FLOOD EARLY WARNING SYSTEM
-A WARNING MECHANISM FOR
MITIGATING DISASTERS DURING FLOOD

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DEPARTMENT OF ADMINISTRATIVE REFORMS & PUBLIC GRIEVANCES
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TABLE OF CONTENTS

SL.NO.	CONTENTS		PAGE NO.
1.0	**Introduction**		**1**
2.0	**Early Warning System**		**1-5**
	2.1	Background	1
	2.2	Key Elements of Early Warning System	2
	2.2.1	Risk Knowledge	3
	2.2.2	Monitoring and Warning Services	3
	2.2.3	Dissemination and Communication	3
	2.2.4	Response Capability	4
	2.3	Flood Early Warning System	4
	2.3.1	Benefits of Flood Early Warning Systems	5
3.0	**About Assam**		**6-8**
	3.1	Introduction	6
	3.2	Rivers in Assam	7
	3.2.1	The Brahmaputra River	7
	3.2.2	The Barak River	8
4.0	**District-Wise Flood Hazard Index**		**9-10**
5.0	**Flood Early Warning System (FLEWS) in Assam**		**11-26**
	5.1	Statement of problem	11
	5.2	Motivators of the Project	11
	5.3	Purpose & Priorities of the Initiative	12
	5.4	The Project	12
	5.4.1	Major Technical Components of the Project	14
	5.4.2	The Meteorological Component	15
	5.4.3	The Hydrological Component	18
	5.5	Generation and Dissemination of Flood Early Warning	23
	5.5.1	Methodology for dissemination of flood warning alerts to districts	26
6.0	**Role of different organisations/stakeholders**		**27-28**
	6.1	Assam State Disaster Management Authority (ASDMA)	27
	6.2	North Eastern Space Application Centre (NESAC)	27
	6.3	Central Water Commission (CWC)	28
	6.4	Indian Meteorological Department (IMD)	28
	6.5	Assam Water Resources Department (AWRD)	28
7.0	**Strategies adopted for bringing about the transformation and its impact**		28
8.0	**Uniqueness of the Project**		**28-29**
9.0	**Effectiveness of FLEWS**		29

10.0	**Success of FLEWS**		**29-38**
	10.1	Area affected, Population affected and Human Lives lost-A comparative analysis	30
	10.2	Voices from the Districts	32-38
	10.2.1	Barpeta	32
	10.2.2	Dhemaji	33
	10.2.3	Goalpara	34
	10.2.4	Nalbari	34
	10.2.5	Lakhimpur	35
11.0	**Milestones**		**38**
12.0	**Lessons Learnt**		**38**
13.0	**Conclusion**		**39**
	References		**40**

LIST OF FIGURES

FIGURE NO.	PARTICULARS	PAGE NO.
1	Key Elements of an Early Warning System	2
2	Assam and its neighbouring States	6
3	Major River Systems of Assam	9
4	Districts Covered under FLEWS	13
5	Flow chart of the overall methodology of FLEWS	14
6	WRF Modeling system flow chart	15
7	Total 24hr rainfall from IMD AWS data (left) IMD half degree gridded data (centre) and WRF model output	16
8	Methodology flow chart for synoptic and meso scale rainfall forecast	17
9	The rational model daily peak discharge forecast	19
10	The HEC-HMS model set up	22
11	The HEC-HMS operational block	23
12	Daily flow of events leading to Flood Warning	24
13	FLEWS alert user groups in 14 districts of Assam	25
14	Sample flood alert maps of Baghbar and Bajali revenue circle of Barpeta district	25
15	Flow Chart for Flood Warning Dissemination	26

1.0 INTRODUCTION

There are few places on Earth where people need not be concerned about flooding. Any place where rain falls is vulnerable, although rain is not the only impetus for flood. A flood occurs when water overflows or inundates land that's normally dry. This can happen in a multitude of ways. Most common is when rivers or streams overflow their banks. Excessive rain, a ruptured dam or levee, rapid ice melting in the mountains, or even an unfortunately placed beaver dam can overwhelm a river and send it spreading over the adjacent land, called a floodplain. Coastal flooding occurs when a large storm or tsunami causes the sea to surge inland.

According to reports from the World Meteorological Organization (2009), approximately 70% of all disasters occurring in the world are related to hydro-meteorological events. Among the disasters, flooding probably is one of the most severe disasters affecting the people across the globe.

India is the worst flood affected country in the world after Bangladesh and accounts for one-fifth of global death count due to floods. Nearly 75 percent of the total Indian rainfall is