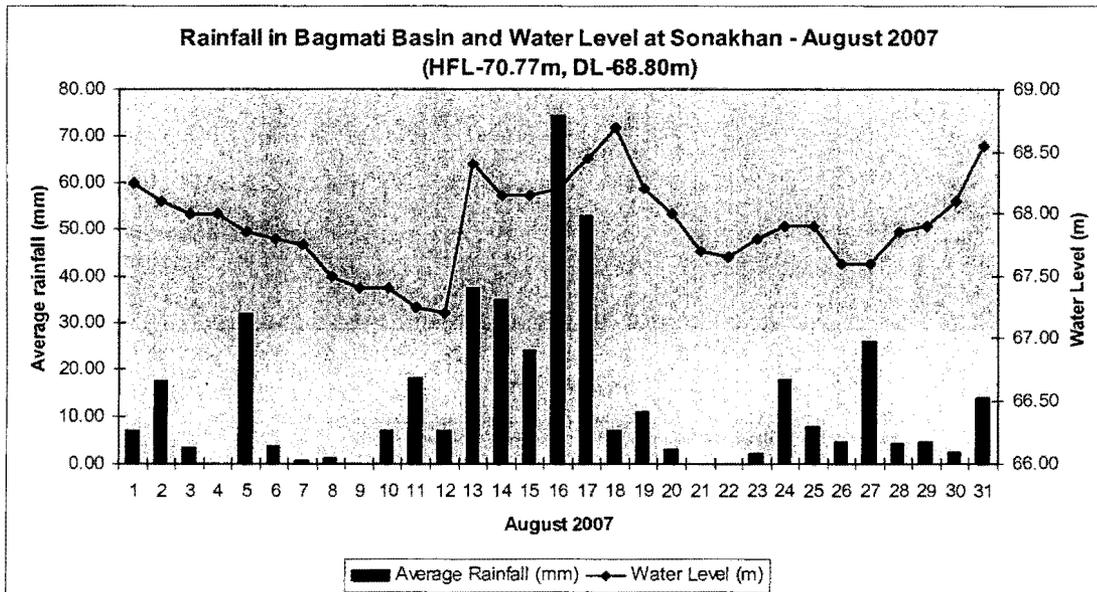
4.3.2 Bagmati

Like Burhi Gandak basin, Bagmati also received good amount of rainfall (average 65.5mm) on 15th June (first day of the monsoon season) which is reported to have caused sudden rise in the water level and consequent damage. There was continuous rainfall from 23rd to 28th June, maximum being 78mm on 25th. River water level at Sonakhan is

available from 23rd only which shows slow but continuous rise in the month of June from 67.20m to 67.40m.

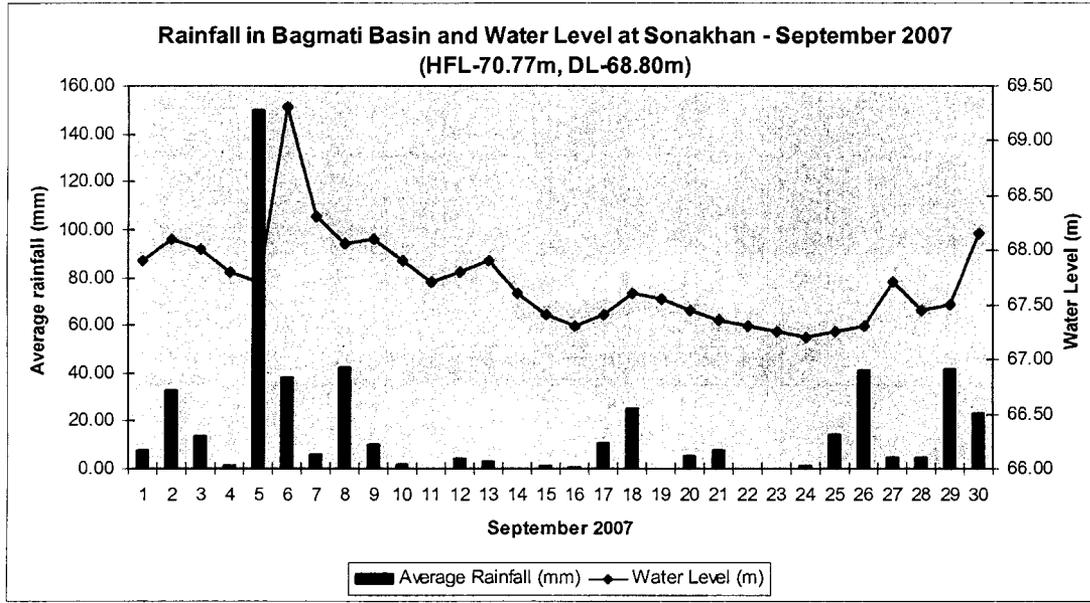


In July, there has been regular rainfall (28 rainy days) which kept the river water level continuously rising. Maximum average rainfall of 70.50mm was observed on 21st. Rise was steep from 27th to 29th when level went from 67.90m to 69.10m. It is interesting to note that most of the time effect of rainfall has been observed on the same day.

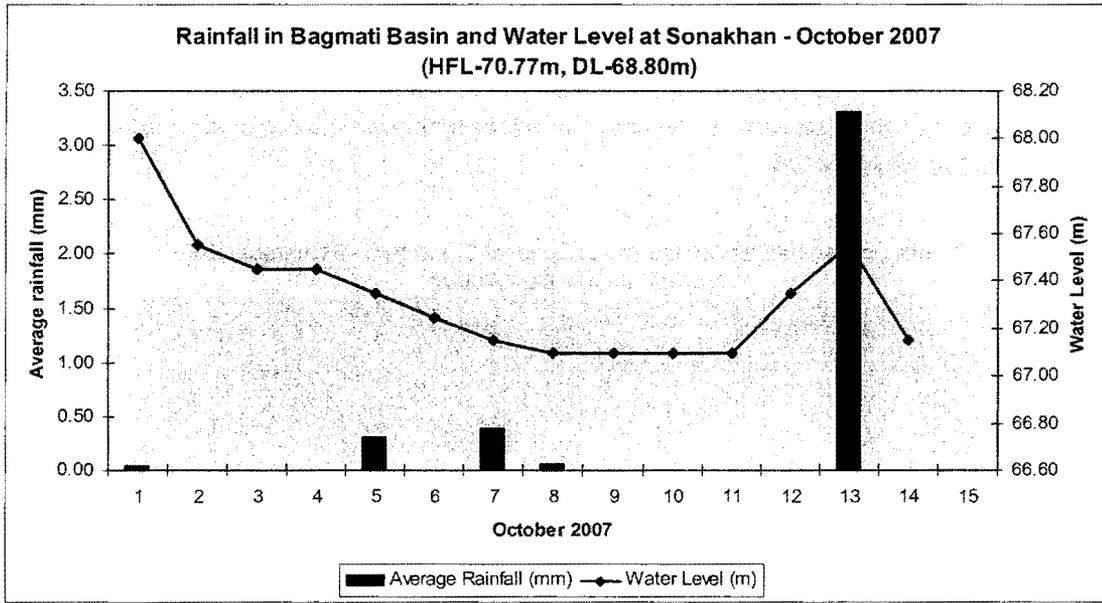


In August also, there has been regular rainfall with 27 rainy days. However, rainfall from 10th to 20th August has resulted in significant rise in water level. On 12-13 level rose from 67.20m to 68.40m and on 18th it reached to 68.70m. Again it is interesting to note the rise

from 67.60m on 27th to 68.55m on 31st when the rainfall observed was quite low. In September, maximum average rainfall of 149.73mm (season's maximum) was observed on 5th which caused steep rise in water level from 67.70m on 5th to 69.30m on 6th. During the rest of the month, rainfall was low and the water level decreasing except the last week when slight rise was marked.

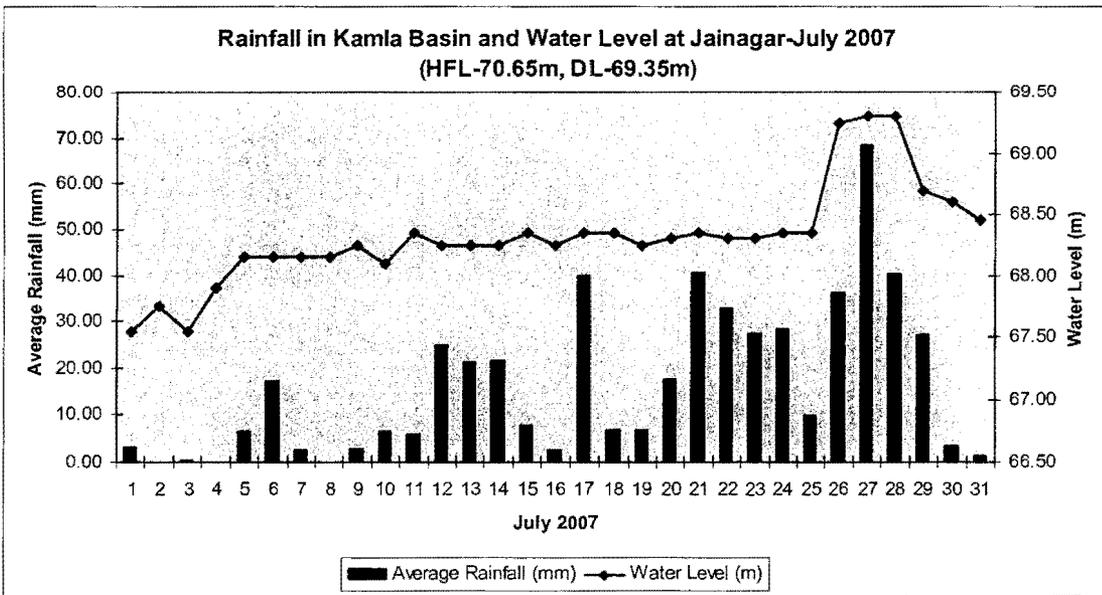


In October there was almost no rainfall up to 15th, however, rise in the water level of 0.45m was observed on 11-13th. It seems four rain gauge stations could not capture the rainfall occurred in some pockets.

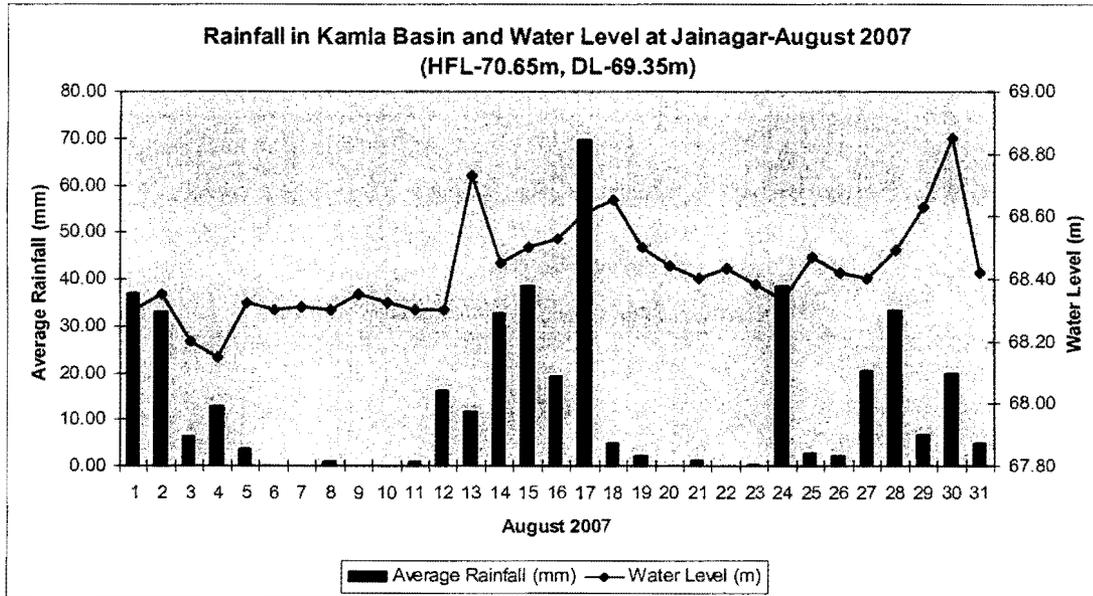


4.3.3 Kamla

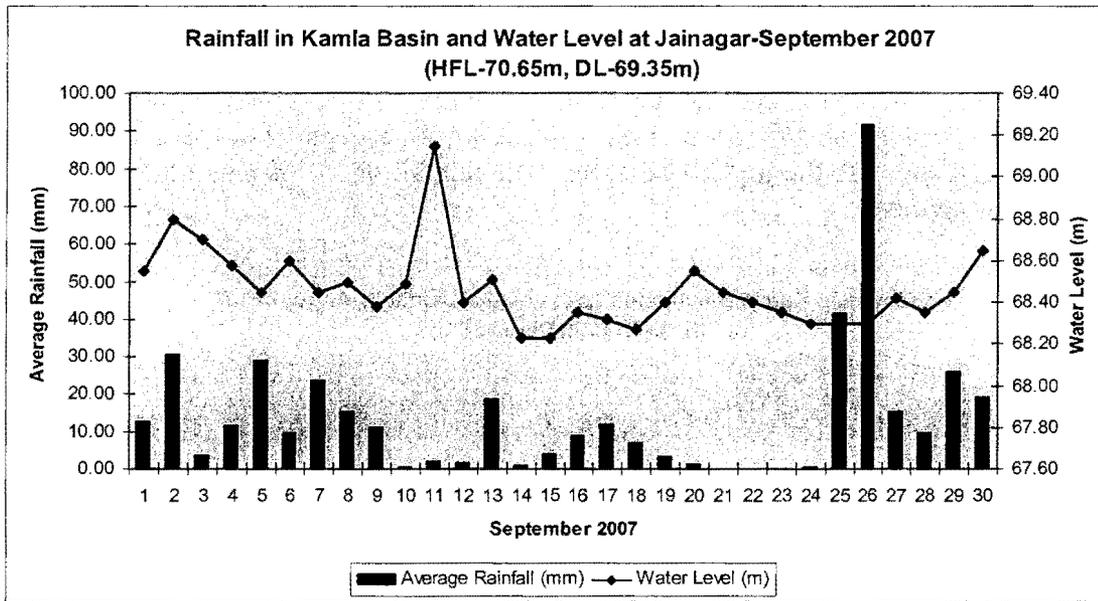
First rainfall of high magnitude was observed on 16th June which was swayed to Bihar portion. At Kamtaul 144mm and at Okhaldunga 29mm rainfall was observed. There was 27 rainy days in July. Maximum rainfall of the month (average daily rainfall of 68.25mm) was observed on 27th. A rise in water level of 0.60m was observed between 3rd to 5th and 0.90m between 25-26th. It is interesting to note that there was no significant rainfall preceding these events. Water level was almost static between 5th to 25th.



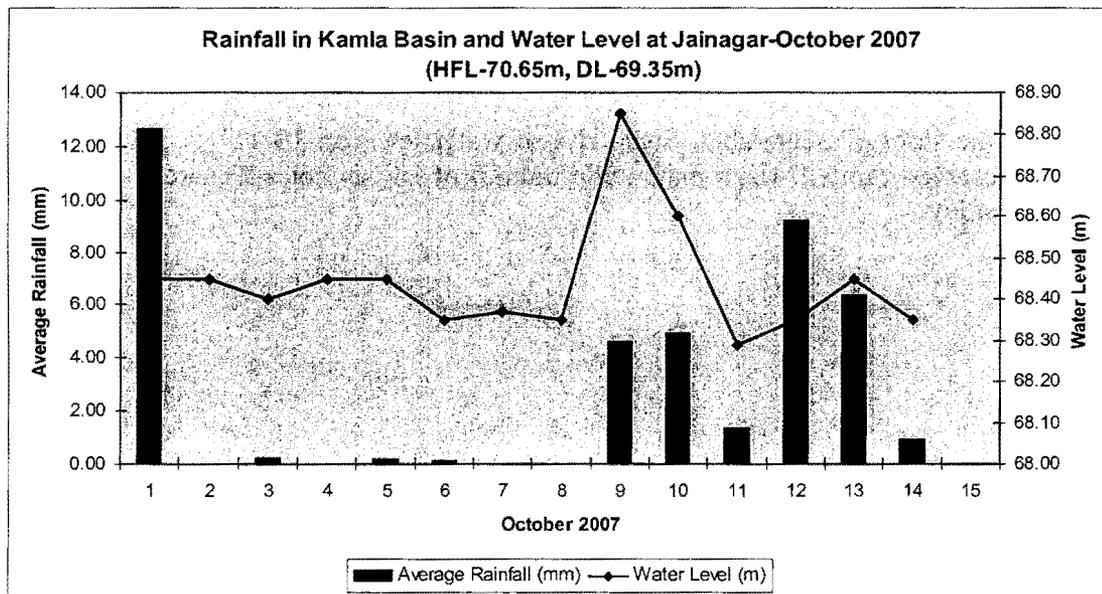
In August three isolated storms can be identified in the following plot. Maximum daily rainfall was observed on 17th. Steep rises of water level between 12-13th and 27-30th are not commensurate with the rainfall observed. The rainfall of 17th is also not reflected in the rise of water level.



Similar is the story of September. Steep rise of water level on 10-11th is not matching with the observed rainfall. High magnitude rainfall of 26th is not adequately felt in the rise of water level.

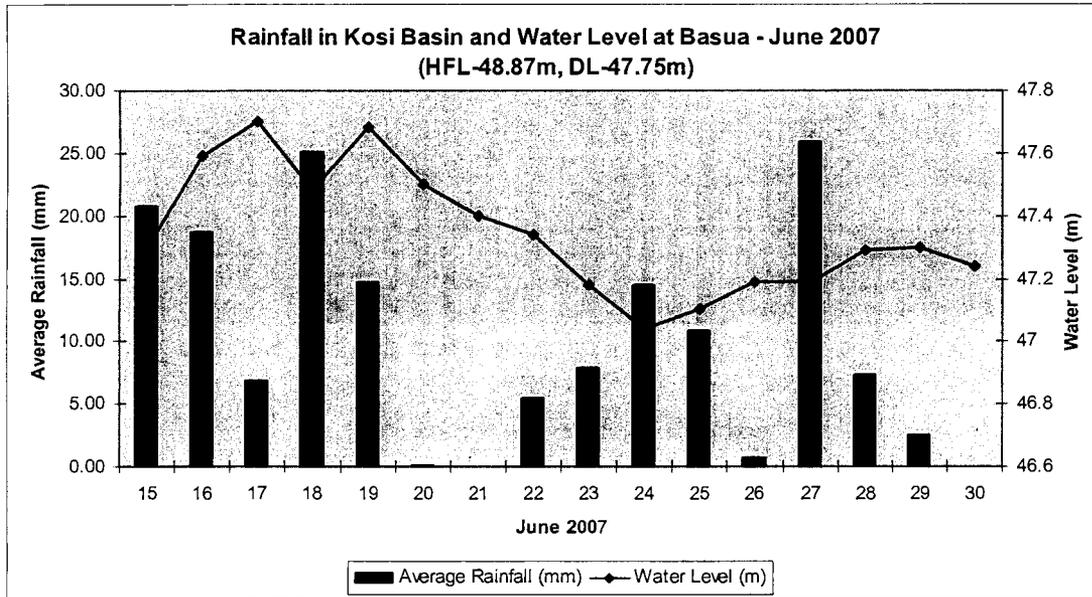


October received quite low rainfall. Steep rise in water level observed on 8-9th does not match with the rainfall occurred.

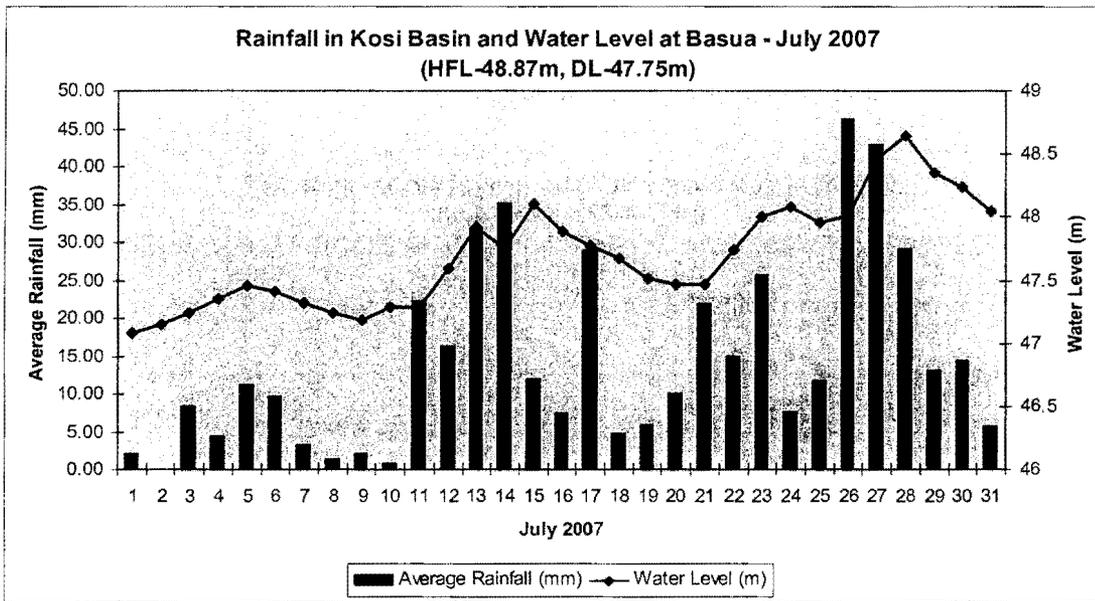


4.3.4 Kosi

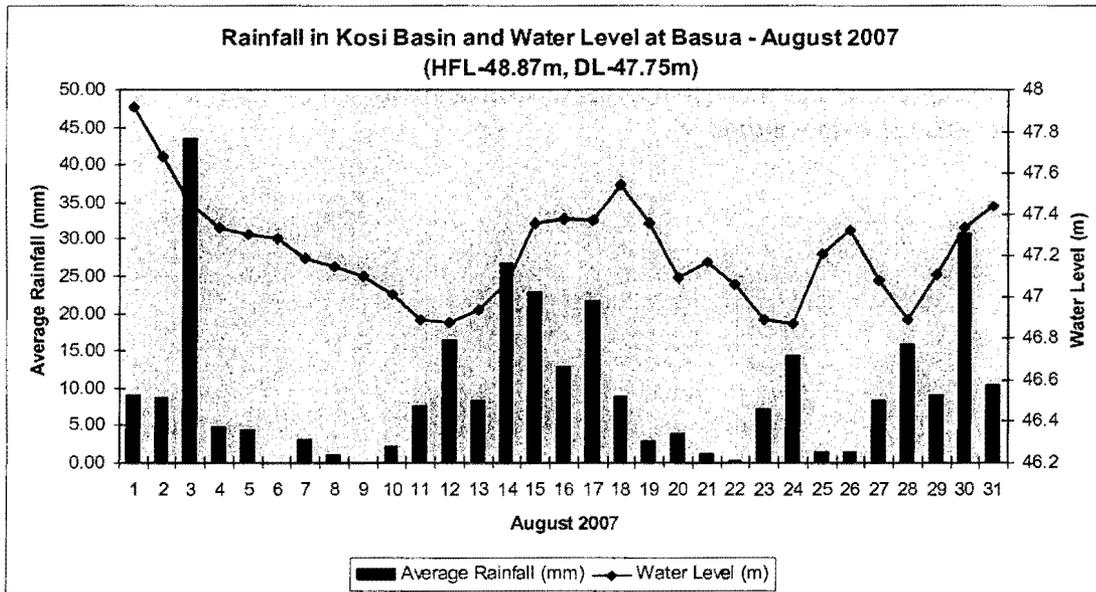
From June 15th almost every day some rainfall has been observed. Early rise in water level was marked which followed a recession after 19th.



July has been a completely wet month observing 30 rainy days. Maximum average rainfall was observed on 26th. Water level appears rising and falling following the pattern of rainfall except a few instances like drop in water level on 13-14th. Rainfall of 17th also does not get reflection in water level.

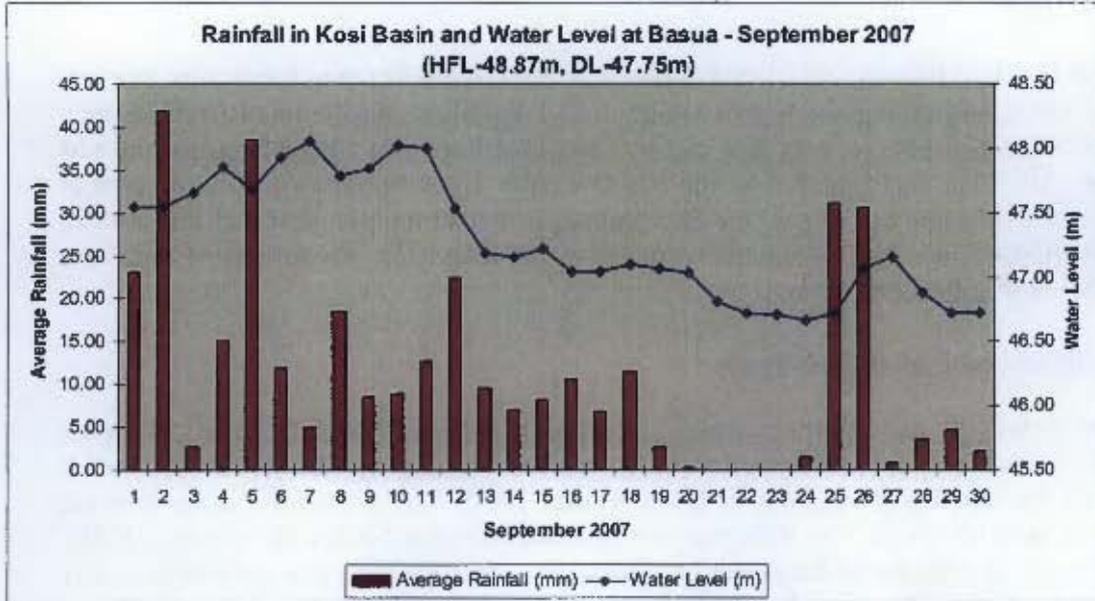


August rainfall pattern shows three different storms of low magnitude to have occurred. There was continuous drop in water level during the first 12 days, however, the rate of drop seems to have slowed down by the rainfall of 3rd August. Water level follows the rainfall but they don't appear in good correlation.

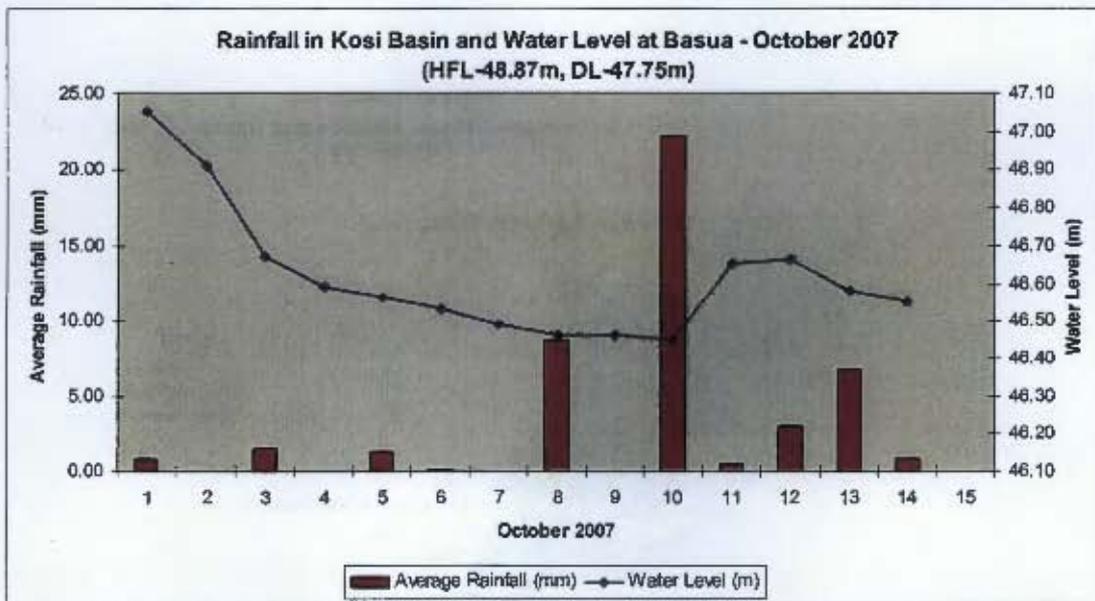


September observes continuous but low magnitude rainfall up to 20th. Thereafter, some considerable amount of rainfall occurred on 25th and 26th which caused rise in water level

making a peak on 27th. Steep drop in water level between 11-13th is not supported by the rainfall pattern.



Rainfall in October has been negligible. Only rainfall of about 22.00mm on 10th caused some rise in water level, otherwise it has been continuously decreasing with minimum on 10th.



Annexure 4. Mapping First Flood Event in 2007 Monsoon Season

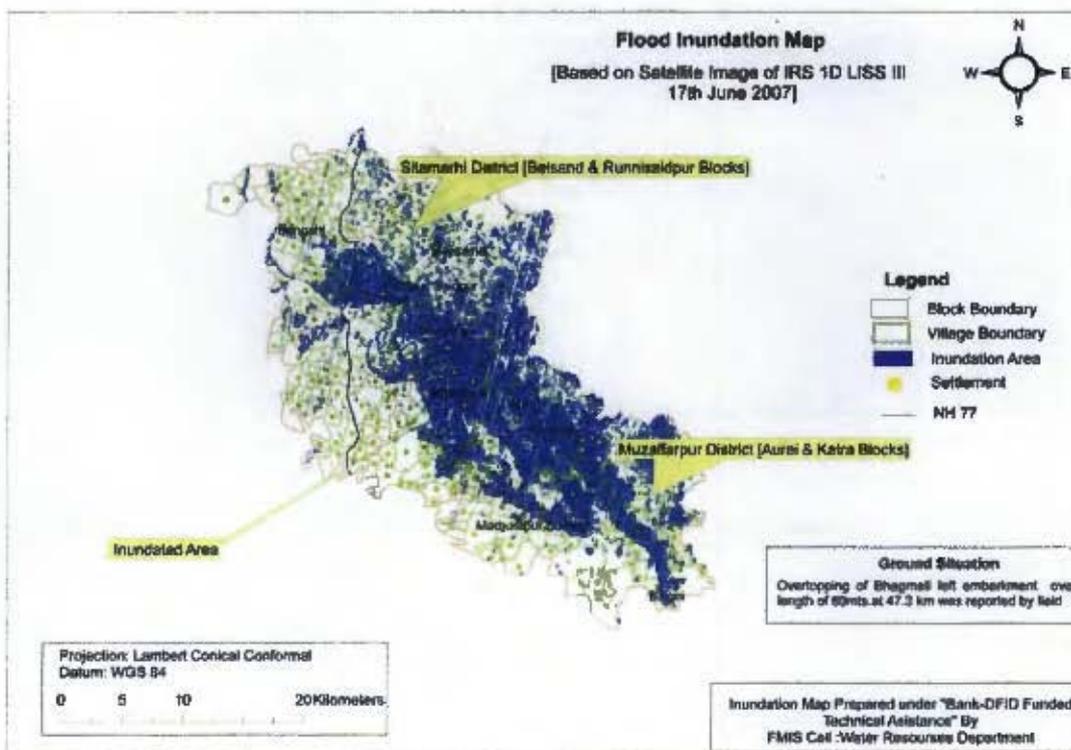
Flood Event

The first flood episode in 2007 flood season occurred in the Bagmati basin, due to overtopping along a length of 60 m at about 47.3 km along the Bagmati Left embankment near Pachnuar village, was reported by the Chief Engineer, Muzzaffarpur at midnight of 15 June. This was reported in the WRD's daily flood bulletin of 16 June received at FMIS Cell in the evening of the day. Subsequent field reports indicated that four blocks in Muzzaffarpur and Sitamarhi districts were inundated. Hydrologic Conditions are described in the table below.

Acquisition of satellite coverage

The first cloud-free satellite coverage of inundation from IRS I D satellite LISS III sensor was on the morning of 17 June. National Remote Sensing Agency (NRSA) in Hyderabad generated the satellite image within 6 hours after FMIS Cell placed the order through email and telephone call. The data was downloaded from the NRSA ftp server at FMIS Cell through its high speed broadband connectivity. Subsequently the FMIS Cell procured IRS satellite WiFS data of 18 June, which was supplemented by Radarsat data of 20 and 27 June, and 6 and 18 July 2007 procured by NRSA. The time sequence of satellite imagery provided for the first time an unprecedented look at the recession of flood inundation from the breach.

Inundation Mapping



Rainfall predicted and observed in Bagmati Basin

Rainfall forecast (mm)

Sl. No.	Grid	11-Jun-07			12-Jun-07			13-Jun-07			14-Jun-07			15-Jun-07			16-Jun-07		
		12-Jun	13-Jun	14-Jun	13-Jun	14-Jun	15-Jun	14-Jun	15-Jun	16-Jun	15-Jun	16-Jun	17-Jun	16-Jun	17-Jun	18-Jun	17-Jun	18-Jun	19-Jun
1	Bihar	1.83	23.15	3.9	3.21	1.63	2.78	4.33	10.08	6.93	2.94	8.79	15.24	12.49	5.57	15.02	10.3	5.69	7.03
2	Bihar	0	12.32	4.5	1.94	2.59	3.34	1.58	0.92	24.98	2.64	10.67	18.81	41.24	8.05	8	13.3	5.66	6.42
3	Bihar	0	5.73	8.11	1.81	2.93	3.94	1.85	2.08	8.4	3.04	6.52	20.34	36.94	9.52	5.95	11.9	3.47	5.96
4	Bihar	0.19	5.26	5.51	2.6	5.74	3.77	2.03	0	15.15	1.62	10.27	14.29	61.93	8.73	9.86	13.2	4.25	6.76
5	Bihar	0	2.26	5.23	0.82	2.67	3.47	0.16	0	6.28	1.22	3.83	14.29	59.53	10.45	7.23	10.5	3.34	7.07
6	Bihar	0	0.46	6.25	0.03	0.88	1.86	0	0	4.54	0.03	0.93	8.93	36.93	14.42	2	11.2	3.23	5.9
7	Nepal	0.74	0.94	5.12	1.6	0.35	1.55	0.66	0	2.51	1.66	1.1	10.32	39.83	9.09	2.65	6.53	1.73	6.02
8	Nepal	0	0.3	5.69	1.27	1.26	1.79	0.03	0	2.51	1.03	0.89	7.63	26.24	13.94	4.44	4	1.98	1
9	Nepal	1.6	1.25	3.8	1.88	0.05	1.44	0.18	1.39	5.33	1.44	8.03	15.16	14.29	3.04	5.51	7.85	1.71	3.15
10	Nepal	4.46	0.1	1.75	1.87	0.37	1.66	0.34	1.43	1.91	1.64	3.28	10.04	15.21	7.95	7.26	1.48	0.84	0.88
11	Nepal	3.49	2.12	3.34	3.66	1.31	9.16	3.36	7.89	7.38	2.23	6.14	15.85	3.64	7.46	8.54	2.7	1.36	1.07

Rainfall observed (mm)

Sl. No.	Region	12-Jun	13-Jun	14-Jun	15-Jun	16-Jun	17-Jun	18-Jun
1	Simra	na	3.2	1.4	142.2	1.2	54.8	1
2	Kathmandu	na	2.1	6.1	29.6	0.5	3.7	0.3
3	Nagarkote	na	12.6	9	65.5	2.2	6.6	0

Water level (m) observed in Bagmati River

Sl. No.	Region	Site	Danger level	13-Jun-07	14-Jun-07	15-Jun-07	16-Jun-07	17-Jun-07	18-Jun-07
1	Bihar	Dubbadhar	61.28	na	na	na	62.52	61.58	60.65
2	Bihar	Kansar	59.06	na	na	na	na	58.1	58.1
3	Bihar	Benibad	48.68	na	na	47.72	47.96	48.26	48.56
4	Bihar	Hayaghat	45.72	na	na	40.39	40.66	41.27	42.08

Notes : Dubbadhar and Kansar are u/s of over-topping site, Water level prior to 15 June not reported by CWC, Data of Dubbadhar and Kansar are from WRD, data of Benibad and Hayaghat are from CWC

The satellite image was processed at the FMIS Cell using ERDAS image processing software, and the necessary overlays of administrative boundary, settlements, and road network were overlaid at the GIS system in the Cell. Hard copy and soft copy maps were generated and provided to Water Resources Department (WRD), Disaster Management Department (DMD) and Agriculture Department. On request from Commissioner, DMD, the list of villages affected by flood inundation in the two blocks of Sitamarhi district and two blocks of Muzaffarpur district was generated, and used in the presentation to Chief Minister on 23 June 07. Flood inundation statistics are shown in Annexure 5.

Lessons Learnt and Actions Taken based on the First Flood Experience

Effective use of rainfall forecasts

- A review of the daily forecasts from India Meteorological Department (IMD) showed that the forecast issued by the afternoon of 15 June indicated heavier and widespread rainfall forecast for the 24 hours up to morning of 16 June, indicating possibility of floods in the upstream parts of Bagmati basin. The IMD forecast provided early warning of flood potential, more than 20 hours ahead of receipt of observed rainfall data.
- FMISC should consider issuing alerts of heavy rainfall forecasts to WRD and its field offices, as well as to DMD and the District Magistrates in the hazard area, as flood guidance for better preparedness.
- The forecasts may need further improvement in grid size and accuracy since the forecasts issued on 13 June and 14 June did not predict heavy rainfall on 15 June, with only the forecast issued on 15 June indicating such possibility. Further, the forecasts from IMD seriously under-estimated the actual rainfall. Hence IMD forecasts at 45 km grid size, till upgraded to 10 km resolution and better accuracy, should be used for flood guidance rather than for quantitative prediction.
- The above evaluation is based on one flood event, and would be reviewed through the flood season.

Evaluation of reported daily rainfall

- The daily flood bulletin of WRD issued on 16 June indicated heavy and widespread rainfall (142.2 mm in Simra site, 29.6 mm in Kathmandu site, and 65.5 mm in Nagarkot site) upto 18 00 hrs on 15 June, in the Nepal portion of Bagmati basin. Heavy rainfall was not reported either in the previous days or after.
- Flood potential indicated by the heavy rainfall in 15 June was not available till afternoon of 16 June (in daily bulletin) from WRD, by which time the embankment was overtopped causing floods. Even if the rainfall data was available to FMISC earlier as soon after receipt at WRD, due to the very short travel time, effective action would not have been possible. Thus rainfall forecast would give earlier warning of flood potential, and hence more time for FMIS Cell to act.
- The website of Meteorological Forecasting Division of Department of Meteorology and Hydrology of Government of Nepal updates the daily rainfall measured at 0845 hrs at about 1800 hrs same day. This means that the heavy

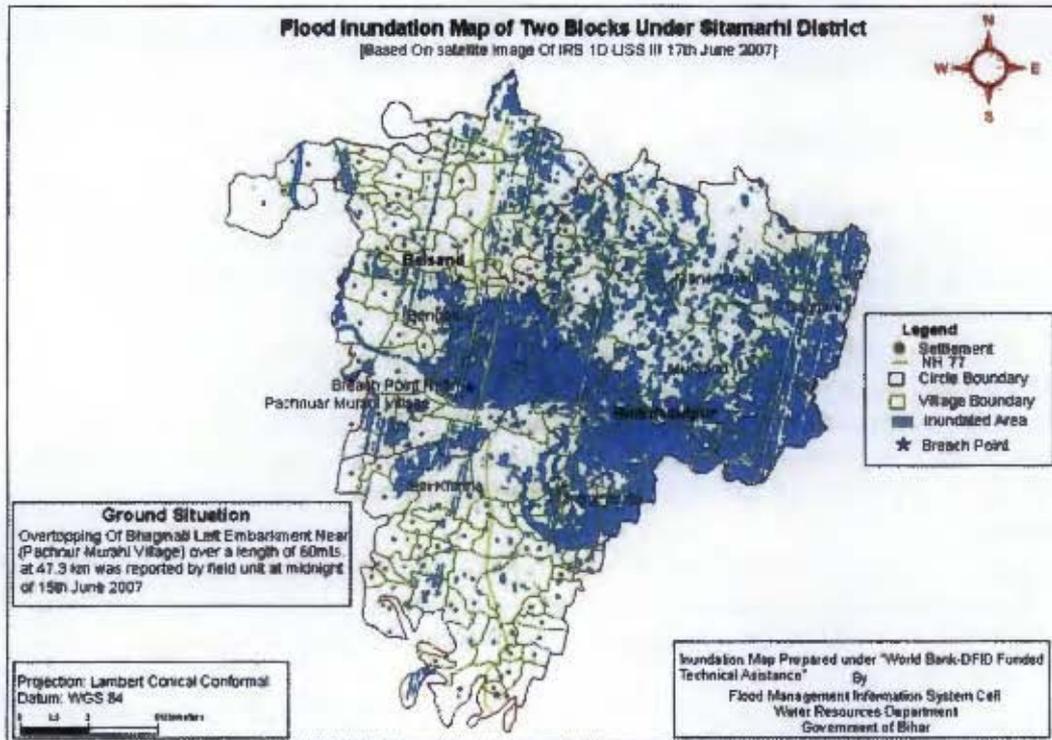
rainfall that occurred later on 15 June 07 would have been updated only by the evening of 16 June, too late for effective use. WRD received this data earlier.

Improving FMIS Cell operations

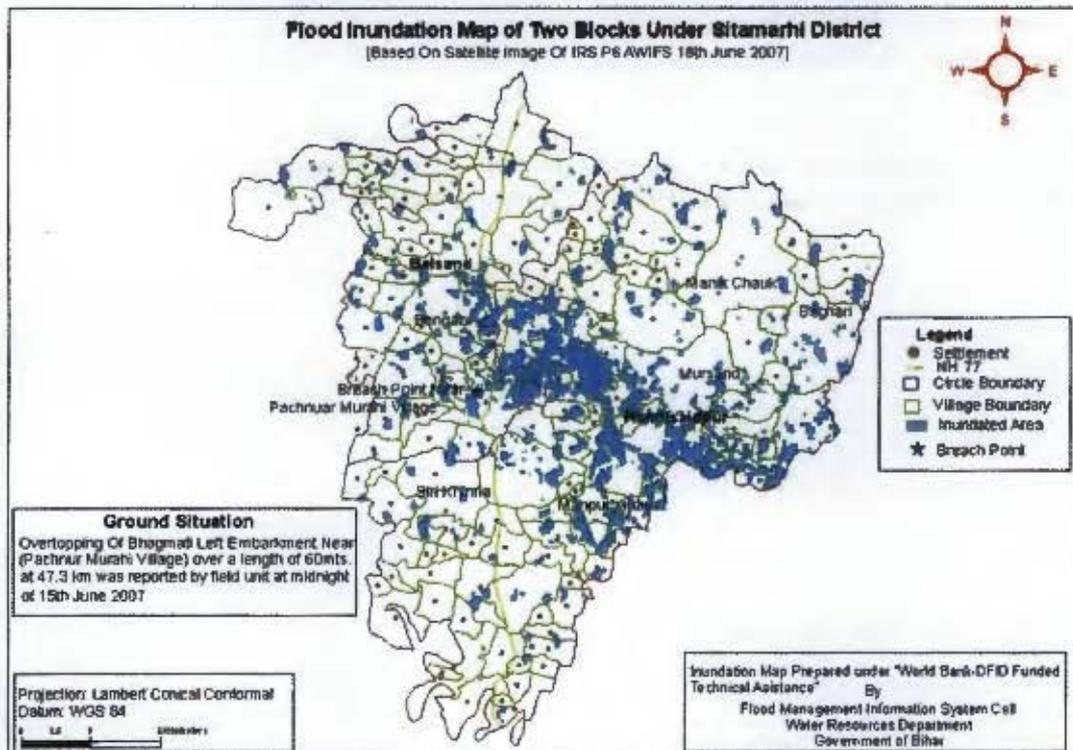
- The delay in receipt of daily flood bulletin from the Flood Cell in WRD to FMIS Cell would be significantly reduced (by 16 hours in this case) by arranging for faxing the information received from the field units immediately to the FMIS Cell soon after receipt at the WRD. This has been instituted.
- Ordering of satellite data in emergent situations would be expedited by developing an appropriate mechanism at the Cell. This has been done.
- The Internet connectivity needs improvement as downloading satellite imagery from NRSA ftp server took a long time. Alternate modes of downloading data through the VSAT connectivity between NRSA and DMD would be employed as needed.
- Round-the-clock operations would improve the time for processing satellite data and generating the inundation maps. The prototype FMIS implemented by NRSA at FMIS Cell would also support quick preparation of customized maps and text reports.

Evaluating Inundation Duration

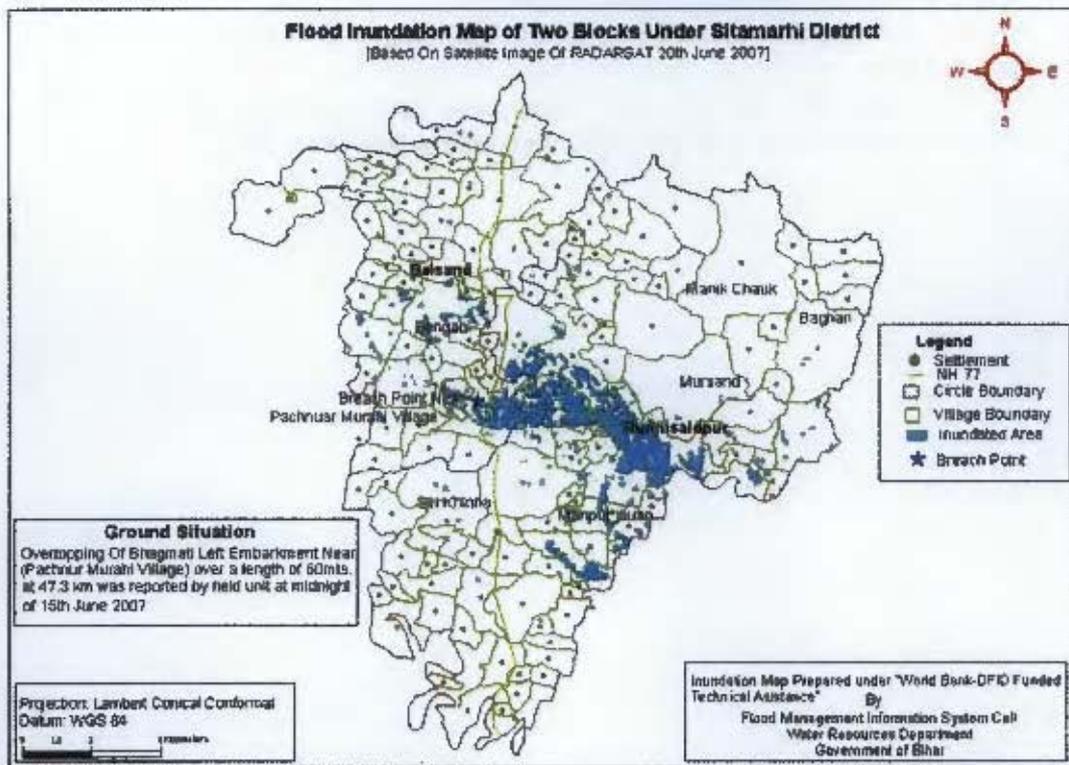
To evaluate inundation duration, IRS P6 satellite AWiFS sensor of 18 June was ordered, and downloaded from NRSA ftp server, and processed. NRSA has also prepared an inundation map using RADARSAT data of 20 June. The comparison of inundation maps between the five satellite overpass dates (17, 20 and 27 June; 6 and 18 July) shows areas where the waters are still standing 2 days, 5 days, 12 days, 21 days, and 33 days after flood inundation. Similar time series maps for floods of different magnitudes would help prepare inundation duration maps, useful in flood management.



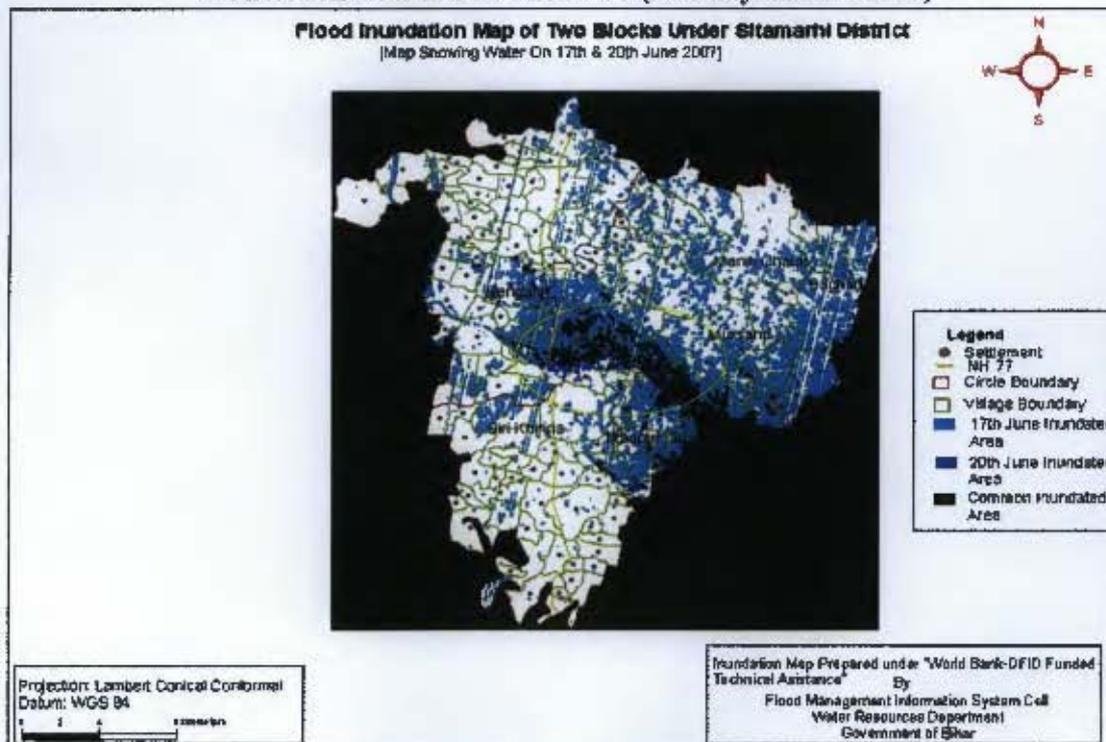
Inundation Extent on 17 June (two days after flood)



Inundation Extent on 18 June (three days after the Flood)



Inundation Extent on 20 June 07 (five days after Flood)



Map showing areas with standing water (dark blue area) even 5 days after flood

Analysis of duration of inundation however will need to take note of satellite data being of different resolution, cloud-cover constraints in optical satellite data, availability of

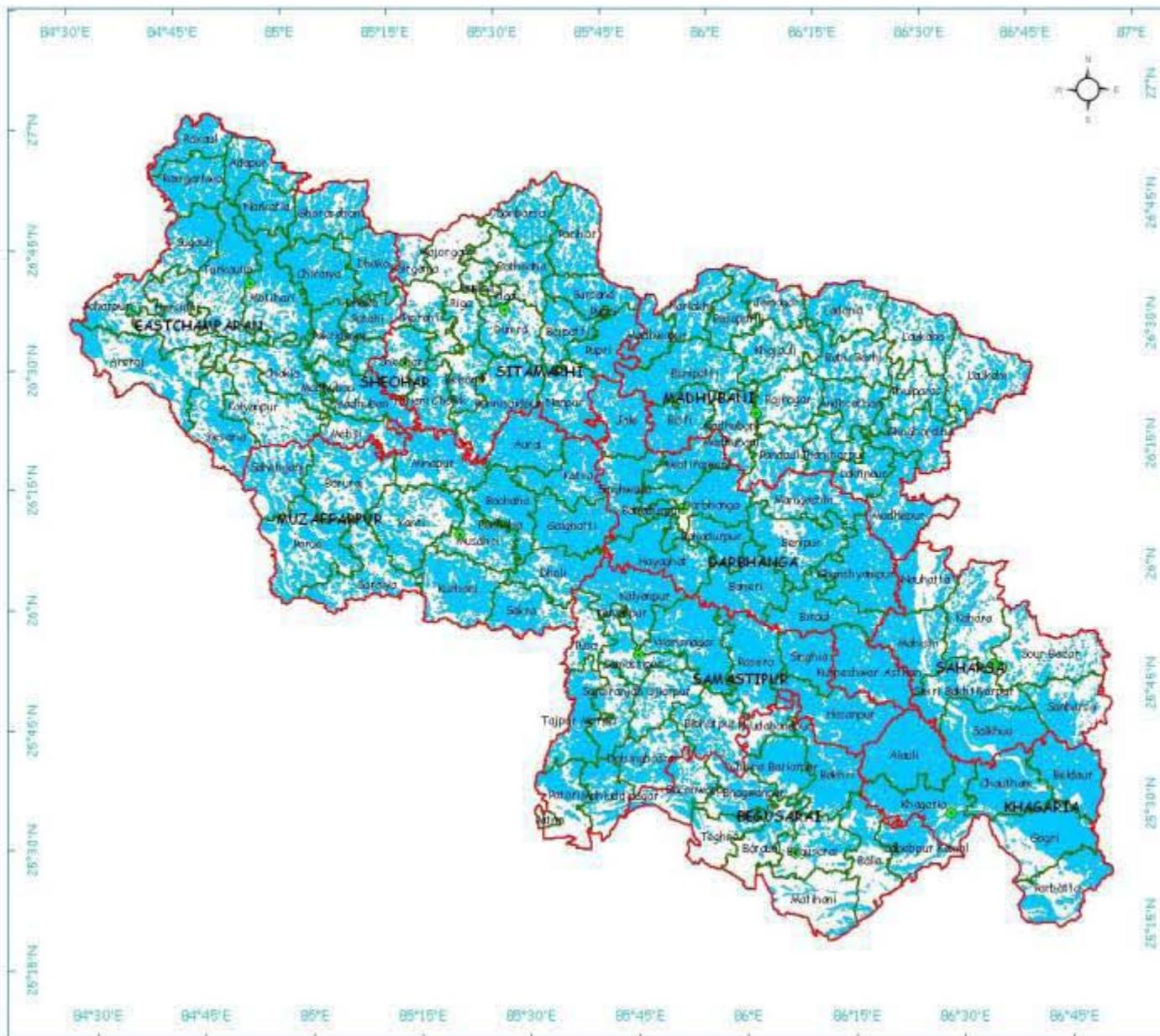
satellite overpass at required frequency, and compounding variables like antecedent and persisting rainfall, antecedent river water level/ discharge, downstream drainage conditions, embankment breach, etc. Frequent flood coverage is currently provided by the Indian satellites like IRS IC, ID, and Resourcesat, and Canadian RADARSAT satellite, and will be augmented when the Indian microwave satellite RISAT is launched next year.

Maximum Inundation Extent in 2007 Flood Season

[Covering Focus Area In North Bihar]

fmis

Bihar



Legend

-  District Boundary
-  Block Boundary
-  Inundation
-  District Headquarter



Projection: Lambert Conformal Conic
 Datum: WGS 84
 Pixel size: 50m*50m

Inundation Layer provided by DSC, NR SA

Max. Inundation Derived From Floods Till 10th October 2007

Prepared Under
 World Bank-DFID Technical Assistance
 By
 Flood Management Information System Cell
 Water Resources Department
 Government of Bihar

fmis e-bulletin

Flood Management Information System
Water Resources Department
Bihar



Vol.1 No.1, 2007
Inaugural Issue

Mr.A.K. Sinha, IAS
Commissioner and
Secretary
Water Resources Dept.

Mr.Asangba Chuba
Ao, IAS
Project Director

Editorial Board
Editor-

Mr. A.K.Samaiyar
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Mr. T.K. Bhadury

Contents

- A Bird's Eye View
- Organisational Structure
- News and activities

*"Towards a culture
of preparedness for
better flood
management"*

From the Project Director's Desk

Every year when the country prepares itself for the monsoons as a relief from the scorching heat, the people living in the flood prone areas of Bihar get ready for another nightmare. Floods have ravaged this fertile stretch since time immemorial but in recent years the situation has aggravated to alarming standards. Today, Bihar is India's most flood prone state with 76% of the population in north Bihar affected. This accounts for crores of people who live under the constant threat of floods. The loss in economic terms is also staggering as from 1999 to 2005 alone, flood damages have been roughly estimated to be about Rs. 2655 crores! All this has led to a move from disaster response to enhanced disaster preparedness by improving the (i) lead time of the forecasts; (ii) forecast information quality, usefulness, dissemination time and flow.

In order to improve the technical and institutional capacity of the state of Bihar for flood management, the Government of Bihar and the World Bank agreed upon on a partnership to make extensive use of modern information technologies to develop a Flood Management Information System (FMIS) in priority areas. The use of satellite technology and computers in this field is a first of its kind not only in Bihar but arguably in India, which makes the task extremely challenging. Key agencies such as NRSA, IMD, CWC and Survey of India are our partners in this attempt to chart untested waters and we have been getting good support from them. Coordinating with similar projects around the world and the possibility of exchange of ideas are being explored.

This e-bulletin, another first in Bihar, aims to keep all our key agencies and stakeholders informed about the progress of the project and in time will also be a medium for the transfer of real time data during the flood season. It can also develop into a base for the exchange of knowledge and link up into the world wide information network.

The possibilities are seemingly endless...for FMIS.....for Bihar!

Editorial

This is the finest hour for FMIS as our maiden e-bulletin is hitting the info network.

FMIS is an ambitious project implemented by the Govt. of Bihar through the Water Resources Department with World Bank assistance. Under this, a flood management information system is to be built to meet the operational requirements of different users involved in flood management, long term flood control measures, relief and rescue. The prime objective is to increase the lead time of flood warning upto 3 days based on rainfall forecast of the Indian Meteorological Department. The focus area for the current stage of the project measures about 22,000 sq. km in north Bihar and extends from the east of the Burhi Gandak river to the west of the Kosi.

Presently, the procurement of goods and services is in progress after obtaining administrative approval. This process is likely to be completed by the end of this month. The procurement is being done with the active cooperation of WALMI which has been identified as the procurement agency.

This inaugural issue gives an overall view of the project and in future editions we hope to give you details of the products we generate shortly. Interestingly this is a zero cost, in house developed e bulletin and a feedback from your end will help the team to strive harder and achieve higher.

With best regards

A Bird's Eye View of FMIS

Need for FMIS

Accounting for 17% of the flood prone area of the country, Bihar is the most flood prone area with crores of people living under recurring threat of flood devastation leading to loss of life and property every year. Flood management is based on structural measures and there is a need to move to a non structural strategy such as forecasting and early warning. Currently, lead time is around 8 to 24 hours which is insufficient for preparation at the grassroots level. An increase in the lead time, properly communicated can dramatically lessen damages.

Vision

- Adoption of new technological approaches to improve the decision processes before, during and after the flood event with the use of remote sensing, GIS and modeling techniques.
- To demonstrate the potential of space applications in a high priority management area for immediate benefits, and to trigger sustained development.
- To develop and implement a comprehensive Flood Management Information System (FMIS) to effectively support flood control and management in the flood prone areas of Bihar.

Objectives

- Improve early warning, both in lead time and spatial information on possible flood impact, for effective preparedness
- Provide time-effective and appropriate spatial information on flood inundation (from onset through recession) for targeted emergency response action
- Build flood database (event and impact) for planning and implementing mitigation measures

Stakeholders

- Indian Meteorological Department
- Water Resources Department
- Ganga Flood Control Commission
- Agriculture Department
- Disaster Management Department
- District Magistrate & concerned Officers of Flood affected districts
- Flood Affected Population

News and Activities

- Cabinet Sanction to FMIS on 22nd Jan, 2007
- Procurement plan approved by WRD on 14.4.07
- MoU signed with NRSA, Hyderabad on the 4th of May, 2007 for supply of satellite imagery, development and implementation of FMIS.
- Training of 3 FMISC officers at NRSA, Hyderabad 9th April to 4th May 07 GIS application..

Information Products

- Hydrologic status maps
- Inundation maps
- Seasonal flood summary
- Post flood river configuration
- Pre season flood protection works alert
- Simulated flood inundation impact
- Flood hazard zoning

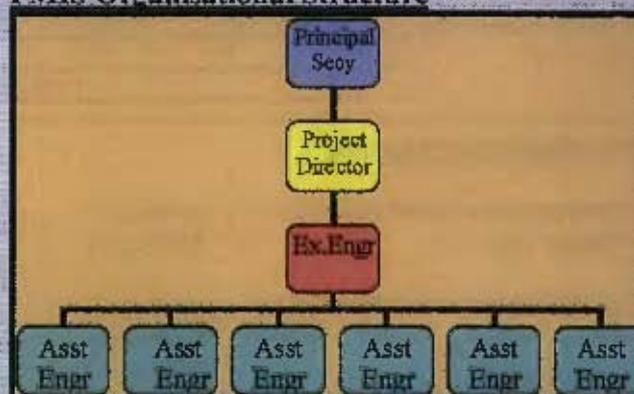
This data will be disseminated in the form of maps as well as text for easier comprehension.

Benefits of FMIS

- a. **Short Term** - Flood Hazard Forecasting and Emergency management
- b. **Medium Term**- Improved flood forecasting, Spatial Warning & Flood Hazard mitigation
- c. **Long Term** - Holistic Flood Management Planning



FMIS Organisational Structure



Contact Information-

FMIS Cell
Water Resources Department
Taramandal, Patna
Bihar-800001
Tel- 0612-2205999 Fax- 0612-2205999
Email- fmisc_bihar@yahoo.co.in

➤ Designed and produced at FMISC. Patna.

Annexure 8. DAILY FLOOD INFORMATION BULLETIN

Flood Indicators (observed as well as forecast) for the focus area of FMIS Bihar

Date : 25-Aug-07
Time : 6:00 PM

1. Basin/River : Burhi Gandak

(R-Rising, S-Steady, F-Falling, DL-Danger Level)

>>Rainfall observed in Nepal region on	24-Aug-07	:	<table border="1"><tr><td>47.30</td></tr></table>	47.30	mm at	Simra	
47.30							
	25-Aug-07	:	<table border="1"><tr><td>0.00</td></tr></table>	0.00	mm at	Simra	
0.00							
>>Maximum rainfall forecast for	26-Aug-07	:	<table border="1"><tr><td>15.62</td></tr></table>	15.62	mm in	<table border="1"><tr><td>Bihar</td></tr></table> region	Bihar
15.62							
Bihar							
	27-Aug-07	:	<table border="1"><tr><td>11.61</td></tr></table>	11.61	mm in	<table border="1"><tr><td>Bihar</td></tr></table> region	Bihar
11.61							
Bihar							
	28-Aug-07	:	<table border="1"><tr><td>14.92</td></tr></table>	14.92	mm in	<table border="1"><tr><td>Bihar</td></tr></table> region	Bihar
14.92							
Bihar							

>>Today's water level at 6.00AM

Gauge Site	Laibagiaghat	Sikandarpur	Samastipur	Rosera	Khagaria
♦Danger Level (m)	63.2	52.53	46.02	42.63	36.58
♦Water Level (m)	63.42	53.78	48.99	45.38	37.12
♦Trend	F	F	F	F	F
♦Status	Above DL	Above DL	Above DL	Above DL	Above DL

2. Basin/River : Bagmati (Including Adhwara Group of Rivers)

>>Maximum rainfall observed in Nepal region on	24-Aug-07	:	<table border="1"><tr><td>6.00</td></tr></table>	6.00	mm at	Kathmandu	
6.00							
	25-Aug-07	:	<table border="1"><tr><td>26.02</td></tr></table>	26.02	mm at	Kathmandu	
26.02							
>>Maximum rainfall forecast for	26-Aug-07	:	<table border="1"><tr><td>9.90</td></tr></table>	9.90	mm in	<table border="1"><tr><td>Bihar</td></tr></table> region	Bihar
9.90							
Bihar							
	27-Aug-07	:	<table border="1"><tr><td>16.04</td></tr></table>	16.04	mm in	<table border="1"><tr><td>Bihar</td></tr></table> region	Bihar
16.04							
Bihar							
	28-Aug-07	:	<table border="1"><tr><td>15.94</td></tr></table>	15.94	mm in	<table border="1"><tr><td>Bihar</td></tr></table> region	Bihar
15.94							
Bihar							

>>Today's water level at 6.00AM

Gauge Site	Sonakhan	Dubbadhar	Kansar	Benibad	Hayaghat	Kamtaul	Ekmlighat
♦Danger Level (m)	68.80	61.28	59.06	48.68	45.72	50.00	46.94
♦Water Level (m)	67.90	60.98	59.20	49.30	47.30	50.35	48.06
♦Trend	F	F	F	S	S	S	F
♦Status			Above DL				

3. Basin/River : Kamala

>>Maximum rainfall observed in Nepal region on	24-Aug-07	:	<table border="1"><tr><td>65.00</td></tr></table>	65.00	mm at	Janakpur	
65.00							
	25-Aug-07	:	<table border="1"><tr><td>NA</td></tr></table>	NA	mm at	Janakpur	
NA							
>>Maximum rainfall forecast for	26-Aug-07	:	<table border="1"><tr><td>14.02</td></tr></table>	14.02	mm in	<table border="1"><tr><td>Bihar</td></tr></table> region	Bihar
14.02							
Bihar							
	27-Aug-07	:	<table border="1"><tr><td>10.87</td></tr></table>	10.87	mm in	<table border="1"><tr><td>Bihar</td></tr></table> region	Bihar
10.87							
Bihar							
	28-Aug-07	:	<table border="1"><tr><td>22.77</td></tr></table>	22.77	mm in	<table border="1"><tr><td>Bihar</td></tr></table> region	Bihar
22.77							
Bihar							

>>Today's water level at 6.00AM

Gauge Site	Jainagar	Jhanjharpur railpul	Jhanjharpur
♦Danger Level (m)	69.35	50.00	50.00
♦Water Level (m)	68.47	50.45	49.87
♦Trend	F	F	F
♦Status		Above DL	

4. Basin/River : Kosi

>>Maximum rainfall observed in	24-Aug-07	:	<table border="1"><tr><td>42.20</td></tr></table>	42.20	mm at	Okhaldunga	
42.20							
Nepal region on	25-Aug-07	:	<table border="1"><tr><td>7.60</td></tr></table>	7.60	mm at	Okhaldunga	
7.60							
>>Maximum rainfall forecast for	26-Aug-07	:	<table border="1"><tr><td>14.06</td></tr></table>	14.06	mm in	<table border="1"><tr><td>Bihar</td></tr></table> region	Bihar
14.06							
Bihar							
	27-Aug-07	:	<table border="1"><tr><td>17.22</td></tr></table>	17.22	mm in	<table border="1"><tr><td>Bihar</td></tr></table> region	Bihar
17.22							
Bihar							
	28-Aug-07	:	<table border="1"><tr><td>26.76</td></tr></table>	26.76	mm in	<table border="1"><tr><td>Bihar</td></tr></table> region	Bihar
26.76							
Bihar							

>>Today's water level at 6.00AM

Gauge Site	Basua	Baltara	Kursela
◆Danger Level (m)	47.75	33.85	30.00
◆Water Level (m)	47.21	35.18	31.03
◆Trend	R	R	F
◆Status		Above DL	Above DL

Sources

- i) IMD for rainfall forecast
- ii) CWC / WRD for water-level at gauge-sites
- iii) www.mfd.gov.np / WRD for Nepal rainfall

Compiled at FMISC, Taramandal, Patna

Attn: Principal Secretary, WRD, GoB, Principal Secretary, DMD, GoB, S.E., Flood Monitoring, WRD, GoB, Patna

Abstract of FMIS Phase II : Project Components and Cost

Sub-Component	Description of activities	Rs.	US \$	Area Coverage	Output	Outcome	Linkage with Phase I
1. Upgrading knowledgebase							
spatial							
1.1 Upgrading and expansion of existing spatial database	Consultancy for development of database for additional districts, integration in FMIS	5,942,000					
Sub-Total		5,942,000					
1.2 Surveys							
1.2.1 Ground based close contour survey	Consultancy for ground survey at 20 cm contour interval over flood plain along main stem of priority river basins, where improved flood forecast models is proposed	65,000,000		Bagmati (including Adhwara group)	DEM with 50 cm interval (25 cm vertical accuracy)	Close-contour DEM to support detailed inundation modeling for extent, depth and duration, and spatial flood warning	
1.2.2 First time river (longitudinal and cross-sectional) surveys	Consultancy study for L/S and C/S survey along main stem of priority river basins, where flood forecast modeling is proposed	61,600,000		Bagmati (including Adhwara group) , Burhi Gandak and Kamla	Hydraulic data along rapidly changing river systems	Improved flood forecasting	Bagmati is being surveyed by WRD through consultant
1.2.3 Survey of embankment status and other flood plain features	1. Consultancy for embankment survey (photos, alignment/cross-section/height, physical/ structural status, maintenance history and status, breach history, vulnerability index) /flood plain features (natural and manmade), river morphological changes, and delivery in GIS format	16,580,000		Bagmati, Kamla (including Adhwara group) and Burhi Gandak	Inputs to EMIS, improved inundation modeling	Improved spatial inundation prediction, flood wave progression and recession, and duration modeling, etc.	
Sub-Total		87,746,000					
1.3 Upgrading hydrologic network							
1.3.1 Improving ground rain gauge network (IMD/State network)	1. Planning/implementation consultancy, 2. Training, 3. Support facilities	1,200,000		Bagmati, Adhwara, Burhi Gandak Gandak & Kamla	Improved near- real time daily rainfall report from State/IMD sites, and hourly data from select IMD sites	Support improved rainfall forecasting and validation, and improved flood inundation	Initiated in Phase I, to be strengthened
1.3.2 Improved river gauge reporting by CWC	Agreement between WRD, GoB and CWC	No cost		Bagmati, Adhwara, Burhi Gandak, Gandak & Kamla	Improved river gauge data receipt, including hourly data	Improved flood stage/inundation forecast	Daily report was received after 6-8 hours, needs to be available earlier
1.3.3 installation and operation of flood plain gauges	Installation of flood plain gauges, agreement with community for data reporting, training, pre-monsoon field inspection and rehabilitation	200,000		Bagmati (including Adhwara group)	Ground data on inundation occurrence, depth and duration for inundation model validation	Validated /upgraded inundation model	
Sub-Total		1,400,000					
1.4 Improved Prediction Models							
1.4.1 Improved medium range weather forecasting	MOU with IMD	No cost		Bihar State and Nepal portion of north Bihar rivers	3 day, 5 km resolution forecast	Increased lead time for flood forecast and inundation prediction	45 km , 3 day forecast provided, but accuracy and reliability and spatial resolution to be improved
1.4.2 Improved climate forecast applications	To be taken up under Bank executed component	WB executed		Bagmati, Kamla (including Adhwara group) and Burhi Gandak	Up to 2 months advance forecast, for integration with medium range forecast and flood models	Increased lead time for flood forecast and inundation prediction	
1.4.3 Improved flood forecast modeling	Consultancy study to improve flood forecast model for Bagmati basin, and extension/customization for other basins	2,000,000		Bagmati (including Adhwara group), Kamla and Burhi Gandak	Improved flood forecast/inundation/embankment break models and inundation scenarios	Improved community preparedness, emergency management, etc	Flood model developed for Bagmati basin to be improved, and extended to other basins
1.4.4 Inundation modeling	Consultancy study for 1D/2D hydrodynamic model, with close contour topographic data over flood plain along main stem of Bagmati and other priority basins	1,000,000		Bagmati (including Adhwara group)	Close-contour DEM to support detailed inundation modeling for extent, depth and duration, and spatial flood warning	Spatial warning for inundation extent, depth and duration	

1.4.5 River migration model based on multi-year river configuration maps from historic satellite data, field data on past breaches and causes, etc	Consultancy study based on multi-year satellite data	3,120,000	Bagmati, Adhwara, Gandak, Burhi Gandak & Karnia	Identify vulnerable embankment reaches	Prediction of future morphological trend for improved flood protection	Satellite data base procured under Phase I to be augmented
Sub-Total		6,120,000				

1.5. Development of EMS (Embankment Management System)							
1.5.1 Develop Embankment Management Information System (EMIS)	Consultancy to design, develop and implement of EMIS	1,000,000		Bagmati, Kamla (including Adhwara group) and Burhi Gandak	Computerized information system with relevant data for priority maintenance and monitoring, and emergency action for breach closure	Support prioritization of reaches for time- and cost- effective patrolling, maintenance and strengthening schedule	
Sub-Total		1,000,000					
1.6 Infrastructure Augmentation							
1.6.1 Hardware & Software	computers/software, communication facilities, dissemination facilities etc	4,070,000					
1.6.2 Incremental O&M		5,275,000			Professional support, travel, hardware/software maintenance, etc		Professional support extended from Phase I for need based specialist functions
1.6.3 Operational support from NRSA	Extend MOU for 1. Supply of inundation maps, 2. Sharing 1 m DEM, 3. Upgrading FMIS software etc	No cost	No cost	entire flood prone 21 districts in North Bihar	Operational inundation maps, improved FMIS software operation, improved DEM	Improved frequency of inundation mapping and dissemination	Operational support received in Phase I to be continued
Sub-Total		9,345,000					
Total for Component 1		111,553,000					
2. Improved community participation							
2.1 Strengthening community outreach and ground data collection and reporting	1. Planning/implementation consultancy, 2. Implementation of alert mechanism, 3. Training for follow-up action, and feedback and ground data collection and reporting	2,000,000		Bagmati (including Adhwara group)	Upgraded community alert mechanism and connectivity, community feedback on ground flood situation, community training	Improved community preparedness, community participation in flood data collection for developing and validating improved inundation modeling, etc	The consultancy for community outreach extended to other basins
2.2 Community participation for embankment monitoring and protection	1. Planning/implementation consultancy, 2. Training, 3. Support facilities/arrangements	1,850,000		Bagmati (including Adhwara group)	community participation for embankment monitoring and protection	Improved embankment surveillance and protection	Handbook prepared by WRD two years earlier, but not implemented
Sub-Total		3,850,000					
3. Dissemination and Training							
3.1 Design & Development of Interactive Website	Consultancy for design, development, implementation and maintenance	1,800,000		entire flood prone 21 districts in North Bihar	Upgraded website, interactive		
3.2 Dissemination, reports, training, multi-level stakeholder workshops, study tours, etc		2,100,000		entire flood prone 21 districts in North Bihar	Dissemination of products, daily and monthly bulletins, awareness raising and training workshops for stakeholders, pre-season and post-season workshops, advanced training in remote sensing, GIS and modeling; study tours to other flood prone states, flood management related agencies	Improved flood preparedness, ownership, capacity building in WRD	Basic training in remote sensing and GIS procured in Phase I to be strengthened with more staff and intensity
Sub-Total	as and when needed	3,900,000					
Total		119,297,000					
Total for Recipient execution		Rs 119,297,000 (US \$ 3.03 m, 1 US \$ = Rs 39.31)					
Project duration will be 30 months (June 2008 to Nov 2010); GoB contribution towards general infrastructure and operational costs, systems and software within WRD upto field units (excluding select nodes in WRD Hqrs under DFID funding), etc.							

Points Discussed with Secretary, WRD on 12 June 08

1. The Secretary was briefed on the two critical procurement issues:

- P4 – The assignment by ROLTA is still incomplete, and needs to be completed prior to project closure. This will require all-round efforts in fire-fighting mode. Priority should be given to completion of critical data sets (WRD flood offices; Command area, Canal network; road and rail network; Flood management works; River configuration and bank line for major rivers; current drainage; land cover-use, Hydrometeorological observation sites; Hydrological observation sites; CWC Flood forecasting stations; IMD Flood Meteorological Offices; administrative units up to village, and settlements (both location and extent) up to hamlet, and Flood inundation extent) in regard to both map content and attribute database. All necessary attribute data for the critical datasets shall be compiled by FMISC and provided to ROLTA or attached in-house. All critical datasets shall be packaged/integrated with Cartosat mosaic.

If the datasets sent by ROLTA on 11 June are seen to be of sub-standard quality, the consultant shall be asked to correct and complete the datasets on-site in FMISC.

Priority 1: Complete critical datasets prior to June 15, or if unavoidable by June 30, 08. In this case payment to the consultant will be regulated based on usable data sets supplied prior to project closure.

Priority 2: Complete all GIS datasets prior to June 15, or if unavoidable by June 30, 08.

- P21 – Hourly stage data was received from CWC on June 9, and sent to consultant the next day. FMISC shall pursue with the consultant to see whether all the activities can be completed by June 25, or latest by June 30, 08. If there is any time constraint, at least one or two models shall be completed. Partial completion would lead to appropriately reduced payment to the consultant.

2. Preparedness of FMISC for the 2008 flood season was discussed. Secretary suggested that the flood forecasting model should be completed and used in the season to demonstrate the improvements in FMIS. All support was assured for two shift operations. Three additional staff were identified for immediate posting in the place of three existing staff who will be transferred based on lack of commitment, additional systems (however may not be available in time due to fund constraints) and support for other facilities like transport still awaited. There would also be problem in procuring contract staff due to departmental procedural constraints and delays, and the right staff may not be finally recruited. Secretary suggested that FMISC shall access all rainfall/flood potential forecasts from global and national sources (IMD, NCMRWF, Global Hazard System (Floods) (TRMM site of GSFC/NASA, USA), COLA, National Weather Service (USA), commercial weather sites like weather.com) and compile and report on daily basis.

3. I pointed out that the involvement and commitment level of FMISC staff has significantly deteriorated. Staff are reporting late to office, leaving early, and taking long breaks for personal reasons; resisting working after office hours or on holidays; and

generally demonstrating decreased level of commitment. Secretary ordered immediate transfer of three staff suggested by Mr. Samaiyar (Ashok Kumar, Tiwari,...), replacing them with three staff from WALMI.

4. The Mobile Inspection System for monitoring embankments using proprietary mobile sets and external server by DIZFRAME of Calcutta was mentioned. This is expected to be replaced with a better system of in-house server, and mobile services and software from AIRTEL. This approach can also support community outreach and participation planned in Phase II.

5. Secretary also mentioned the formation of a modeling team of about 8 staff within WRD to support all modeling studies for project preparation, irrigation management, etc. This unit will be located in WALMI. I mentioned the example of Surface Water Modeling Centre in Bangladesh. The synergy between the modeling unit and FMISC should be explored and strengthened.

6. Secretary showed interest in submitting a larger proposal for improving canal system (including dredging) for lending. I mentioned about the flood control and drainage master plan with pilot investments that was proposed in 2006.

7. Point of interest: about 180 engineers have been very recently promoted as Executive Engineers after decades of no-promotion; necessary orders have been issued.



"Thiruvengadachari"
<charist1@rediffmail.com>

Subject Meeting with Secretary, WRD, GoB on 12 June

06/12/2008 03:45 PM

Please respond to
"Thiruvengadachari"
<charist1@rediffmail.com>

Javier:

Please see attached the note on points discussed with Secretary, RD, GoB on 12 June 08.

I will be travelling to Delhi this evening for overnight stay, and travel to Lucknow on 13 June.

Chari

S.Thiruvengadachari,
Flat 'A', Ground Floor, Uma Villa,
Road No. 10, Banjara Hills,
Hyderabad 500034
Tel: 0091-40-23356785/6
Mob: 98480 12857



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Points_Discussed_with_Secretary_12_June_08.doc

To: "Jzuleta1" <Jzuleta1@Worldbank.Org>

**Govt. of Bihar
Finance Department**

Letter No.- 38/FFIS

From

A V Chaturvedi,
Additional Finance Commissioner,
Finance Deptt. Govt. of Bihar

To

Madhusudan Prasad
Joint Secretary
Ministry of Finance
Room No. - 166 D, North Block
Dept. of Economic Affairs, Govt. of India
New Delhi

Patna Dated:- 02.06.2008

Sub: - Regarding rescheduling FMIS Project Bihar project closure from 31 May to 30th June 2008-DFID Grant for Bihar Flood Management Information System of the Water Resources Dept. Govt. of Bihar under DFID - Bank Trust Fund for India Grant Numbers - TF 057071.

Ref: - Letter from Mr Dalip Kapur, Under Secretary (FB), Ministry of Finance, Department Economic Affairs, Govt. of India, F. No-3/1/2006-FB-III, Dated- 14th March, 2008

Sir,

The project has made substantial progress by now, with 14 procurement packages completed, and 6 more will be completed by the current closure date. The balance three packages will require additional three weeks beyond the current closure date. Status of the last three packages is given below:

1. P-4: Developing additional database for integration in FMIS.

Under this package twenty two data layers are being developed by the consultant ROITA India Ltd. Out of these twenty two, twenty layers have been received by FMISC. These layers are being checked and corrections made on-site in Patna. Rest two layers are also being developed simultaneously. After getting all the corrected layers as per specification attributes will be attached to each layer and the quality check report of all deliverables will be submitted by the consultant. The whole process may take three more weeks and expected to complete by June 21, 08.

2. P-21: - Improved Flood Forecast Modeling: -This activity has been delayed due to delayed supply of data from IMD/ CWC. While the hourly rainfall data from IMD has been received, supply of hourly gauge data from CWC has been unduly delayed, and is now expected before end May. The FMISC has requested the consultant to provide additional resources on priority and complete it within one month by the end of June 2008.

3. P-22: - Strengthening Hydrologic Network and Telemetry: - The draft final report was submitted by the consultant and reviewed by the members of the technical committee. The committee has given few suggestions which have been communicated to the consultant to revise the report accordingly. The revised final draft report is awaited after further analysis and data collection. Submission of final report would require three more weeks.

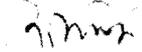
On the disbursement side we have submitted a claim of reimbursement for the quarter January – March 2008 for Rs. 133.81 lac against total project cost of Rs. 219.271 lac. Till date actual disbursement is Rs. 145.3 lac which will rise up to Rs. 152 lac (approx) i.e. nearly 70% of the total project cost by the present closure date 31st May 08.

In view of the above facts and circumstances, we request extension of closure date till 30th June 2008, which will help in completion of all the remaining activities and successful completion of this prestigious project.

Enclosures:

- i) Current physical and disbursement Status
- ii) IFR (1A & 1B) for quarter ending March 2008.
- iii) Updated Procurement Plan

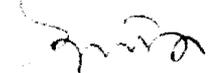
Yours faithfully


(A V Chaturvedi)

Letter No. - 38/AF/08

Patna/Dated:- 02.06.2008

- Copy to:
1. Javier Zuleta, Senior Water Resources Specialist, World Bank
 2. Mr Dalip Kapur, Under Secretary (FB), Ministry of Finance, Department of Economic Affairs, Govt. of India
 3. Ms. Isabel Guerrero, Country Director, The World Bank New Delhi Office, 70- Lodhi Estate, New Delhi
 4. Mandakini Kaul, Country Officer, World Bank for information and necessary action.


(A V Chaturvedi)

disbursement status 23.05.08											
Project activity	Package No.	Item	Procurement Category	Procurement mode	Actual / committed / estimated Value in Rs. Lakhs	disbursement till 30.04.08	balance amount lakhs	disbursement plan		current status/ % completion	remarks
								by May 08	by June 08		
1	2	3	4	5	6	7	8	9	10		11
1. Preparation of FMIS	P-1	1.1 Preparation of Cartosat data mosaic of focus area	Consultancy	SSS - NRSA	20.2	20.2	nil	nil	nil	100%	completed
		1.1.a. Preparation of additional Cartosat mosaic	Consultancy	SSS - NRSA	6	6	nil	nil	nil	100%	
	P-2	1.2 Generation of processed historic Radarsat and optical satellite data	Consultancy	SSS - NRSA	5	5	nil	nil	nil	100%	
	P-3	1.3 Generation of processed 2007 flood season Radarsat and optical satellite data (as needed basis)	Consultancy	SSS - NRSA	6	6	nil	nil	nil	100%	
	P-4	1.4 Developing additional database for integration in FMIS	Consultancy	CQS	45	9.00	36.000	nil	36.000	36%	20 layers out of total 22 received, rest 2 layers along with QC report are also simultaneously being prepared corrections in these layers are being done by ROLTA staff in FMISC
	P-5	1.5 Topographic map digitization as per FMIS specifications	Consultancy	SSS- Survey of India	7.725	7.725	nil	nil	nil	100%	completed
	P-6	1.6 FMIS facilitation	Consultancy	SSS - BIRSAC	8.600	7.16	1.440	1.06 (paid)	nil	100%	0.38 lac is saving, being reallocated to more satellite data procurement
	P-7	1.7 Develop modalities for community outreach, preparedness, and flood management	Consultancy	Individual	6	3	3.000	1.8	1.2	80%	preparation of draft final report in final stage, expected on 21th May 08.
	P-8	1.8 Computer for remote sensing and GIS software (2 Nos)	Goods	Shopping	3.182	3.182	nil	nil	nil	100%	completed
		1.9 HP Designjet 500 PostScript printer (42 inch)	Goods	Shopping	1.934	1.934	nil	nil	nil	100%	completed
		1.10 1 UPS + Battery	Goods	Shopping	1.143	1.143	nil	nil	nil	100%	completed
	P-9	1.10 2 Diesel generator	Goods	Shopping	2.705	2.705	nil	nil	nil	100%	completed
	P-10	1.11 Remote sensing (ERDAS Imagine) software	Goods	Proprietary	9.625	9.625	nil	nil	nil	100%	completed
	P-11	1.12 GIS (ArcGIS) software	Goods	Proprietary	22	22	nil	nil	nil	100%	completed
P-12	1.13 Oracle RDBMS (1 license), Windows XP Professional SP2+ Antivirus software (enterprise version), Visual C++ (2 licenses), Visual Basic (2 licenses)	Goods	Shopping	1.132	1.132	nil	nil	nil	100%	completed	
Non-procurement item		Develop integrated FMIS database, develop and integrate application software, implement in Patna, and maintain for 1 year	Consultancy	SSS-NRSA							2nd version has been developed by NRSA, expected by 31.05.08
		Sub Total			146.246	105.806	40.44	1.8	37.2		0.38 lac saving in above packages

	Note: - <u>underlined costs</u> are estimated costs i.e for packages p-15, p-17, p-24 & for contingent expenditures								
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1	2	3	4	5	6	7	8	9	10	11	
				B. F.	146.246	105.806	40.44	2.86	37.2	0.38 lac saving in above packages	
	P-13	Hiring HR firm			Not taken up						
2. Creation of flood website	P-14	2.1. Hiring consultants for operational support	Consultancy	Individual	17.371	11.614	5.757	3.5 (paid)	1.75	90%	0.507 lac saving, being reallocated to more satellite data procurement
	P-15	2.2 Inhouse Flood website development and maintenance, i) hiring support staff ii) purchase of software	Consultancy	individual shopping	<u>2.500</u>	0.36	2.140	0.6 (paid)	1.3	90%	English edition of website developed, Hindi version of website in progress, 0.24 lac saving of this package being reallocated to additional satellite data
3. Training	P-16	3.1 Plan Stakeholder workshops, meetings and training at Hqs and up to field office, and community level for support to conduct of workshops, meeting and training	Training	Individual	4	2	2.000	1.2	0.8	80%	draft final report in final stage, expected by 24.05.08
	P-17	3.2 Implement programme & plan of 3.1	Training		<u>6.00</u>	5.5	0.5	0.5	nil	85%	all workshop conducted, activity completed
	P-18	3.3.1 Training in satellite data processing and GIS 3.3.2 Training on procurement Procedures for the World Bank aided projects	Training B-1 Training B-2 Training B-3	SSS-NRSA CQS -JNTU SSS- ASCI	2.734	2.734	nil	nil	nil	100%	completed
4. Improving flood forecast modeling	P-19	4.1 Development of DEM	Consultancy	Individual	1.2	0.600	0.600	0.6	nil	100%	completed
	P-20	4.2 Generation of customized rainfall forecasts	Consultancy	SSS - JMD	no cost	nil	nil	nil	nil	100%	completed
	P-21	4.3 Develop models for improved flood forecasting	Consultancy	CQS	13.5 lac Rs. 6.72 lakhs for Phase II of Package-1	4.050	9.45 6.72	nil	9.450	20%	CWC data delayed, will require extension for completion, the unused amount Rs. 6.72 lakhs for Phase-II Package- 21 is being reallocated to more satellite data procurement
	P-24	4.4 Innovative inundation modeling	Consultancy	CQS	<u>5.00</u>	nil	5.000	nil	nil	Not taken up	this unused amount Rs 5 lac is being reallocated to more satellite data procurement
5. Developing a plan for upgrading hydrologic measurements, telemetry and FMIS	P-22	5.1 Develop plan for strengthening hydrologic network, telemetry, etc	Consultancy	Individual	6	3.000	3.000	nil	3.00	50%	comments on Draft final report sent to the consultant to revise the Draft final report, will require extension for completion
6. Updating Bihar flood control manuals	P-23	6.1 FMIS integration in flood management manuals and action plans, and institutional arrangements	Consultancy	Individual	6	3.000	3.000	1.8	1.20	80%	Draft final report received on 19.05.08, reviewed by the review committee on 22.05.08, report again to be revised as per comments
		Provision for essential contingent expenditures involved in procurement process			<u>2.00</u>	0.9	1.100	0.5	0.6		
		Total			219.271	139.564	79.707	11.560	54.300	64%	total saving of Rs 13.847 lac being reallocated to more satellite data procurement and operational support
NRSA - National Remote Sensing Agency, BIRSAC - Bihar Remote Sensing Applications Centre, NCMRWF - National Centre for Medium Range Weather Forecasting, WALMI - Water and Land Management Institute, SSS- Single Source Selection, CQS - Consultants' Qualification based Selection, FMISC - Flood Management Information System Cell, DEM - Digital Elevation Model											
Note:- underlined costs are estimated costs i.e for packages p-15, p-17, p-24 & for contingent expenditures											

Procurement Plan

04.02.08

Project activity	Package No.	Item	Procurement Category	Procurement mode	Actual / committed / estimated Value in Rs. Lakhs	date for contract award	Target date for contract award	Assignment duration (in months)	Expected /Actual Completion Date	Revised expected completion date
1	2	3	4	5	6	7	8	9	10	11
1. Preparation of FMIS	P-1	1.1 Preparation of Cartosat data mosaic of focus area	Consultancy	SSS - NRSA	20.2	04.05.07		1.5	05.11.07	completed
		1.1.a. Preparation of additional Cartosat mosaic	Consultancy	SSS - NRSA	6	27.10.07		1	05.11.07	completed
	P-2	1.2 Generation of processed historic Radarsat and optical satellite data	Consultancy	SSS - NRSA	5	04.05.07		1.5	04.10.07	31.05.08
	P-3	1.3 Generation of processed 2007 flood season Radarsat and optical satellite data (as needed basis)	Consultancy	SSS - NRSA	6	04.05.07		5	04.10.07	
	P-4	1.4 Developing additional database for integration in FMIS	Consultancy	CQS	45	11.09.07		4	31.10.07	29.02.08
	P-5	1.5 Topographic map digitization as per FMIS specifications	Consultancy	SSS- Survey of India	7.725	08.06.07		1.5	03/08/2007	completed
	P-6	1.6 FMIS facilitation	Consultancy	SSS - BIRSAC	9.174	14.08.07		14	31.10.07	31.12.07
	P-7	1.7 Develop modalities for community outreach, preparedness, and flood management	Consultancy	Individual	6	24.05.07		4	23-09-07	29.02.08
	P-8	1.8 Computer for remote sensing and GIS software (2 Nos)	Goods	Shopping	3.182	09.04.07		0.5	13.06.07	completed
		1.9 HP Designjet 500 PostScript printer (42 inch)	Goods	Shopping	1.934	09.04.07		0.5	13.06.07	completed
		1.10.1 UPS + Battery	Goods	Shopping	1.143	09.04.07		0.5	13.06.07	completed
	P-9	1.10 .2 Diesel generator	Goods	Shopping	2.705			0.5	15.07.07	completed
	P-10	1.11 Remote sensing (ERDAS Imagine) software	Goods	Proprietary	9.625	01.03.07		0.5	23.03.07	completed
	P-11	1.12 GIS (ArcGIS) software	Goods	Proprietary	22	07.03.07		0.5	30.03.07	completed
	P-12	1.13 Oracle RDBMS (1 license), Windows XP Professional SP2 + MS Office suite 2003+ Antivirus software (enterprise version), Visual C++ (2 licenses), Visual Basic (2 licenses)	Goods	Shopping	1.132	09.04.07		0.5	13.06.07	completed
	Non-procurement item		Develop integrated FMIS database , develop and integrate application software, implement in Patna, and maintain for 1 year	Consultancy	SSS-NRSA		04.05.07		2.3	
		Sub Total			146.82		C.O.			

1	2	3	4	5	6	7	8	9	10	11
				B. F.	146.82					
	P-13	Hiring HR firm								
										Not taken up
2. Creation of flood website	P-14	2.1. Hiring consultants for operational support	Consultancy	Individual	17.371			5	31.10.07	31.05.08
	P-15	2.2 Inhouse Flood website development and maintenance, i) hiring support staff ii) hiring one system	Consultancy	individual shopping	<u>1.926</u>			In house development of website in progress	4	31.05.08
3. Training	P-16	3.1 Plan Stakeholder workshops, meetings and training at Hqs and up to field office, and community level for support to conduct of workshops, meeting and training	Training	Individual	4	25.05.07		4	25.09.07	29.02.08
	P-17	3.2 Implement programme & plan of 3.1	Training		<u>6.00</u>			being inhouse conducted by WALMI	2	30.04.08
	P-18	3.3.1 Training in satellite data processing and GIS 3.3.2 Training on procurement Procedures for the World Bank aided projects	Training B-1 Training B-2 Training B-3	SSS-NRSA CQS -JNTU SSS- ASCI	2.734	02.04.07 18.05.07 11.01.08		30 days 10 days 10 days	29-05-07	04.05.07 29.05.07 01.02.08
4. Improving flood forecast modeling	P-19	4.1 Development of DEM	Consultancy	Individual	1.2	12.06.07		1.5	10.12.07	31.03.08
	P-20	4.2 Generation of customized rainfall forecasts	Consultancy	SSS - IMD	no cost	07.06.07		7		31.05.08
	P-21	4.3 Develop models for improved flood forecasting	Consultancy	CQS	13.5 6.72	24.07.07		3 3	24.10.07 for ph- I+II	31.05.08
	P-24	4.4 Innovative inundation modeling	Consultancy	CQS	<u>5.00</u>			4		31.05.08
5. Developing a plan for upgrading hydrologic measurements, telemetry and FMIS	P-22	5.1 Develop plan for strengthening hydrologic network, telemetry, etc	Consultancy	Individual	6	07.06.07		4	07.10.07	30.04.08
6. Updating Bihar flood control manuals	P-23	6.1 FMIS integration in flood management manuals and action plans, and institutional arrangements	Consultancy	Individual	6	25.05.07		4	25.09.07	30.04.08
		Provision for essential contingent expenditures involved in procurement process			<u>2.00</u>					
		Total			219.271					

NRSA - National Remote Sensing Agency, BIRSAC - Bihar Remote Sensing Applications Centre , NCMRWF - National Centre for Medium Range Weather Forecasting, WALMI - Water and Land Management Institute, SSS- Single Source Selection, CQS - Consultants' Qualification based Selection, FMISC - Flood Management Information System Cell, DEM - Digital Elevation Model

Note:- underlined costs are estimated costs i.e for packages p-15, p-17, p-24 & for contingent expenditures

Procurement Plan

23.05.08

Project activity	Package No.	Item	Procurement Category	Procurement mode	Actual / committed / estimated Value in Rs. Lakhs	date for contract award	Target date for contract award	Assignment duration (in months)	Expected /Actual Completion Date	Revised expected completion date
1	2	3	4	5	6	7	8	9	10	11
1. Preparation of FMIS	P-1	1.1 Preparation of Cartosat data mosaic of focus area	Consultancy	SSS - NRSA	20.2	04.05.07		1.5	05.11.07	completed
		1.1.a. Preparation of additional Cartosat mosaic of whole 11 districts	Consultancy	SSS - NRSA	6	27.10.07		1	05.11.07	completed
		1.1.b Preparation of Cartosat mosaic of additional districts of North Bihar		SSS - NRSA	10.853		31.05.08		30.06.08	
	P-2	1.2 Generation of processed historic Radarsat and optical satellite data	Consultancy	SSS - NRSA	5	04.05.07		1.5	04.10.07	completed
	P-3	1.3 Generation of processed 2007 flood season Radarsat and optical satellite data (as needed basis)	Consultancy	SSS - NRSA	6	04.05.07		5	04.10.07	completed
	P-4	1.4 Developing additional database for integration in FMIS	Consultancy	CQS	45	11.09.07		4	31.10.07	30.06.08
	P-5	1.5 Topographic map digitization as per FMIS specifications	Consultancy	SSS- Survey of India	7.725	08.06.07		1.5	03/08/2007	completed
	P-6	1.6 FMIS facilitation	Consultancy	SSS - BIRSAC	8.158	14.08.07		14	31.10.07	31.12.07 completed
	P-7	1.7 Develop modalities for community outreach, preparedness, and flood management	Consultancy	Individual	6	24.05.07		4	23-09-07	31.05.08
	P-8	1.8 Computer for remote sensing and GIS software (2 Nos)	Goods	Shopping	3.182	09.04.07		0.5	13.06.07	completed
		1.9 HP Designjet 500 PostScript printer (42 inch)	Goods	Shopping	1.934	09.04.07		0.5	13.06.07	completed
		1.10.1 UPS + Battery	Goods	Shopping	1.143	09.04.07		0.5	13.06.07	completed
	P-9	1.10 .2 Diesel generator	Goods	Shopping	2.705			0.5	15.07.07	completed
	P-10	1.11 Remote sensing (ERDAS Imagine) software	Goods	Proprietary	9.625	01.03.07		0.5	23.03.07	completed
	P-11	1.12 GIS (ArcGIS) software	Goods	Proprietary	22	07.03.07		0.5	30.03.07	completed
	P-12	1.13 Oracle RDBMS (1 license), Windows XP Professional SP2+ Antivirus software (enterprise version), Visual C++ (2 licenses), Visual Basic (2 licenses)	Goods	Shopping	1.132	09.04.07		0.5	13.06.07	completed
Non-procurement item		Develop integrated FMIS database , develop and integrate application software, implement in Patna, and maintain for 1 year	Consultancy	SSS-NRSA		04.05.07		2.3		First version software by 31 Oct, second version and integrated database by 31.05.08
		Sub Total			156.657		C.O.			

1	2	3	4	5	6	7	8	9	10	11
				B. F.	145.804					
	P-13	Hiring HR firm				Not taken up				
2. Creation of flood website	P-14	2.1. Hiring consultants for operational support	Consultancy	Individual	<u>18.620</u>	recruitment by FMISC		5	31.10.07	30.06.08
	P-15	2.2 Inhouse Flood website development and maintenance, i) hiring support staff ii) purchase of software for website development	Consultancy	individual shopping	<u>2.560</u>	In house by FMISC		4		30.06.08
3. Training	P-16	3.1 Plan Stakeholder workshops, meetings and training at Hqs and up to field office, and community level for support to conduct of workshops, meeting and training	Training	Individual	4	25.05.07		4	25.09.07	31.05.08
	P-17	3.2 Implement programme & plan of 3.1	Training		<u>6.00</u>	In house by WALMI		2		31.05.08
	P-18	3.3.1 Training in satellite data processing and GIS 3.3.2 Training on procurement Procedures for the World Bank aided projects	Training B-1 Training B-2 Training B-3	SSS-NRSA CQS -JNTU SSS- ASCI	2.734	02.04.07 18.05.07 11.01.08		30 days 10 days 10 days	29-05-07	04.05.07 29.05.07 01.02.08
4. Improving flood forecast modeling	P-19	4.1 Development of DEM	Consultancy	Individual	1.2	12.06.07		1.5	10.12.07	31.03.08 completed
	P-20	4.2 Generation of customized rainfall forecasts	Consultancy	SSS - IMD	no cost	07.06.07		7		completed
	P-21	4.3 Develop models for improved flood forecasting	Consultancy	CQS	13.5	24.07.07		3 3	24.10.07 for ph- 1	30.06.08
	P-24	4.4 Innovative inundation modeling	Consultancy	CQS						NOT TAKEN UP
5. Developing a plan for upgrading hydrologic measurements, telemetry and FMIS	P-22	5.1 Develop plan for strengthening hydrologic network, telemetry, etc	Consultancy	Individual	6	07.06.07		4	07.10.07	30.06.08
6. Updating Bihar flood control manuals	P-23	6.1 FMIS integration in flood management manuals and action plans, and institutional arrangements	Consultancy	Individual	6	25.05.07		4	25.09.07	31.05.08
		Provision for essential contingent expenditures involved in procurement process			<u>2.00</u>					
Total					219.271					
NRSA - National Remote Sensing Agency, BIRSAC - Bihar Remote Sensing Applications Centre , NCMRWF - National Centre for Medium Range Weather Forecasting, WALMI - Water and Land Management Institute, SSS- Single Source Selection, CQS - Consultants' Qualification based Selection, FMISC - Flood Management Information System Cell, DEM - Digital Elevation Model										

Note:- underlined costs are estimated costs i.e for packages p-1.1b, p-15, p-17 & for contingent expenditures

**Govt. of Bihar
Finance Department**

CD'S Incoming Mail	
Date:	June 18
For action	
cc:	Zulka/Dina Gopal Bhaskar Ravi
	CD's file

Letter No.- 38/A.F.C.16

From
A V Chaturvedi,
Additional Finance Commissioner,
Finance Deptt. Govt. of Bihar

To
Madhusudan Prasad
Joint Secretary
Ministry of Finance
Room No. - 166 D, North Block
Dept. of Economic Affairs, Govt. of India
New Delhi

Patna/Dated:- 02.06.2008

Sub: - Regarding rescheduling FMIS Project Bihar project closure from 31 May to 30th June 2008-DFID Grant for Bihar Flood Management Information System of the Water Resources Dept. Govt. of Bihar under DFID - Bank Trust Fund for India Grant Numbers - TF 057071.

Ref: - Letter from Mr Dalip Kapur, Under Secretary (FB), Ministry of Finance, Department Economic Affairs, Govt. of India, F. No-3/1/2006-FB-III, Dated- 14th March, 2008

Sir,

The project has made substantial progress by now, with 14 procurement packages completed, and 6 more will be completed by the current closure date. The balance three packages will require additional three weeks beyond the current closure date. Status of the last three packages is given below:

1. P-4: Developing additional database for integration in FMIS.

Under this package twenty two data layers are being developed by the consultant ROLTA India Ltd. Out of these twenty two, twenty layers have been received by FMISC. These layers are being checked and corrections made on-site in Patna. Rest two layers are also being developed simultaneously. After getting all the corrected layers as per specification attributes will be attached to each layer and the quality check report of all deliverables will be submitted by the consultant. The whole process may take three more weeks and expected to complete by June 21, 08.

2. P-21: - Improved Flood Forecast Modeling: --This activity has been delayed due to delayed supply of data from IMD/ CWC. While the hourly rainfall data from IMD has been received, supply of hourly gauge data from CWC has been unduly delayed, and is now expected before end May. The FMISC has requested the consultant to provide additional resources on priority and complete it within one month by the end of June 2008.

3. P-22: - Strengthening Hydrologic Network and Telemetry: -- The draft final report was submitted by the consultant and reviewed by the members of the technical committee. The committee has given few suggestions which have been communicated to the consultant to revise the report accordingly. The revised final draft report is awaited after further analysis and data collection. Submission of final report would require three more weeks.

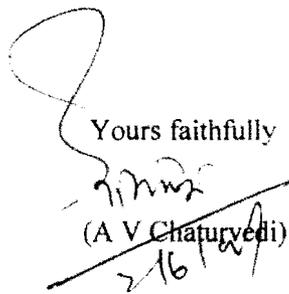
On the disbursement side we have submitted a claim of reimbursement for the quarter January – March 2008 for Rs. 133.81 lac against total project cost of Rs. 219.271 lac. Till date actual disbursement is Rs. 145.3 lac which will rise up to Rs. 152 lac (approx) i.e. nearly 70% of the total project cost by the present closure date 31st May 08.

In view of the above facts and circumstances, we request extension of closure date till 30th June 2008, which will help in completion of all the remaining activities and successful completion of this prestigious project.

Enclosures:

- i) Current physical and disbursement Status
- ii) IFR (1A & 1B) for quarter ending March 2008.
- iii) Updated Procurement Plan

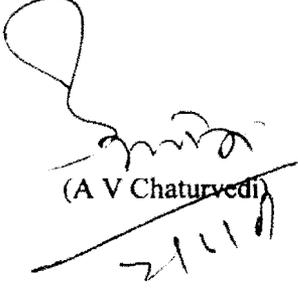
Yours faithfully


(A V Chaturvedi)

Letter No. - 38/AFC/E

Patna/Dated:- 02.06.2008

- Copy to:
1. Javier Zuleta, Senior Water Resources Specialist, World Bank
 2. Mr Dalip Kapur, Under Secretary (FB), Ministry of Finance, Department of Economic Affairs, Govt. of India
 3. Ms. Isabel Guerrero, Country Director, The World Bank New Delhi Office, 70- Lodhi Estate, New Delhi
 4. Mandakini Kaul, Country Officer, World Bank for information and necessary action.


(A V Chaturvedi)

disbursement status 23.05.08											
Project activity	Package No.	Item	Procurement Category	Procurement mode	Actual / committed / estimated Value in Rs. Lakhs	disbursement till 30.04.08	balance amount lakhs	disbursement plan		current status/ % completion	remarks
								by May 08	by June 08		
1	2	3	4	5	6	7	8	9	10	11	11
1. Preparation of FMIS	P-1	1.1 Preparation of Cartosat data mosaic of focus area	Consultancy	SSS - NRSA	20.2	20.2	nil	nil	nil	100%	completed
		1.1.a Preparation of additional Cartosat mosaic	Consultancy	SSS - NRSA	6	6	nil	nil	nil	100%	
	P-2	1.2 Generation of processed historic Radarsat and optical satellite data	Consultancy	SSS - NRSA	5	5	nil	nil	nil	100%	
	P-3	1.3 Generation of processed 2007 flood season Radarsat and optical satellite data (as needed basis)	Consultancy	SSS - NRSA	6	6	nil	nil	nil	100%	20 layers out of total 22 received, rest 2 layers along with QC report are also simultaneously being prepared corrections in these layers are being done by ROLTA staff in FMISC
	P-4	1.4 Developing additional database for integration in FMIS	Consultancy	CQS	45	9.00	36.000	nil	36.000	36%	
	P-5	1.5 Topographic map digitization as per FMIS specifications	Consultancy	SSS - Survey of India	7.725	7.725	nil	nil	nil	100%	completed
	P-6	1.6 FMIS facilitation	Consultancy	SSS - BRSAC	8,600	7.16	1,440	1.06 (paid)	nil	100%	0.38 lac is saving, being reallocated to more satellite data procurement
	P-7	1.7 Develop modalities for community outreach, preparedness, and flood management	Consultancy	Individual	6	3	3,000	1.8	1.2	80%	preparation of draft final report in final stage, expected on 21st May 08
	P-8	1.8 Computer for remote sensing and GIS software (2 Nos)	Goods	Shopping	3,182	3,182	nil	nil	nil	100%	completed
		1.9 HP Designjet 500 PostScript printer (42 inch)	Goods	Shopping	1,934	1,934	nil	nil	nil	100%	completed
		1.10.1 UPS + Battery	Goods	Shopping	1,143	1,143	nil	nil	nil	100%	completed
	P-9	1.10.2 Diesel generator	Goods	Shopping	2,705	2,705	nil	nil	nil	100%	completed
	P-10	1.11 Remote sensing (ERDAS Imagine) software	Goods	Proprietary	9,625	9,625	nil	nil	nil	100%	completed
	P-11	1.12 GIS (ArcGIS) software	Goods	Proprietary	22	22	nil	nil	nil	100%	completed
	P-12	1.13 Oracle RDBMS (1 license), Windows XP Professional SP2+ Antivirus software (enterprise version), Visual C++ (2 licenses), Visual Basic (2 licenses)	Goods	Shopping	1,132	1,132	nil	nil	nil	100%	completed
Non-procurement item		Develop integrated FMIS database, develop and integrate application software, implement in Patna, and maintain for 1 year	Consultancy	SSS-NRSA							2nd version has been developed by NRSA, expected by 31.05.08
		Sub Total			146,246	105,806	40.44	1.8	37.2		0.38 lac saving in above packages

28/5/08

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Procurement Plan

23.05.08

Project activity	Package No.	Item	Procurement Category	Procurement mode	Actual / committed / estimated Value in Rs. Lakhs	date for contract award	Target date for contract award	Assignment duration (in months)	Expected /Actual Completion Date	Revised expected completion date
1	2	3	4	5	6	7	8	9	10	11
1. Preparation of FMIS	P-1	1.1 Preparation of Cartosat data mosaic of focus area	Consultancy	SSS - NRSA	20.2	04.05.07		1.5	05.11.07	completed
		1.1.a. Preparation of additional Cartosat mosaic of whole 11 districts	Consultancy	SSS - NRSA	6	27.10.07	31.05.08	1	05.11.07	completed
		1.1.b Preparation of Cartosat mosaic of additional districts of North Bihar		SSS - NRSA	<u>10,853</u>				30.06.08	
	P-2	1.2 Generation of processed historic Radarsat and optical satellite data	Consultancy	SSS - NRSA	5	04.05.07		1.5	04.10.07	completed
	P-3	1.3 Generation of processed 2007 flood season Radarsat and optical satellite data (as needed basis)	Consultancy	SSS - NRSA	6	04.05.07		5	04.10.07	completed
	P-4	1.4 Developing additional database for integration in FMIS	Consultancy	CQS	45	11.09.07		4	31.10.07	30.06.08
	P-5	1.5 Topographic map digitization as per FMIS specifications	Consultancy	SSS - Survey of India	7.725	08.06.07		1.5	08/03/2007	completed
	P-6	1.6 FMIS facilitation	Consultancy	SSS - BIRSAC	8.158	14.08.07		14	31.10.07	31.12.07 completed
	P-7	1.7 Develop modalities for community outreach, preparedness, and flood management	Consultancy	Individual	6	24.05.07		4	23-09-07	31.05.08
	P-8	1.8 Computer for remote sensing and GIS software (2 Nos)	Goods	Shopping	3.182	09.04.07		0.5	13.06.07	completed
		1.9 HP Designjet 500 PostScript printer (42 inch)	Goods	Shopping	1.934	09.04.07		0.5	13.06.07	completed
		1.10.1 UPS + Battery	Goods	Shopping	1.143	09.04.07		0.5	13.06.07	completed
	P-9	1.10 .2 Diesel generator	Goods	Shopping	2.705			0.5	15.07.07	completed
	P-10	1.11 Remote sensing (ERDAS Imagine) software	Goods	Proprietary	9.625	01.03.07		0.5	23.03.07	completed
P-11	1.12 GIS (ArcGIS) software	Goods	Proprietary	22	07.03.07		0.5	30.03.07	completed	
P-12	1.13 Oracle RDBMS (1 license), Windows XP Professional SP2+ Antivirus software (enterprise version), Visual C++ (2 licenses), Visual Basic (2 licenses)	Goods	Shopping	1.132	09.04.07		0.5	13.06.07	completed	
Noe-procurement item		Develop integrated FMIS database , develop and integrate application software, implement in Patna, and maintain for 1 year	Consultancy	SSS-NRSA		04.05.07		2.3		First version software by 31 Oct, second version and integrated database by 31.05.08
		Sub Total			156.657		C.O.			

DK
23/5/08
S. Panigrahy 23/5

1	2	3	4	B. F.	145.804	7	8	9	10	11
	P-13	Hiring HR firm				Not taken up				
2. Creation of flood website	P-14	2.1. Hiring consultants for operational support	Consultancy	Individual	<u>18,620</u>	recruitment by FMISC		5	31.10.07	30.06.08
	P-15	2.2 Inhouse Flood website development and maintenance, i) hiring support staff ii) purchase of software for website development	Consultancy	individual shopping	<u>2,560</u>	In house by FMISC		4		30.06.08
3. Training	P-16	3.1 Plan Stakeholder workshops, meetings and training at Hqs and up to field office, and community level for support to conduct of workshops, meeting and training	Training	Individual	4	25.05.07		4	25.09.07	31.05.08
	P-17	3.2 Implement programme & plan of 3.1	Training		<u>6,00</u>	in house by WALMI		2		31.05.08
	P-18	3.3.1 Training in satellite data processing and GIS 3.3.2 Training on procurement Procedures for the World Bank aided projects	Training B-1 Training B-2 Training B-3	SSS-NRSA CQS -JNTU SSS- ASCI	2,734	02.04.07 18.05.07 11.01.08		30 days 10 days 10 days	29-05-07	04.05.07 29.05.07 01.02.08
4. Improving flood forecast modeling	P-19	4.1 Development of DEM	Consultancy	Individual	1.2	12.06.07		1.5	10.12.07	31.03.08 completed
	P-20	4.2 Generation of customized rainfall forecasts	Consultancy	SSS - IMD	no cost	07.06.07		7		completed
	P-21	4.3 Develop models for improved flood forecasting	Consultancy	CQS	13.5	24.07.07		3 3	24.10.07 for pb-1	30.06.08
	P-24	4.4 Innovative inundation modeling	Consultancy	CQS						NOT TAKEN UP
5. Developing a plan for upgrading hydrologic measurements, telemetry and FMIS	P-22	5.1 Develop plan for strengthening hydrologic network, telemetry, etc	Consultancy	Individual	6	07.06.07		4	07.10.07	30.06.08
6. Updating Bihar flood control manuals	P-23	6.1 FMIS integration in flood management manuals and action plans, and institutional arrangements	Consultancy	Individual	6	25.05.07		4	25.09.07	31.05.08
		Provision for essential contingent expenditures involved in procurement process			<u>2,00</u>					
Total					219,271					

NRSA - National Remote Sensing Agency, BIRSAC - Bihar Remote Sensing Applications Centre, NCMRWF - National Centre for Medium Range Weather Forecasting, WALMI - Water and Land Management Institute, SSS- Single Source Selection, CQS - Consultants' Qualification based Selection, FMISC - Flood Management Information System Cell, DEM - Digital Elevation Model

Note:- underlined costs are estimated costs i.e for packages p-1.1b, p-15, p-17 & for contingent expenditures

JS
23/10/08
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Bihar FMIS
Interim Financial Reports (in Rs)

S.No	Activity	For the month Jan- March 2008		Cumulative YTD		Cumulative- Project	
		Plan	Actual	Plan	Actual	Plan	Actual
	Sources of funds						
	World Bank (Through GOI and GoB)	4,680,000	1,932,700	18,019,300	13,291,630	21,927,100	13,381,195
	Total Sources						
	Application of funds						
1	Preparation of FMIS	1,980,000	1,072,840	13,280,200	10,579,874	14,682,000	10,579,874
2	Creation of Flood Control Websites for Bihar	685,860	685,860	1,272,100	1,197,424	1,929,700	1,197,424
3	Training	420,000	174,000	620,000	449,332	1,273,400	449,332
4	Improving Flood Forecasting Module	1,341,000	0	1,707,000	465,000	2,642,000	465,000
5	Developing a plan for upgrading Hydrologic measurements	300,000	0	600,000	300,000	600,000	300,000
6	Updating Bihar Flood Control Manuals	300,000	0	600,000	300,000	600,000	300,000
	contingency					200,000	89,565
	Total	6,026,860	1,932,700	18,079,300	13,291,630	21,927,100	13,381,195

The necessary supporting documents including contracts substantiating this expenditure is retained at WALMI, Phulwarisharif, Patna & FMISC and are available for review.

23/5/08
23/5/08

BIHAR Flood Management Information System

Procurement Information

For the month Jan- March 08

30.04.08

Project activity	Sub Activity	Procurement Category	Procurement mode	Plan			Actual					
				Estimated value (Rs. lakhs)	Estimated value ('000 US \$)	Target date for contract award	Procurement Category	Procurement mode	Contract value (Rs. lakhs)	Contract value ('000 US \$)	Date of Award	Remarks
1. Preparation of FMIS	1.1 Preparation of Cartosat data mosaic of focus area	Consultancy	SSS - NRSA	30	66.66	31-Dec-06	Consultancy	SSS - NRSA	26.2	66.65	04.05.07	full payment made
	1.2 Generation of processed historic Radarsat and optical satellite data	Consultancy	SSS - NRSA	5	11.11	31-Dec-06	Consultancy	SSS - NRSA	5	12.719	04.05.07	full payment made
	1.3 Generation of processed 2007 flood status Radarsat and optical satellite data (as needed basis)	Consultancy	SSS - NRSA	6	13.33	31-May-06	Consultancy	SSS - NRSA	6	15.263	04.05.07	full payment made
	1.4 Developing additional database for integration in FMIS	Consultancy	SSS - BIRSAC	15	33.33	11-Oct-06	Consultancy	CQS	45	114.475	11.09.07	1st installment of Rs 9.0 lac paid to KOLTA
	1.5 Topographic map digitization as per FMIS specifications	Consultancy	SSS - Survey of India	8	17.77	10-Nov-06	Consultancy	SSS - Survey of India	7.725	19.651	08.06.07	full payment made
	1.6 FMIS facilitation and technical support	Consultancy	SSS - BIRSAC	16	35.55	30-Sep-06	Consultancy	SSS - BIRSAC	9.176	23.338	14.08.07	payment till 10.07 done, rest underway
	1.7 Develop modalities for for community outreach, preparedness, and flood management	Consultancy	CQS	5	13.33	15-Nov-06	Consultancy	Individual	6	15.263	24.05.07	payment of 2nd 30% released
	1.8 Computer Hardware for remote scanning and GIS software (2 Nos)	Goods	Shopping	4	8.88	15-Oct-06	Goods	Shopping	3.18	8.095	09.04.07	full payment made
	1.9 HP Designjet 500 PostScript printer (42 inch)	Goods	Shopping	2.5	5.55	15-Oct-06	Goods	Shopping	1.934	4.92	09.04.07	full payment made
	1.10.1 UPS	Goods	Shopping	3.7	8.22	15-Oct-06	Goods	Shopping	1.143	2.908	04.07.07	full payment made
	1.10.2 diesel generator	Goods	Shopping	3.7	8.22	15-Oct-06	Goods	Shopping	2.705	6.881	09.04.07	full payment made
	1.11 Remote scanning (ERDAS Imagine) software	Goods	Proprietary	10.7	23.77	15-Oct-06	Goods	Proprietary	9.625	24.484	01.03.07	full payment made
	1.12 GIS (ArcGIS) software	Goods	Proprietary	20	44.44	15-Oct-06	Goods	Proprietary	22	55.965	07.03.07	full payment made
	1.13 Oracle RDBMS (1 license), Windows XP Professional SP2+Autovirus software (enterprise version), Visual C++ (2 licenses), Visual Basic (2 licenses)	Goods	Shopping	2	4.44	15-Oct-06	Goods	Shopping	1.132	2.88	09.04.07	payment made
Sub Total				128.9	286.38			146.82	373.493			
2. Creation of flood control website for Bihar	2.1 Operational support	Consultancy	Least cost individual	19.5	43.33		Consultancy	not taken up individual	17.371	44.19	15.06.07	regular payment on monthly basis
	2.1.1 Hiring HR firm											
	2.1.2 Hiring individuals											
2.2 Flood website development, hosting and maintenance	Consultancy	CQS		10	22.22	30-Nov-06	Consultancy	inhouse development	1.926	4.9		prototype website already prepared & hosted
Sub Total				29.5	65.55			14.121	49.09			
3. Training	3.1 Consultancy for support to conduct of workshops, meeting and training	Training	Individual	4	8.888		Consultancy	Individual	4	10.175	25.03.07	payment of 2nd 30% released
	3.2 Implement programme	Training	SSS Consultancy	6	13.332				6	15.263		
	3.3.1 Training in satellite data processing and GIS at NRSA	training batch-I, batch-II	SSS-NRSA (batch-I) CQS (batch-II)	5	11.11	30-Nov-06	Consultancy	SSS-NRSA (batch-I) CQS (batch-II)	2.734	6.955	04.05.07	payment made to NRSA, INTU & ASCI
	3.3.2 Training on procurement	batch-III	SSS- ASCI									
Sub Total				15	33.33			12.734	32.393			
4. Improving flood forecast modeling	4.1 Development of DEM	Consultancy	Individual	1.2	2.67	15-Nov-06	Consultancy	Individual	1.2	3.051	12.06.07	payment of 1st 50% released, rest in process
	4.2 Generation of customized rainfall forecasts	Consultancy	SSS - NCMRWF	13	28.88	15-Nov-06	Consultancy	SSS - IMD	no cost		07.06.07	rainfall received regularly
	4.3 Develop models for improved flood forecasting and predicted inundation mapping	Consultancy	CQS	15	33.33	20-Nov-06	Consultancy	CQS	13.5	34.342	24.07.07	1st installment of Rs 4.05 lac paid to IIT D
	4.4 Innovative inundation modeling						Consultancy	CQS	5.00	12.719	29.02.08 exp	
Sub Total								28.42	67.209			
5. Developing plan for hydrologic measurements, telemetry and FMIS	5.1 Develop plan for strengthening hydrologic network, telemetry, etc	Consultancy	Individual	6	13.33	31-Dec-06	Consultancy	Individual	6	15.263	07.06.07	payment of 1st 50% released
Sub Total				6	13.33			6	15.263			
6. Updating Bihar flood control manuals	6.1 FMIS integration in flood management manuals and action plans, and institutional arrangements	Consultancy	Individual	6	13.33	30-Nov-06	Consultancy	Individual	6	15.263	25.05.07	payment of 1st 50% released
Sub Total				6	13.33			6	15.263			
Contingency								2	5.048			
Total				214.6	476.8 (1 \$= Rs 45)			219.211	557.800 (1 \$= Rs 39.31)			

23/5/08
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K.D. Shukla
Chief Engineer, PACT



PACT
U.P. Water Sector Restructuring Project
Irrigation Department, U.P.
Pakari Ka Pul, VIP Road,
Alambagh, Lucknow-226012
Ph: 0522-2422915 (322)

Dated : 5 June, 2008

Sub: Inspection of works of Naseerabad Dy System package B-5 under contract agreement no. 23/SE/07-08 dated 24-11-07.

Dear Mr. Javier,

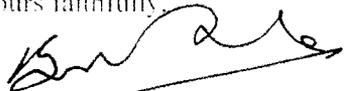
Please find enclosed herewith the report of inspection of works of Naseerabad Dy System on 20-05-08. This is for your information please.

With best regards,

Encls: As above

Mr. Javier Zuleta,
Senior Water Resource Specialist,
& Task Team Leader UPWSRP,
World Bank,
70- Lodi Estate, New-Delhi-110003

Yours faithfully,


(K.D. Shukla)

Govt. of Bihar
Finance Department

Letter No.- 38 | AF (E)

From

A V Chaturvedi,
Additional Finance Commissioner,
Finance Deptt. Govt. of Bihar

To

Madhusudan Prasad
Joint Secretary
Ministry of Finance
Room No. – 166 D, North Block
Dept. of Economic Affairs, Govt. of India
New Delhi

Patna/Dated:- 02.06.2008

Sub: - Regarding rescheduling FMIS Project Bihar project closure from 31 May to 30th June 2008-DFID Grant for Bihar Flood Management Information System of the Water Resources Dept. Govt. of Bihar under DFID – Bank Trust Fund for India Grant Numbers - TF 057071.

Ref: - Letter from Mr Dalip Kapur, Under Secretary (FB), Ministry of Finance, Department Economic Affairs, Govt. of India, F. No-3/1/2006-FB-III, Dated- 14th March, 2008

Sir,

The project has made substantial progress by now, with 14 procurement packages completed, and 6 more will be completed by the current closure date. The balance three packages will require additional three weeks beyond the current closure date. Status of the last three packages is given below:

1. P-4: Developing additional database for integration in FMIS.

Under this package twenty two data layers are being developed by the consultant ROLTA India Ltd. Out of these twenty two, twenty layers have been received by FMISC. These layers are being checked and corrections made on-site in Patna. Rest two layers are also being developed simultaneously. After getting all the corrected layers as per specification attributes will be attached to each layer and the quality check report of all deliverables will be submitted by the consultant. The whole process may take three more weeks and expected to complete by June 21, 08.

2. P-21: - Improved Flood Forecast Modeling: –This activity has been delayed due to delayed supply of data from IMD/ CWC. While the hourly rainfall data from IMD has been received, supply of hourly gauge data from CWC has been unduly delayed, and is now expected before end May. The FMISC has requested the consultant to provide additional resources on priority and complete it within one month by the end of June 2008.

3. P-22: - Strengthening Hydrologic Network and Telemetry: – The draft final report was submitted by the consultant and reviewed by the members of the technical committee. The committee has given few suggestions which have been communicated to the consultant to revise the report accordingly. The revised final draft report is awaited after further analysis and data collection. Submission of final report would require three more weeks.

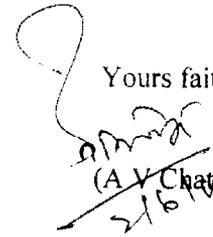
On the disbursement side we have submitted a claim of reimbursement for the quarter January – March 2008 for Rs. 133.81 lac against total project cost of Rs. 219.271 lac. Till date actual disbursement is Rs. 145.3 lac which will rise up to Rs. 152 lac (approx) i.e. nearly 70% of the total project cost by the present closure date 31st May 08.

In view of the above facts and circumstances, we request extension of closure date till 30th June 2008, which will help in completion of all the remaining activities and successful completion of this prestigious project.

Enclosures:

- i) Current physical and disbursement Status
- ii) IFR (1A & 1B) for quarter ending March 2008.
- iii) Updated Procurement Plan

Yours faithfully


(A.V. Chaturvedi)
2/6/08

Procurement Plan

23.05.08

Project activity	Package No.	Item	Procurement Category	Procurement mode	Actual / committed / estimated Value in Rs. Lakhs	date for contract award	Target date for contract award	Assignment duration (in months)	Expected /Actual Completion Date	Revised expected completion date
1	2	3	4	5	6	7	8	9	10	11
1. Preparation of FMIS	P-1	1.1 Preparation of Cartosat data mosaic of focus area	Consultancy	SSS - NRSA	20.2	04.05.07		1.5	05.11.07	completed
		1.1.a. Preparation of additional Cartosat mosaic of whole 11 districts	Consultancy	SSS - NRSA	6	27.10.07		1	05.11.07	completed
		1.1.b. Preparation of Cartosat mosaic of additional districts of North Bihar		SSS - NRSA	<u>10.853</u>		31.05.08		30.06.08	
	P-2	1.2 Generation of processed historic Radarsat and optical satellite data	Consultancy	SSS - NRSA	5	04.05.07		1.5	04.10.07	completed
	P-3	1.3 Generation of processed 2007 flood season Radarsat and optical satellite data (as needed basis)	Consultancy	SSS - NRSA	6	04.05.07		5	04.10.07	completed
	P-4	1.4 Developing additional database for integration in FMIS	Consultancy	CQS	45	11.09.07		4	31.10.07	30.06.08
	P-5	1.5 Topographic map digitization as per FMIS specifications	Consultancy	SSS- Survey of India	7.725	08.06.07		1.5	08/03/2007	completed
	P-6	1.6 FMIS facilitation	Consultancy	SSS - BIRSAC	8.158	14.08.07		14	31.10.07	31.12.07 completed
	P-7	1.7 Develop modalities for community outreach, preparedness, and flood management	Consultancy	Individual	6	24.05.07		4	23-09-07	31.05.08
	P-8	1.8 Computer for remote sensing and GIS software (2 Nos)	Goods	Shopping	3.182	09.04.07		0.5	13.06.07	completed
		1.9 HP Designjet 500 PostScript printer (42 inch)	Goods	Shopping	1.934	09.04.07		0.5	13.06.07	completed
		1.10.1 UPS + Battery	Goods	Shopping	1.143	09.04.07		0.5	13.06.07	completed
	P-9	1.10.2 Diesel generator	Goods	Shopping	2.705			0.5	15.07.07	completed
	P-10	1.11 Remote sensing (ERDAS Imagine) software	Goods	Proprietary	9.625	01.03.07		0.5	23.03.07	completed
	P-11	1.12 GIS (ArcGIS) software	Goods	Proprietary	22	07.03.07		0.5	30.03.07	completed
P-12	1.13 Oracle RDBMS (1 license), Windows XP Professional SP2+ Antivirus software (enterprise version), Visual C++ (2 licenses), Visual Basic (2 licenses)	Goods	Shopping	1.132	09.04.07		0.5	13.06.07	completed	
Noe-procurement item		Develop integrated FMIS database , develop and integrate application software, implement in Patna, and maintain for 1 year	Consultancy	SSS-NRSA		04.05.07		2.3		First version software by 31 Oct, second version and integrated database by 31.05.08
		Sub Total			156.657		C.O.			

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1	2	3	4	B. F.	145.804	7	8	9	10	11
2. Creation of flood website	P-13	Hiring HR firm	Not taken up							
	P-14	2.1. Hiring consultants for operational support	Consultancy	Individual	<u>18.620</u>	recruitment by FMISC		5	31.10.07	30.06.08
	P-15	2.2 Inhouse Flood website development and maintenance. i) hiring support staff ii) purchase of software for website development	Consultancy	individual shopping	<u>2.560</u>	In house by FMISC		4		30.06.08
3. Training	P-16	3.1 Plan Stakeholder workshops, meetings and training at Hqs and up to field office, and community level for support to conduct of workshops, meeting and training	Training	Individual	4	25.05.07		4	25.09.07	31.05.08
	P-17	3.2 Implement programme & plan of 3.1	Training		<u>6.00</u>	In house by WALMI		2		31.05.08
	P-18	3.3.1 Training in satellite data processing and GIS 3.3.2 Training on procurement Procedures for the World Bank aided projects	Training B-1 Training B-2 Training B-3	SSS-NRSA CQS -JNTU SSS- ASCI	2.734	02.04.07 18.05.07 11.01.08		30 days 10 days 10 days	29-05-07	04.05.07 29.05.07 01.02.08
4. Improving flood forecast modeling	P-19	4.1 Development of DEM	Consultancy	Individual	1.2	12.06.07		1.5	10.12.07	31.03.08 completed
	P-20	4.2 Generation of customized rainfall forecasts	Consultancy	SSS - IMD	no cost	07.06.07		7		completed
	P-21	4.3 Develop models for improved flood forecasting	Consultancy	CQS	13.5	24.07.07		3 3	24.10.07 for ph- 1	30.06.08
	P-24	4.4 Innovative inundation modeling	Consultancy	CQS						NOT TAKEN UP
5. Developing a plan for upgrading hydrologic measurements, telemetry and FMIS	P-22	5.1 Develop plan for strengthening hydrologic network, telemetry, etc	Consultancy	Individual	6	07.06.07		4	07.10.07	30.06.08
6. Updating Bihar flood control manuals	P-23	6.1 FMIS integration in flood management manuals and action plans, and institutional arrangements	Consultancy	Individual	6	25.05.07		4	25.09.07	31.05.08
		Provision for essential contingent expenditures involved in procurement process			<u>2.00</u>					
Total					219.271					

NRSA - National Remote Sensing Agency, BIRSAC - Bihar Remote Sensing Applications Centre, NCMRWF - National Centre for Medium Range Weather Forecasting, WALMI - Water and Land Management Institute, SSS- Single Source Selection, CQS - Consultants' Qualification based Selection, FMISC - Flood Management Information System Cell, DEM - Digital Elevation Model

Note:- underlined costs are estimated costs i.e for packages p-1.1b, p-15, p-17 & for contingent expenditures

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				B. F.	146.246	105.806	40.44	2.86	37.2		0.38 lac saving in above packages
1	2	3	4	5	6	7	8	9	10		11
2. Creation of flood website	P-13	Hiring HR firm									Not taken up
	P-14	2.1. Hiring consultants for operational support	Consultancy	Individual	17.371	11.614	5.757	3.5 (paid)	1.75	90%	0.507 lac saving, being reallocated to more satellite data procurement
	P-15	2.2 Inhouse Flood website development and maintenance, i) hiring support staff ii) purchase of software	Consultancy	individual shopping	<u>2.500</u>	0.36	2.140	0.6 (paid)	1.3	90%	English edition of website developed, Hindi version of website in progress, 0.24 lac saving of this package, being reallocated to additional satellite data
3. Training	P-16	3.1 Plan Stakeholder workshops, meetings and training at Hqs and up to field office, and community level for support to conduct of workshops, meeting and training	Training	Individual	4	2	2.000	1.2	0.8	80%	draft final report in final stage, expected by 24.05.08
	P-17	3.2 Implement programme & plan of 3.1	Training		<u>6.00</u>	5.5	0.5	0.5	nil	85%	all workshop conducted, activity completed
	P-18	3.3.1 Training in satellite data processing and GIS 3.3.2 Training on procurement Procedures for the World Bank aided projects	Training B-1 Training B-2 Training B-3	SSS-NRSA CQS -JNTU SSS- ASCI	2.734	2.734	nil	nil	nil	100%	completed
4. Improving flood forecast modeling	P-19	4.1 Development of DEM	Consultancy	Individual	1.2	0.600	0.600	0.6	nil	100%	completed
	P-20	4.2 Generation of customized rainfall forecasts	Consultancy	SSS - IMD	no cost	nil	nil	nil	nil	100%	completed
	P-21	4.3 Develop models for improved flood forecasting	Consultancy	CQS	13.5 lac Rs. 6.72 lakhs for Phase II of Package-I	4.050	9.45 6.72	nil	9.450	20%	CWC data delayed, will require extension for completion, the unused amount Rs. 6.72 lakhs for Phase-II Package- 21 is being reallocated to more satellite data procurement
	P-24	4.4 Innovative inundation modeling	Consultancy	CQS	<u>5.00</u>	nil	5.000	nil	nil	Not taken up	this unused amount Rs 5 lac is being reallocated to more satellite data procurement
5. Developing a plan for upgrading hydrologic measurement, telemetry and FMIS	P-22	5.1 Develop plan for strengthening hydrologic network, telemetry, etc	Consultancy	Individual	6	3.000	3.000	nil	3.00	50%	comments on Draft final report sent to the consultant to revise the Draft final report, will require extension for completion
6. Updating Bihar flood control manuals	P-23	6.1 FMIS integration in flood management manuals and action plans, and institutional arrangements	Consultancy	Individual	6	3.000	3.000	1.8	1.20	80%	Draft final report received on 19.05.08, reviewed by the review committee on 22.05.08, report again to be revised as per comments
		Provision for essential contingent expenditures involved in procurement process			<u>2.00</u>	0.9	1.100	0.5	0.6		
		Total			219.271	139.664	79.707	11.660	64.300	64%	total saving of Rs 13.847 lac being reallocated to more satellite data procurement and operational support
NRSA - National Remote Sensing Agency, BIRSAC - Bihar Remote Sensing Applications Centre, NCMRWF - National Centre for Medium Range Weather Forecasting, WALMI - Water and Land Management Institute, SSS- Single Source Selection, CQS - Consultants' Qualification based Selection, FMISC - Flood Management Information System Cell, DEM - Digital Elevation Model											
Note:- underlined costs are estimated costs i.e for packages p-15, p-17, p-24 & for contingent expenditures											

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disbursement status 23.05.08											
Project activity	Package No.	Item	Procurement Category	Procurement mode	Actual / committed / estimated Value in Rs. Lakhs	disbursement till 30.04.08	Balance amount lakhs	disbursement plan		current status/ % completion	remarks
								by May 08	by June 08		
1	2	3	4	5	6	7	8	9	10	11	
1. Preparation of FMIS	P-1	1.1 Preparation of Cartosat data mosaic of focus area	Consultancy	SSS - NRSA	20.2	20.2	nil	nil	nil	100%	completed
		1.1.a Preparation of additional Cartosat mosaic	Consultancy	SSS - NRSA	6	6	nil	nil	nil	100%	
	P-2	1.2 Generation of processed historic Radarsat and optical satellite data	Consultancy	SSS - NRSA	5	5	nil	nil	nil	100%	
	P-3	1.3 Generation of processed 2007 flood season Radarsat and optical satellite data (as needed basis)	Consultancy	SSS - NRSA	6	6	nil	nil	nil	100%	
	P-4	1.4 Developing additional database for integration in FMIS	Consultancy	CQS	45	9.00	36.000	nil	36.000	36%	20 layers out of total 22 received, rest 2 layers along with QC report are also simultaneously being prepared corrections in these layers are being done by ROLTA staff in FMISC
	P-5	1.5 Topographic map digitization as per FMIS specifications	Consultancy	SSS - Survey of India	7.725	7.725	nil	nil	nil	100%	completed
	P-6	1.6 FMIS facilitation	Consultancy	SSS - BIRSAC	8.600	7.16	1.440	1.06 (paid)	nil	100%	0.38 lac is saving, being reallocated to more satellite data procurement
	P-7	1.7 Develop modalities for community outreach, preparedness, and flood management	Consultancy	Individual	6	3	3.000	1.8	1.2	80%	preparation of draft final report in final stage, expected on 21st May 08
	P-8	1.8 Computer for remote sensing and GIS software (2 Nos)	Goods	Shopping	3.182	3.182	nil	nil	nil	100%	completed
		1.9 HP Designjet 500 PostScript printer (42 inch)	Goods	Shopping	1.934	1.934	nil	nil	nil	100%	completed
		1.10.1 UPS + Battery	Goods	Shopping	1.143	1.143	nil	nil	nil	100%	completed
	P-9	1.10.2 Diesel generator	Goods	Shopping	2.705	2.705	nil	nil	nil	100%	completed
	P-10	1.11 Remote sensing (ERDAS Imagine) software	Goods	Proprietary	9.625	9.625	nil	nil	nil	100%	completed
	P-11	1.12 GIS (ArcGIS) software	Goods	Proprietary	22	22	nil	nil	nil	100%	completed
	P-12	1.13 Oracle RDBMS (1 license), Windows XP Professional SP2+ Antivirus software (enterprise version), Visual C++ (2 licenses), Visual Basic (2 licenses)	Goods	Shopping	1.132	1.132	nil	nil	nil	100%	completed
Non-procurement item		Develop integrated FMIS database, develop and integrate application software, implement in Patna, and maintain for 1 year	Consultancy	SSS-NRSA							2nd version has been developed by NRSA, expected by 31.05.08
		Sub Total			146.246	105.806	40.44	1.8	37.2		0.38 lac saving in above packages

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Bihar FMIS
Interim Financial Reports (In Rs)

S.No	Activity	For the month Jan- March 2008		Cummulative YTD		Cummulative- Project	
		Plan	Actual	Plan	Actual	Plan	Actual
	Sources of funds						
	World Bank (Through GOI and GoB)	4,690,000	1,932,700	18,019,300	13,291,630	21,927,100	13,381,195
	Total Sources						
	Application of funds						
1	Preparation of FMIS	1,980,000	1,072,840	13,280,200	10,579,874	14,682,000	10,579,874
2	Creation of Flood Control Website for Bihar	685,860	685,860	1,272,100	1,197,424	1,929,700	1,197,424
3	Training	420,000	174,000	620,000	449,332	1,273,400	449,332
4	Improving Flood Forecasting Module	1,341,000	0	1,707,000	465,000	2,642,000	465,000
5	Developing a plan for upgrading Hydrologic measurements	300,000	0	600,000	300,000	600,000	300,000
6	Updating Bihar Flood Control Manuals	300,000	0	600,000	300,000	600,000	300,000
	contingency					200,000	89,565
	Total	6,026,860	1,932,700	18,079,300	13,291,630	21,927,100	13,381,195

The necessary supporting documents including contracts substantiating this expenditure is retained at WALMI, Phulwarisharif, Patna & FMISC and are available for review.

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BIHAR Flood Management Information System

Procurement Information

For the month Jan- March 08

30.04.08

Project activity	Sub Activity	Procurement Category	Procurement mode	Plan			Actual					
				Estimated value (Rs. lakhs)	Estimated value ('000 US \$)	Target date for contract award	Procurement Category	Procurement mode	Contract value (Rs. lakhs)	Contract value ('000 US \$)	Date of Award	Remarks
1. Preparation of FMIS	1.1 Preparation of Cartosat data mosaic of focus area	Consultancy	SSS - NRSA	39	66.96	31-Dec-06	Consultancy	SSS - NRSA	29.2	52.65	04.05.07	full payment made
	1.2 Generation of processed historic Radarast and optical satellite data	Consultancy	SSS - NRSA	5	11.11	31-Dec-06	Consultancy	SSS - NRSA	5	12.719	04.05.07	full payment made
	1.3 Generation of processed 2007 flood season Radarast and optical satellite data (as needed basis)	Consultancy	SSS - NRSA	6	13.33	31-May-06	Consultancy	SSS - NRSA	6	15.263	04.05.07	full payment made
	1.4 Developing additional database for integration in FMIS	Consultancy	SSS - BIRSAC	15	33.33	11-Oct-06	Consultancy	CQS	45	134.475	11.09.07	1st installment of Rs 9.0 lac paid to ROLTA
	1.5 Topographic map digitization as per FMIS specifications	Consultancy	SSS- Survey of India	8	17.77	10-Nov-06	Consultancy	SSS- Survey of India	7.725	19.651	08.06.07	full payment made
	1.6 FMIS facilitation and technical support	Consultancy	SSS - BIRSAC	16	35.55	30-Sep-06	Consultancy	SSS - BIRSAC	9.174	23.338	14.08.07	payment till 10.07 done rest underway
	1.7 Develop modalities for for community outreach, preparedness, and flood management	Consultancy	CQS	6	13.33	15-Nov-06	Consultancy	Individual	6	15.262	24.05.07	payment of 2nd 30% released
	1.8 Computer Hardware for remote sensing and GIS software (2 Nos)	Goods	Shopping	4	8.88	15-Oct-06	Goods	Shopping	3.182	8.095	09.04.07	full payment made
	1.9 HP Designjet 590 PostScript printer (42 inch)	Goods	Shopping	2.5	5.55	15-Oct-06	Goods	Shopping	1.954	4.92	09.04.07	full payment made
	1.10.1 UPS	Goods	Shopping	3.7	8.22	15-Oct-06	Goods	Shopping	1.143	2.908	04.07.07	full payment made
	1.10.2 diesel generator	Goods	Shopping	3.7	8.22	15-Oct-06	Goods	Shopping	2.705	6.881	09.04.07	full payment made
	1.11 Remote sensing (ERDAS Imagine) software	Goods	Proprietary	10.7	23.77	15-Oct-06	Goods	Proprietary	9.625	24.484	01.03.07	full payment made
	1.12 GIS (ArcGIS) software	Goods	Proprietary	20	44.44	15-Oct-06	Goods	Proprietary	22	55.965	07.03.07	full payment made
	1.13 Oracle RDBMS (1 license), Windows XP Professional SP2+Antivirus software (enterprise version), Visual C++ (2 licenses), Visual Basic (2 licenses)	Goods	Shopping	2	4.44	15-Oct-06	Goods	Shopping	1.137	2.88	09.04.07	payment made
Sub Total				128.9	286.38				145.82	373.493		
2. Creation of flood control website for Bihar	2.1 Operational support	Consultancy	Least cost individual	19.5	43.33		Consultancy	not taken up	17.371	44.19	15.06.07	regular payment on monthly basis
	2.1.1 Hiring HR firm											
	2.1.2 Hiring individuals							Individual				
	2.2 Flood website development, hosting and maintenance	Consultancy	CQS	10	22.22	30-Nov-06	Consultancy	inhouse development	1.926	4.9		prototype website already prepared & hosted
Sub Total				29.5	65.55				14.121	49.09		
3. Training	3.1 Consultancy for support to conduct of workshops, meeting and training	Training	Individual	4	8.888		Consultancy	Individual	4	10.175	25.05.07	payment of 2nd 30% released
	3.2 Implement programme	Training	SSS Consultancy	6	13.332				6	15.263		
	3.3.1 Training in satellite data processing and GIS at NRSA	training batch-I, batch-II	SSS-NRSA (batch-I) CQS (batch-II)	5	11.11	30-Nov-06	Consultancy	SSS-NRSA (batch-I) CQS (batch-II)	2.734	6.935	04.05.07	payment made to NRSA, JNTU & ASCI
	3.3.2 Training on procurement		SSS- ASCI					SSS- ASCI				
Sub Total				15	33.33				12.734	32.393		
4. Improving flood forecast modeling	4.1 Development of DEM	Consultancy	Individual	1.2	2.67	15-Nov-06	Consultancy	Individual	1.2	3.053	12.06.07	payment of 1st 50% released, rest in process
	4.2 Generation of customized rainfall forecasts	Consultancy	SSS - NCMRWF	13	28.88	15-Nov-06	Consultancy	SSS - IMD	no cost		07.06.07	rainfall received regularly
	4.3 Develop models for improved flood forecasting, and predicted inundation mapping	Consultancy	CQS	15	33.33	20-Nov-06	Consultancy	CQS	13.5	34.342	24.07.07	1st installment of Rs 4.05 lac paid to IIT U
	4.4 Innovative inundation modeling		NEW ACTIVITY				Consultancy	CQS	5.00	12.719	29.02.08 exp	
Sub Total								26.42	67.209			
5. Developing plan for hydrologic measurements, telemetry and FMIS	5.1 Develop plan for strengthening hydrologic network, telemetry, etc	Consultancy	Individual	6	13.33	31-Dec-06	Consultancy	Individual	6	15.263	07.06.07	payment of 1st 50% released
	Sub Total			6	13.33				6	15.263		
6. Updating Bihar flood control manuals	6.1 FMIS integration to flood management manuals and action plans, and institutional arrangements	Consultancy	Individual	6	13.33	30-Nov-06	Consultancy	Individual	6	15.263	25.05.07	payment of 1st 50% released
	Sub Total			6	13.33				6	15.263		
	Contingency							2	8.088			
Total				214.4	476.8 (15 = Rs 45)				219.271	557.809 (15 = Rs 39.31)		

23/5/08 Panayya 23/5

**Govt. of Bihar
Finance Department**

Letter No.- 39/AFC/E

From

A V Chaturvedi,
Additional Finance Commissioner,
Finance Deptt. Govt. of Bihar

To

Madhusudan Prasad
Joint Secretary
Ministry of Finance
Room No. - 166 D, North Block
Dept. of Economic Affairs, Govt. of India
New Delhi

Patna/Dated:- 02.06.2008

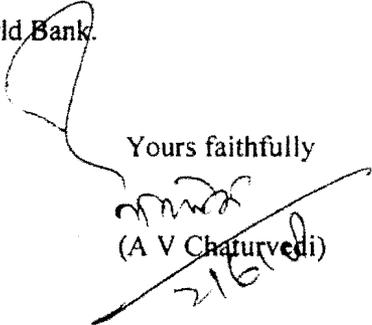
Sub: - Submission of Grant proposal of FMIS (Phase II) Bihar Project under Water Resources Dept. Govt. of Bihar.

Sir,

The project closure date of FMIS (Phase I) Bihar Project -DFID Grant for Bihar Flood Management Information System of the DFID – Bank Trust Fund for India Grant Numbers - TF 057071 is 31 May 2008. The project activities are nearly complete Therefore we are in a position to the move on to the next follow on phase of this project i.e FMIS (Phase II) Bihar Project. A Grant proposal for Phase II worth Rs 11.92 crore (equivalent to US \$ 3.03 million @ 1 US \$= Rs 39.31) has been prepared and is submitted for the consideration of the World Bank.

Enclosures: as above

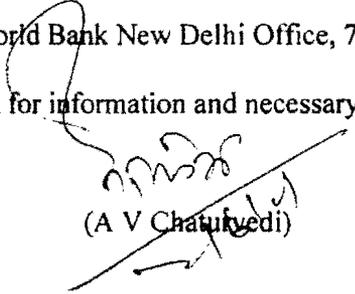
Yours faithfully


(A V Chaturvedi)

Letter No. - 39/AFC/E

Patna/Dated:- 02.06.2008

- Copy to: 1. Javier Zuleta, Senior Water Resources Specialist, World Bank
2. Mr Dalip Kapur, Under Secretary (FB), Ministry of Finance, Department of Economic Affairs, Govt. of India
3. Ms. Isabel Guerrero, Country Director, The World Bank New Delhi Office, 70-Lodhi Estate, New Delhi
4. Mandakini Kaul, Country Officer, World Bank for information and necessary action.


(A V Chaturvedi)

Funding Proposal For Recipient Executed Window

DFID Trust Fund to Enhance Bank Effectiveness in Enabling Reforms and Poverty Reduction in Support of Government of India's Five-year Plan (TF054784)

1. Title of proposed activity: Bihar Flood Management Information System Phase II
2. Recipient: Government of India
3. Implementing Entities: **WATER RESOURCES DEPARTMENT GOVT. OF BIHAR, PATNA**
4. Contact Information: **WATER RESOURCES DEPARTMENT**
 Sinchai Bhawan, Patna
 Pin – 800 015
 Tel – 0612-2217040
 Fax – 0612- 2215850
 E-mail – wrd.bih@nic.in

 Bihar Flood Management Information System Cell
 2nd Floor, Jal Sansadhan Bhawan
 Anisabad, Patna – 800 002
 Ph + Fax – 0612- 2256999
 E-mail : - finisc_bihar@yahoo.co.in
5. World Bank Contact Person: **Javier Zuleta, Senior Water Resources Specialist**
 71, Lodhi Estate, New Delhi.
6. Theme/Sector: **Water Resources Management, Flood Management**
7. Timeframe for Program Implementation: July 2008 to December 2010
8. Amount Requested (in US\$) \$: 3.03 million
9. Objectives of proposed activity: Attached with other details

63
65

INDIA

Bihar Flood Management Information System Proposal for Technical Assistance for Phase II of FMIS

A. Sector Context

Bihar is India's most flood-prone State, with 76 per cent of the population in the north living under the recurring threat of flood devastation, and being the poorest state of India, the MDG indicators are the lowest in India. The Government of Bihar has identified improvement of flood management as a priority area for all-round development of the State. The flood management so far has focused mostly on structural interventions (embankments, town/village protection, river training works, and river bank protection), and annual programme covering river training and bank protection works, drainage sluice works, and raising and strengthening of embankments. Non-structural interventions covered mainly flood forecasting by Central Water Commission (CWC) and empirical flood flow forecasting by WRD to support non-structural interventions. Flood plain zoning for regulation of flood plain activities is yet to be undertaken. The Second Bihar Irrigation Commission (1994) reiterated that flood management needs to "form part of the overall comprehensive plan for optimum development of water resources of a basin". The large scale flood damages in 2007 flood season has again reiterated the need for a comprehensive flood management strategy in the State, instead of ad-hoc and isolated interventions, covering an optimum suite of management interventions.

Bihar accounts for 16.5% of the flood-prone area and 22.1% of the flood-affected population in India. The flood prone area in Bihar accounts for 73 percent of its geographical area, and 76 percent of North Bihar, while the area protected by structural interventions is only 43 percent of Bihar area, and 68 percent of North Bihar area. Flood damage is about 30 to 40 percent of all India damages. The rivers that regularly inundate the plains are the Ganga, Kosi, Burhi Gandak, Kamla, Adhwara group, Bagmati, and Gandak in north Bihar, and lower reaches of Sone and Punpun rivers in south Bihar.

The plains of Bihar, adjoining Nepal, are drained by a number of rivers that have their catchments in the steep and geologically nascent Himalayas. Torrential rains in the Nepal Himalayas have made these rivers in north Bihar- including the Ghaghra, the Gandak, the Burhi Gandak, the Bagmati¹, the Bhutahi Balan, the Kamala, the Kosi and the Mahananda - carry high discharge and very high sediment load² down to the plains. Once the rivers enter the plains much of the silt begins to settle, raising the beds of the rivers³, shrinking their channels, blocking their flow. The rivers cut fresh paths through the sediment in the subsequent monsoon season.

The flood are caused by inadequate carrying capacity and over-bank flow in un-embanked rivers, through gaps in embankment or embankment breaches and cuts, inadequate waterways in rail and road bridges, non-operation of sluice gates during floods, concurrent floods in main river and tributary, silting and change in river course and avulsion, drainage congestion behind and between embankments, drainage congestion between embankments of main river and tributaries, and impeded natural drainage and water logging caused by micro-relief.

¹ Includes the Adhwara group of rivers

² Monsoon silt load can be as much as 99 million tones in Burhi Gandak river, and ranges from 76 to 95 million tones in other rivers

³ The comparison of topographical the surveys conducted in 1989 and 2006 in Bagmati river at Benibad (2/3 of the length in India), indicates that the raise of the river-bed in Bagmati is 2 meters on an average reaching 4 meters in certain critical reaches.

Drainage management, crucial to mitigate the impact of floods, has not been given its due importance. The Master Plan on Drainage developed in the seventies needs to be reviewed and upgraded. The drainage schemes implemented to relieve water-logging in about 1.5 lakh ha have become dysfunctional due to no maintenance⁴. The NABARD loan of about Rs. 350 crores in 2005-06 has been used only for initiating 13 schemes, of which only two schemes have been completed. The remaining 15 schemes originally proposed have been withdrawn due to higher proposed unit cost, with GoB deciding to execute these schemes out of State or centrally sponsored Command Area Development (CAD) funds at Rs. 4,000 per ha. Considering this shortage of financial resources, GoB has decided to restrict the drainage rehabilitation activities to those areas where standing waters can be easily drained before the Rabi sowing season (November 15th), covering about 30 percent of total waterlogged area only. So that this reclaimed land will be available for Rabi cultivation, and the residual inundated area could be used for developing fisheries and other aquaculture related activities.

In the past three to four decades, the population has grown rapidly and human occupation of the flood plains of the river has reached alarming proportions, resulting in increasing damages. It has been estimated that, from 1999 to 2005, the flood damages reached Rs. 2655 crores (USD 531 millions). The capital expenditure on flood protection and drainage works each year amounts to Rs. 64.43 crores (USD 13 millions), and Rs. 108.54 crores (USD 21.5 millions) in revenue expenditure. The flood in 2007 was again very destructive affecting more than 190 blocks in 19 districts, and 32 embankment breaches, causing widespread damage to lives, crops and public and private property estimated at Rs. 331913 lakhs. The GoB requested for immediate central assistance of Rs. 521 crores to restore the basic public damaged assets and systems.

B. On-going Technical Assistance

A World Bank Technical Assistance (TA) with DFID Trust Fund is currently under way to implement the first stage of the Flood Management Information System (FMIS) to improve flood management in the State. The TA was agreed in Aug 06 and is scheduled for closure on May 31, 2008. The substantial progress made in the first phase and the compelling need for technical enhancements and horizontal expansion to cover the whole flood-prone area in the State is the basis for the next phase of FMIS Phase II in the four-stage development framework.

C. Proposal for FMIS Phase II

The second and next phase of FMIS is planned at an estimated outlay of about US \$ 3.33 millions (Rs.13.11 crores), with the following inter-related elements: a) develop a comprehensive Embankment Management Information System (EMIS) to sustain protection to flood-prone areas; b) upgrade knowledge base on flood hazard and extend to all flood prone districts of North Bihar c) upgrade timely and appropriate flood information generation and delivery systems for better institutional and community preparedness in selected river basins; d) Improve community participation and outreach, and e) facilitate sharing of international knowledge and experience in developing appropriate FMIS.

The strategy in Phase II would be to build upon the achievements in the earlier phase, with expanded geographic coverage (21 districts of North Bihar) and technical enhancements. Horizontal expansion would vary with the sub-component. The piloting of technical enhancements takes note of inter-connectivity between project sub-components, and fund constraints.

⁴ The FY 2007-08 the budget for drainage is only Rs. 308 lakhs, about Rs. 32 per ha of total waterlogged area in Bihar. The budget provision covers only completion of on-going schemes and investigation of new schemes, but does not include maintenance activities. This source of funding is a NABARD loan for Rs. 179 lakhs.

Geographical Coverage of Project Components

Component	Activity and Linkages	Geographic coverage
1.1 Expansion of spatial database	Preparation of spatial data sets for additional 10 Districts, integration with existing FMIS	Whole north Bihar
1.2 Surveys	1.2.1 Close-contour survey, input to 1.4.4	Bagmati basin
	1.2.2 River survey, input to 1.4.3	Bagmati, Kamla and Burhi Gandak basin
	1.2.3 Embankment survey, input to 1.5	Bagmati, Kamla and Burhi Gandak basin
1.4 Improved predictive models	1.4.3 Flood forecast model, input to 1.5, 1.4.4	Bagmati, Kamla and Burhi Gandak basin
	1.4.4 Inundation model, input for community outreach	Bagmati basin
	1.4.5 River migration model	Bagmati, Kamla, BurhiGandal and Gand rivers
1.5 Embankment Management System	Inputs from 1.1, 1.2.2, 1.2.3, 1.4.3, and 1.4.5	Bagmati, Kamla and Burhi Gandak basin
2.1 Strengthening community outreach, ground data collection/reporting	Inputs from 1.4.3, 1.4.4; input to 1.1.3, 1.4.4	Bagmati basin
2.2 Community participation for embankment protection	Inputs from 1.5	Pilot in Bagmati basin

C.1 Objective

The main objective of the proposed activity is to significantly upgrade existing FMIS into a more effective management tool for sustainable and community participated flood management in Bihar State

C.2 Description of Project Components

The critical FMIS project activities, outputs and outcomes are described in Annex 1. The detailed activities, outputs and outcomes and the cost is shown in Annex 2. The project components are described in detail in subsequent sections.

1. Upgrading Knowledge Base

1.1 Upgrading/ expansion of existing spatial database: The flood database developed in Phase I will be expanded to cover additional ten flood-prone districts of North Bihar. The expanded database would include LISS III and Cartosat I satellite imagery (2.5 m spatial resolution), and thematic maps from the satellite datasets. These satellite data have been selected, though data of better spatial resolution is available, to provide consistent spatial data sets across the whole project area. The upgraded knowledge base will enable dissemination of customized inundation maps to key GoB agencies for effective emergency management, and to plan flood mitigation in the extended coverage of twenty one districts.

1.2 Surveys

1.2.1 Ground based close contour survey: Detailed topographic data (20 cm contour interval) is essential for inundation modeling in the very flat flood plains of North Bihar. This survey will be restricted to Bagmati only in view of the high cost and need to complete the survey within the project period. The close-contour topographic data would enable inundation modeling and community alerts, and flood plain zoning to support flood insurance and regulation of flood plain activities.

1.2.2 First time river (longitudinal and cross-sectional) survey: The rivers of North Bihar has been continuously swinging, meandering and changing course due to the excessive silt load carried by them and the flat slope. So the past river surveys, which were typically needed for DPRs and hence restricted in coverage, is no longer relevant or adequate. Current cross-sectional details of Bagmati, Kamla and Burhi Gandak rivers will enable development of improved flood forecast modeling in these rivers. It may be noted that cross-sectional survey of Bagmati River is already being carried out by the Water Resources Department, Bihar. Additional and fresh survey of Kamla (120 km) and Burhi Gandak (320 km) rivers is proposed.

1.2.3 Survey of Embankment and relevant flood plain features: Data is needed on current details and physical status of existing embankments and roads in the flood plains to be used in the development of Embankment Management Information System (EMIS), and for use in Flood Forecast Model and Innovative Inundation Model. Existing embankments along Burhi Gandak, Bagmati, and Kamla rivers, and all important roads in the adjacent flood plain will be covered. Approximate length of all embankments and roads is around 1510 km and 1000 km respectively.

The data base would include:

- Alignment – alignment of embankments and roads will be obtained by measuring latitudes and longitudes at suitable intervals (1km or less) and key locations using GPS.
- Photos – The features will be photographed to depict the deteriorated condition as and where required. Camera of not than 10 mega pixel will be used.
- Longitudinal and cross section – Embankments will be surveyed to prepare longitudinal and cross section. Cross sections will be taken at interval of 30m and extend at least 100m beyond toes and heels. Roads will be surveyed to prepare longitudinal sections.
- Structural Information – Structures existing along embankments and roads such as bridges, anti-flood-sluice gates, spurs etc. will be surveyed to gather information like locations, types, measurements of visible dimensions, conditions (working, damaged, repairable, chocked etc.) and any other relevant information.
- Maintenance history – It will be collected from the respective Divisions of WRD, Bihar for last ten years.
- Breach history - It will be collected from the respective Divisions of WRD, Bihar for last ten years.
- River Morphology – Information on river morphological change will be gathered from fields. This will help in the validation of the satellite data.
- Any other features – Any other relevant features, natural or manmade, found in the flood plain will be surveyed and reported.

Delivery – All above data will be prepared and delivered in GIS format compatible with the software available in FMISC

1.3 Upgrading Hydrologic Network

1.3.1 Improving ground rain gauge network (IMD/ State Govt. network): This includes: i) as an immediate measure, seven rain gauge stations would be located in Water Resources Division offices in the upstream part of Bagmati, Kamla and Burhi Gandak basins, in which flood forecast models are to be developed. A consultancy will be procured for planning augmentation of rainfall stations based on adequacy, reliability, functional status of existing stations and information flow for flood prone districts of Bihar covering twenty one districts. The study done in FMIS Phase-1 is going to recommend the raingauge network in Kosi, Bagmati, Kamla and Adhwara and Burhi Gandak basin. The improved ground rain gauge network planning augmentation will now cover Gandak, Mahananda basin. The network augmentation will be based on requirements from flood monitoring and forecasting requirements. It would involve upgrading of CWC, IMD & DSO rainfall stations (eg Darbhanga, Minapur etc.) and installation of ARGIS at WRD divisions located adjacent to border with Nepal, ensuring readiness of stations to transmit in real time rainfall. The upgrading of CWC and IMD stations has not been costed, and will be completed with concerned Agency funds under agency plans in 11th five year plan. FMIS will negotiate agreements for near-real time reporting of rainfall data. The implementation will follow after the consultancy for planning network augmentation is completed.

1.3.2 Improved river gauge reporting by CWC: Appropriate arrangements and protocols would be developed and agreed for near-real time transmission of daily and hourly river gauge measurements at CWC sites as well as at cooperative sites in Nepal, through the CWC, Patna office. No cost is involved.

1.3.3 Installation and operation of flood plain gauges: Ground data on inundation occurrence, depth and duration in the flood plain, which is currently not measured, is needed for inundation model development and validation. The ground data on water level and heavy rainfall occurrence would be measured and reported by identified local community groups. Necessary training would be imparted for effective community participation. The first implementation activity will be the installation of flood plain gauges. At least one plain gauge would be installed at an appropriate location in 200 villages in the typically flood prone areas in the Bagmati (including Adhwara group) flood plains as trial basis.

1.4 Improved Prediction Models

1.4.1 Improved medium range weather forecasting: An MOU is already in place with IMD for rainfall forecast covering North Bihar and Nepal portion of river basins, and is providing forecasts at 45 km resolution, 6 hourly interval and three days in advance. Initial validation has indicated that the forecast accuracy and reliability require improvement. The current MOU will be extended to cover improved forecasts at 5 km resolution, based on improved prediction models, and is expected to better represent expected rainfall at ground and extended focus area now covers entire North Bihar. As this development is to be undertaken by IMD and no cost is involved

1.4.2 Improved climate forecast applications (World Bank executed): Experience in Bangla Desh has shown that Climate Forecast Application (CFA) models could provide longer-term

(6)

forecasts, to support better ground preparedness. The CFA model would depend as little as possible on in situ data from the Nepal reaches of north Bihar Rivers but would depend data from satellite, model data from international organizations such as NOAA National Center for Environmental prediction (NOAA/NCEP) and the European Center for Medium Range Weather Forecasts (ECMWF). Forecasts would be made on times scales ranging from days to months. The short-term (1-6 day) forecasts would have great utility. The basic aim is to generate discharge forecasts at the international boundary with Nepal, which will be coupled to the flood forecasts in north Bihar, developed under other sub-components. Together, the coupled scheme could provide forecasts up to 8 days, possibly allowing early decisions for flood mitigation and disaster management, particularly useful in the agricultural sector. The medium range forecasts (20-25 days) will have maximum applicability to agriculture and disaster mitigation. It is possible to make adjustments to agricultural planning and water management. In addition, it provides a sufficient forewarning so that resources can be marshaled aid and for disaster mitigation. The long-range forecasts (1-6 months) provide an overview of expectations for climate. Currently, they are the least developed of the forecasting tools. The forecasts depend on the long-term forecasts prepared by ECMWF. CFA model needs to adapt these forecasts to allow the determination of discharge into Bihar. Long range climate models have been developed by IMD in India, and are continuously upgraded to increase resolution in the spatial and temporal dimensions. The proposed CFA model would also explore developments in India by IMD and NCMRWF for integration in medium and long term CFA models.

1.4.3 Improved flood forecasting modeling: The consultancy study to improve flood forecast model is under preparation for Bagmati basin under phase I. This model development will be validated and the ground truth needs to be established. If the on going work spills on account of some unavoidable circumstances, then this will be a critical component that would need to be finished urgently. The model development for flood forecasting for Burhi Gandak and Kamla (including Adhwara group) will also be considered as critical component and will be based on the successful implementation of the model development undertaken in first Phase. This model will be an improved one which would come from improved hydrologic database, improved hydrologic network, high resolution rainfall forecasts, and morphometric data from river cross-sectional survey, embankment survey, and river morphology trend study.

1.4.4 Inundation modeling: The consultancy study would cover development of 1D/2D hydrodynamic models for different river segments, with close contour topographic data over full Bagmati basin, (including Adhwara group). As close contour topographical survey would cover flood plain of Bagmati basin, (including Adhwara group) the flood inundation model is to be developed for such flood plains only.

1.4.5 River Migration Model: The Rivers in North Bihar continuously change course and can swing significantly between the embankments, impacting the safety of the embankment. It is hence essential to study the change in river morphology over a period of at least ten years to identify vulnerable embankment reaches and to predict short to medium term trend for longer term planning for strengthening flood control works like embankments, spurs, and bank protection. Trend modeling would require high resolution satellite imagery of at least ten years, covering pre and/ or post-flood seasons. The morphology trend model would require mapping river configuration (river bank, active channels, sand bars, stable and unstable reaches, actual and potential bank erosion location and severity, drainage block location and type, etc),

157
(59)

developing an Artificial Neural Network (ANN) based trend model for predicting short to medium term changes. The trend model would be continuously updated to reflect most recent river morphology regime. This would be a valuable input to the Embankment Management System.

1.5 Development of Embankment Management System

1.5.1 Develop “Embankment Management System (EMS): The EMS will support flood management functions including maintenance of existing embankment, anti-erosion works, flood fighting works etc and planning of new flood control structures. All administrative and technical details will be stored in this user-friendly GIS application for analysis and planning. The software will have tools for visualization of embankments as 2D/3D maps as well as retrieving cross sections with details at any given location of Embankment. Modules for asset management including annual maintenance schedule, surveillance schedule, etc will also be developed.

1.6 Infrastructure Augmentation

1.6.1 Hardware & Software: - In view of expanded geographic coverage and technical enhancements in Phase II, additional licenses for image processing software (4 no) and GIS software (3 no) would be required which are being procured from WRD funding independently. Since the Bihar flood website developed in the first phase is the primary public information dissemination tool, a dedicated system for Web development and data entry and dynamic updating is required. A high speed communication network is required for the Web and Database servers. To archive the large number of information products that would be generated, a Storage & Backup solution is also required. Software procurement for in-house web development would include upgrading of visual basic and visual C++ procured in phase I. Adobe creative suit, Dream weaver CS3, Flash CS 3 Professional, Photoshop CS3, Fireworks CS3, In design Flash menu builder factory, Flash Slide show maker, Web server software.. Map server, Map toolkit, Microsoft Visual web developer 2008, and of course Licensed Antivirus & anti Spyware software. Mobile field data collection and mapping support is required for in field creation of GIS database by WRD field staff through PDA, ArcPad & GPS systems

- **1.6.2 Incremental O and M:** To upgrade and sustain the technical capacity of the Cell there is need for continuing five professional specialist (RS Specialist, GIS Specialist, Flood Management Specialist, Database Specialist and Web Master- one each) support for at least twenty more months (the project duration is 30 months). It is also essential to maintain the systems procured in Phase I and proposed in Phase II. The need of a system manager to look after the systems and to ensure their continuous uninterrupted functioning is highly needed. During implementation, officers/Specialist Staff will have to travel within and outside the state to expedite the implementation process. For the same, provision for incurring cost of travel and also for hiring a vehicle has been made separately.

1.6.3 Operational support from NRSA: Agreement with National Remote Sensing Agency (NRSA) concluded in the first phase will be extended for Phase-II period also.

2. Improved Community Participation

2.1 Strengthening Community Outreach and ground data collection and reporting:

The Consultancy study for planning and implementing modalities for community outreach will include community level study of existing modes of communication regarding flood preparedness and flood management in Bagmati Basin, where flood inundation model is to be developed. This will be a continuation and intensifications of the study conducted in FMIS Phase I, focusing on community alert systems and protocols. Implementation of alert system and protocols will require training of community members who will receive the data and disseminate within the community.

For improvement and validation of flood forecast model and inundation model, and development of inundation model for the flood plain away from main rivers, spatial data at ground level on rainfall incidence and inundation is required. Extent, depth (measured by flood plain gauge) and duration of inundation will be reported by community members. Incidence of heavy rainfall would also be reported to the FMIS Cell on real time basis. This can be done by PRIs through respective District Magistrates or NGOs if felt essential considering the time and other constraints. Training will also be imparted to more than 1000 villagers for collecting data on experimental basis. A two-way SMS connectivity through interactive website is proposed for receipt of flood warning and action taken, and for querying and reporting of flood plain data.

One person in each flood-prone village in Bagmati basin will be trained to use the FMIS alerts and for ground data collection and reporting. After the flood season workshops at community level will be held for sharing flood experience and to upgrade the alerts. This work will be done by existing PRIs through respective districts magistrate.

2.2 Community Participation for Embankment Monitoring and Protection: This includes a consultancy for planning and implementation for community participation for embankment monitoring and piloting implementation in Bagmati basin. The consultancy will aim at improved embankment surveillance, protection and active participation of the villages in plugging the cuts/breaches. The study will review the current status of community participation and suggest an appropriate plan for pragmatic community participation. Couple of hundreds of villages is along the existing embankments. A plan for training and support facilities/ arrangement for implementation of the above plan are to be developed. The community participation plan is to be implemented.

3. Dissemination and Training

3.1 Design and development of interactive website: -The website developed in the first phase will be significantly upgraded for effective public dissemination and access. The fully interactive web site will enable real-time dissemination of dynamic flood information and also provide the interface for SMS response from the people about ground conditions (heavy rainfall events, inundation occurrence, depth and duration, possible impact on embankment, cuts/breaches etc). The main features of this website would be, provision for secure login sessions for authenticated users, integration of non-spatial data items, dynamic map generation & administration, generation of hybrid data products for different stakeholders, provision of offline & online discussion forum for registered users, interface to disseminate information products providing ground status on the basis of SMS data, active weather alerts, interface for dissemination of archival information, provision for query on spatial & non-spatial data etc.

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3.2 Dissemination of reports, training, stakeholders workshops, study tours, etc.: This includes preparing action plan and developing institutional mechanisms in WRD and other key agencies for disseminating reports, bulletins, and products prepared by FMISC. Agency-wise study will be completed. Daily/monthly bulletins and seasonal flood reports will be disseminated. Training in advance GIS and remote sensing applications and study tours to different areas in the country will be organized. Stakeholder workshops will be conducted in all key agencies at different hierarchical levels, as well as PRIs in the project area. A national seminar on flood management will be organized in Patna.

D. Project Duration and Schedule of Activities

The project duration will be 30 months from July 2008 to Dec 2010.

- i. Inception Workshop of stakeholders to start the activity : July 2008
- ii. Implementation Report preparation : Aug 2008
- iii. Procurement of systems and software, consultancy services, etc : Dec 2008
- iv. Conduct of ground surveys, satellite based surveys and data collection : May 2009
- v. FMIS system upgrading : May 2009
- vi. Upgrading FMIS, with improved models, knowledge base, etc : Dec 2009
- vii. Completion of FMIS upgrading : June 2010
- viii. Evaluation of upgraded FMIS operation : Oct 2010
- ix. Stakeholder workshop for Acceptance of upgraded FMIS : Nov 2010
- x. Final Report : Dec 2010

E. Value of Proposed Assistance:

US\$ 3.03 million (Rs. 11, 92, 97,000)

Detailed cost estimate

1. Upgrading Knowledge Base:-9, 36, 82,000/-

1.1 Spatial: --total cost-Rs 59, 42,000/-

Upgrading and expansion of existing spatial database (spatial)

Districts	No. of Blocks
West Champaran	18
Araria	09
Kishanganj	07
Purnia	14
Katihar	16
Gopalganj	14
Siwan	19
Saran	20
Vaishali	16
Madhepura	13

Sum: -	146

Cost of consultancy services for developing GIS layers @ Rs 35,000 each block
= Rs 51, 10,000/-

These blocks will be covered in 52 scenes.

So cost of Satellite data @ Rs 16000 each scene for 52 scenes = Rs 8, 32,000/-

Sl.No.	Discription	amount	Remarks
1	GIS Layers For 10 Districts @35,000 per block for 146 blocks	51, 10,000/-	Number and type of layer as per Phase I specification
2	Cartosat 1 Imagery @ Rs. 16,000 for 52 scenes	8, 32,000/-	Raw scenes full image to be acquired from NRSA on regular rate
		59,42,000	Rs 59.42 lakh

1.2 Surveys: - total cost- Rs 8, 77, 40,000/-

1.2.1 Ground based close contour survey: -

Consultancy for ground survey at 20 cm contour interval over whole basin of Bagmati including Adhwara group of Rivers where flood forecast and inundation modeling is proposed

catchment of Bagmati (including Adhwara group of Rivers) = 6500 sq km

Total cost 6500x 100 x 100 = **Rs 6, 50, 00,000/-**

1.2.2 First time river (longitudinal and cross-sectional) survey:

Consultancy study for L/S and C/S survey along main stem of priority river basins (Bagmati including Adhwara group of Rivers, Kamla and Burhi Gandak), where flood forecast modeling is proposed

- i) survey of Bagmati is being done by WRD by its own fund.
- ii) length of Kamla = 120 km
length of Burhi Gandak = 320 km
total length = 120 + 320 = 440 km
rate of survey work = Rs 14000 per km
total cost = 440 x 14000 = **Rs 61,60,000/-**

1.2.3 Surveys of embankment status and other flood plain features:

All above activities for embankments except preparation of data in GIS format

@ Rs 8000 per km = 1510 x 8000 = Rs 1, 20, 80,000/-

All above activities for roads except preparation of data in GIS format

@ Rs 2500 per km = 1000 x 2500 = Rs 25, 00,000/-

Preparation and delivery of data in GIS format compatible with the software available in

FMISC = Rs 20, 00,000/-

Total estimated cost = **Rs 1, 65, 80,000/-**

1.3 Upgrading hydrologic network- total cost- Rs 14, 00,000

1.3.1 Improving ground rain gauge network (IMD/ State network)

Consultancy study to design network in Gandak and Mahananda basin

Installation of 7 automated Rain gauges with no real time telemetry system, (as decided by flood management expert) in the boarder region of India Nepal in WRD regional offices @ Rs. 150,000 and infrastructures for installation lump sum Rs. 150,000

Total cost = 7 x 150,000 + 1, 05,000

= 150,000 + 1, 05,000 = **Rs. 1,200,000/-**

1.3.2 Improved river gauge reporting by CWC:

No cost involved, need to have MoU with CWC for hourly gauge data reporting.

1.3.3 Installation and operation of flood plain gauges:

In the old focus area 200 villages on experimental basis will be identified and installation and operation of flood plain gauges will be taken up.

Cost @ approximately Rs 1,000 per plain gauge would give

Total cost = **Rs 2, 00,000**

1.4 Improved Prediction Models: - total cost- Rs 61, 20,000/-

1.4.1 Improved medium range weather forecasting: -

As this activity is to be taken by IMD so no cost involved. A fresh MoU with IMD is to be signed.

1.4.2 Improved climate forecast applications (World Bank executed):

To be taken up under Bank executed component. Not to be funded by WRD.

1.4.3 Improved flood forecast modeling:

for Bagmati (including Adhwara group of rivers), Burhi Gandak and Kamla
= Rs 20,00,000/-

1.4.4 Inundation modeling:

for Bagmati and Adhwara group of rivers = Rs 10,00,000/-

1.4.5 River migration model based on multilayer river configuration maps from historic satellite data, field data on past breaches and causes etc: -

COST COMPONENT :

1	Purchase of Satellite (LISS III) Data :	NUMBER OF DATA			Total	Rate	Amount (lakh)
		Pre flood	Post flood				
	year	number	number	number			
	2010	12	12	24			
	2009	12	12	24			
	2008	12	12	24			
	2007	0	0	0			
	2006	0	0	0			
	2005	0	0	0			
	2004	0	0	0			
	2003	0	0	0			
	2002	12	0	12			
	2001	12	0	12			
	2000	12	0	12			
	1999	12	0	12			
	1998	12	0	12			
				Total	132	Rs.12000	15.84
2	Purchase of higher resolution satellite data :	Year	No. of data				
		2010	7				
		2009	7				

	TOTAL:	21	Rs.16000	3.30
3	Consultancy Study:			
	Bagmati		Rs.300000	3
	Kamla		Rs.300000	3
	Burhi Gandak		Rs.300000	3
	Gandak		Rs.300000	3
	GRAND TOTAL.....		Rs	31.2 lac

1.5 Development of EMS (Embankment Management System): -
Total cost- Rs 10, 00,000/-

1.5.1 Development of EMS (Embankment Management System): -

One specialist @ Rs 100000 per month and two supporters @ Rs 50000 per month for six months with all necessary software and hardware = Rs 9,00,000

Contingency = Rs 1, 00,000

Total estimated cost **Rs 10, 00,000/-**

1.6 Infrastructure Augmentation: - total cost- Rs 93, 45,000/-

1.6.1 Hardware and software: -

Item	Unit price	Total units	Total price	Justification
workstation	200000	4	600000	More Arc Info working seats are required for analysis.
PCS	35000	2	70000	Dedicated for Web development and data entry
Arc GIS				Being purchased by WRD by its own fund
networking	100000	1	100000	Since FMIS Cell works in emergency mode for seven months in a year therefore an alternative hi speed communication network is required
lease line	200000	2	400000	for in-house hosting & maintenance of servers
server	550000	1	550000	Web & Database server
storage	100000	2	200000	For Storage & backup solution
Soft wares	400000	1	400000	Upgrading visual basic and visual C++ to visual studio, Adobe creative suit 3 for website design & graphic design, Dream weaver CS3, Flash CS 3 Professional, Photoshop CS3, Fireworks CS3, In design. Flash menu builder factory. Flash Slideshow maker. Web server

iv) Hire charge of vehicle (including fuel) on as and when needed basis for FMISC lump sum = **Rs 5,00,000/-**

total i) + ii) + iii) + iv) = **Rs 52,75,000/-**

1.6.3. Operational support from NRSA - No cost.

2. Improved Community participation: -total cost- Rs 38,50,000/-

2.1 Strengthening Community Outreach:

This project component consists of three activities.

i) Consultancy study for planning and implementing modalities for community outreach: will include micro level study of existing modes of communication regarding flood preparedness and flood management in Bagmati including Adhwara group of rivers Basin.

In Phase-I modalities for community outreach, preparedness and flood management is being developed by a consultant. But due to lack of time, data other resources the consultancy will not be able to represent the true picture because only 36 villages are selected from 11 districts. In Phase-II emphasis will be on micro level analysis at community level for taking decisions regarding contents of alert and institutional mechanism for dissemination of information regarding flood preparedness and flood management on the basis of data collected from more than 30 villages.

A lump sum amount of **Rs.5 lakh** has been proposed for undertaking this job by a consultant.

ii) Implementation of alert mechanism: This will require a team of trained community members who will be provided mobiles and connected to centralized SMS machine from where messages regarding flood preparedness will be disseminated regularly. This may require an approximate expenditure of **rupees 5.0 lakhs** for purchase of 500 mobiles (5 no mobiles/ block in 100 blocks) @ Rs 1000/ mobile.

iii) Training for follow up actions and feed back and ground data collection and reporting: -

For improvement and validation of flood forecast model and inundation model spatial data at ground level on rainfall and inundation is required. Extent, depth and duration of inundation will be reported by community members. Rainfall data can also be collected and sent to FMIS Cell on real time basis. Training will also be imparted to more than 1000 villagers for collecting data. The data so collected will be used for calibrating and validating flood inundation and flood forecast models.

More than 1000 persons (50 per block for 20 blocks) will be trained prior to flood for using FMIS information products and ground data collection and reporting. A mock test will be conducted during flood for examining the effectiveness and usefulness of alert mechanisms. After flood workshops at community level will be held for collecting feedback and sharing flood experiences.

Number of people to be trained = 1000

Number of trainings = 2 (pre & post flood)

Number of batches required (50 people in a batch) = 40

Cost of training per batch = 25000/-

Approx. total cost = 40 x 25000/- = **Rs 10,00,000/-**

Total of (i + ii + iii) = 5 + 5 + 10 = 20 lakhs

2.2 Community Participation for Embankment Monitoring and Protection:

A consultancy for planning & implementation of community participation for Embankment Monitoring and Protection in the entire basin

Cost = **Rs. 500,000**

Embankment length

Bagmati (including Adhwara)= 600 km (approx)

3 km buffering the embankments for Bagmati no of villages = 800

Total no. of villages = 800

A proposal is there to make a group constituting 30 villages so,

Total no of group to be trained will be $800/30 = 26.66$ say = 27 groups

For training each group @ Rs. 50,000 (as per present rate in phase 1)

For training $27 \times 50,000 = \mathbf{Rs. 13, 50,000}$

Total for activity no. 7.2 it comes to be $5, 00,000 + 13, 50,000 = \mathbf{Rs. 18, 50,000/-}$

3. Dissemination and training: -total cost 39, 00,000/-

3.1 design and development of interactive website: -

Sl No	Item	Est Cost
1	Consultancy for Design of Website	210,000
2	In house Development of website Integration testing, modification with database, map server ,SMS server & Deployment	1260000
3	Hosting and maintenance services	200,000
4	SMS services	100,000
5	Other contingent and unforeseen expenses	30,000
		18,00,000

3.2 Dissemination of reports, training, stakeholders' workshops, and study tours, etc.:

This sub component of project can be split into following activities:-

- 1. Study tour:** - There is no denying to the fact that study tour is of utmost importance for any scientific pursuit. The level of work undertaken in FMIS cell is of World standard which require sound engineering knowledge. Therefore it is proposed that at least one study tour of FMIS engineers led by its In charge to Overseas Training Centre to share their knowledge, where such type of work has been successfully implemented be undertaken.- L S **Rs 5.0 lakh**
- 2. State and District level Workshop:-** Stakeholders workshops at state level, district level in 21 districts is proposed to be organized requiring a lump sum amount of rupees 0.5 lakh per district, totaling Rs 10.5 lakh which also includes planning, implementation & actual dissemination of the report of Workshop. A further requirement for conducting TOT and State level workshops, and a

(49)

National seminar costing a total of Rs 2.5 lakh is proposed. This will require in total a sum of **Rs 13.0 lakh**.

3. **Training:-** A national level training in Advanced GIS and Remote sensing from IIS, Dehradun for all the engineers at FMIS is proposed, which will require a cost of **Rs 3.0 lakh**.

Total: - Approximately Rs 21, 00,000/-

Gross total WRD (Bihar) executed: -Rs 11, 92, 97,000/-
(Nearly US \$ 3.03 m)

Abstract of FMIS Phase II : Project Components and Cost

Sub-Component	Description of activities	Rs.	US \$	Area Coverage	Output	Outcome	Linkage with Phase I
1. Upgrading knowledgebase							
spatial							
1.1 Upgrading and expansion of existing spatial database	Consultancy for development of database for additional districts, integration in FMIS	5,942,000					
Sub-Total		5,942,000					
1.2 Surveys							
1.2.1 Ground based close contour survey	Consultancy for ground survey at 20 cm contour interval over flood plain along main stem of priority river basins, where improved flood forecast models is proposed	65,000,000		Bagmati (including Adhwara group)	DEM with 50 cm interval (25 cm vertical accuracy)	Close-contour DEM to support detailed inundation modeling for extent, depth and duration, and spatial flood warning	
1.2.2 First time river (longitudinal and cross-sectional) surveys	Consultancy study for L/S and C/S survey along main stem of priority river basins, where flood forecast modeling is proposed	61,600,000		Bagmati (including Adhwara group), Burhi Gandak and Kamla	Hydraulic data along rapidly changing river systems	Improved flood forecasting	Bagmati is being surveyed by WRD through consultant
1.2.3 Survey of embankment status and other flood plain features	1. Consultancy for embankment survey (photos, alignment/cross-section/height, physical/ structural status, maintenance history and status, breach history, vulnerability index) /flood plain features (natural and manmade), river morphological changes, and delivery in GIS format	16,580,000		Bagmati, Kamla (including Adhwara group) and Burhi Gandak	inputs to EMIS, improved inundation modeling	Improved spatial inundation prediction, flood wave progression and recession, and duration modeling, etc.	
Sub-Total		87,748,000					
1.3 Upgrading hydrologic network							
1.3.1 Improving ground rain gauge network (IMD/State network)	1. Planning/implementation consultancy 2. Training, 3. Support facilities	1,200,000		Bagmati, Adhwara, Burhi Gandak, Gandak & Kamla	Improved near- real time daily rainfall report from State/IMD sites, and hourly data from select IMD sites	Support improved rainfall forecasting and validation, and improved flood inundation	Initiated in Phase I, to be strengthened
1.3.2 improved river gauge reporting by CWC	Agreement between WRD, GoB and CWC	No cost		Bagmati, Adhwara, Burhi Gandak, Gandak & Kamla	Improved river gauge data receipt, including hourly data	Improved flood stage/inundation forecast	Daily report was received after 6-8 hours, needs to be available earlier
1.3.3 installation and operation of flood plain gauges	Installation of flood plain gauges, agreement with community for data reporting, training, pre monsoon field inspection and rehabilitation	200,000		Bagmati (including Adhwara group)	Ground data on inundation occurrence, depth and duration for inundation model validation	Validated /upgraded inundation model	
Sub-Total		1,400,000					
1.4 Improved Prediction Models							
1.4.1 Improved medium range weather forecasting	MOU with IMD	No cost		Bihar State and Nepal portion of north Bihar rivers	3 day, 5 km resolution forecast	Increased lead time for flood forecast and inundation prediction	45 km, 3 day forecast provided, but accuracy and reliability and spatial resolution to be improved
1.4.2 Improved climate forecast applications	To be taken up under Bank executed component	WB executed		Bagmati, Kamla (including Adhwara group) and Burhi Gandak	Up to 2 months advance forecast, for integration with medium range forecast and flood models	Increased lead time for flood forecast and inundation prediction	
1.4.3 Improved flood forecast modeling	Consultancy study to improve flood forecast model for Bagmati basin, and extension/customization for other basins	2,000,000		Bagmati (including Adhwara group), Kamla and Burhi Gandak	Improved flood forecast/inundation/embankment break models and inundation scenarios	Improved community preparedness, emergency management, etc.	Flood model developed for Bagmati basin to be improved, and extended to other basins
1.4.4 Inundation modeling	Consultancy study for 1D/2D hydrodynamic model, with close contour topographic data over flood plain along main stem of Bagmati and other priority basins	1,000,000		Bagmati (including Adhwara group)	Close-contour DEM to support detailed inundation modeling for extent, depth and duration, and spatial flood warning	Spatial warning for inundation extent, depth and duration	
1.4.5 River migration model based on multi-year river configuration maps from historic satellite data, field data on past breaches and causes, etc.	Consultancy study based on multi-year satellite data	3,120,000		Bagmati, Adhwara, Gandak, Burhi Gandak & Kamla	Identify vulnerable embankment reaches	Prediction of future morphological trend for improved flood protection	Satellite data base procured under Phase I to be augmented
Sub-Total		6,120,000					

1.5. Development of EMS (Embankment Management System)							
1.5.1 Develop Embankment Management Information System (EMIS)	Consultancy to design, develop and implement of EMIS	1,000,000		Bagmati, Kamla (including Adhwara group) and Buhri Ganda)	Computerized information system with relevant data for priority maintenance and monitoring and emergency action for breach closure	Support prioritization of reaches for time- and cost- effective patrolling, maintenance and strengthening schedule	
Sub-Total		1,000,000					
1.6 Infrastructure Augmentation							
1.6.1 Hardware & Software	computers/software, communication facilities, dissemination facilities etc.	4,070,000					
1.6.2 Incremental O&M		5,275,000			Professional support, travel hardware/software maintenance, etc.		Professional support extended from Phase I for need based specialist functions.
1.6.3 Operational support from NRSA	Extend MOU for 1. Supply of inundation maps, 2. Sharing 1 m DEM, 3. Upgrading FMS software etc.	No cost	No cost	entire flood prone 21 districts in North Bihar	Operational inundation maps, improved FMS software operation, improved DEM	Improved frequency of inundation mapping and dissemination	Operational support received in Phase I to be continued
Sub-Total		9,345,000					
Total for Component 1		111,553,000					
2. Improved community participation							
2.1 Strengthening community outreach and ground data collection and reporting	1. Planning/implementation consultancy, 2. Implementation of alert mechanism, 3. Training for follow-up action, and feedback and ground data collection and reporting	2,000,000		Bagmati (including Adhwara group)	Upgraded community alert mechanism and connectivity, community feedback on ground flood situation, community training	Improved community preparedness, community participation in flood data collection for developing and validation improved inundation	The consultancy for community outreach extended to other basins
2.2 Community participation for embankment monitoring and protection	1. Planning/implementation consultancy, 2. Training, 3. Support facilities/arrangements	1,850,000		Bagmati (including Adhwara group)	community participation for embankment monitoring and protection	Improved embankment surveillance and protection	Handbook prepared by WRD two years earlier, but not implemented
Sub-Total		3,850,000					
3. Dissemination and Training							
3.1 Design & Development of Interactive Website	Consultancy for design, development, implementation and maintenance	1,800,000		entire flood prone 21 districts in North Bihar	Upgraded website, interactive		
3.2 Dissemination, reports, training, multi-level stakeholder workshops, study tours, etc.		2,100,000		entire flood prone 21 districts in North Bihar	Dissemination of products, daily and monthly bulletins, awareness raising and training workshops for stakeholders, pre-season and post-season workshops, advanced training in remote sensing, GIS and modeling; study tours to other flood prone states, flood management related agencies	Improved flood preparedness ownership, capacity building in WRD	Basic training in remote sensing and GIS procured in Phase I to be strengthened with more staff and intensity
Sub-Total		3,900,000					
Total		119,297,000					
Total for Recipient execution		Rs 119,297,000 (US \$ 3.03 m, 1 US \$ = Rs 39.31)					
Project duration will be 30 months (June 2008 to Nov 2010); GoB contribution towards general infrastructure and operational costs, systems and software within WRD upto field units (excluding select nodes in WRD Hqs under DFID funding), etc.							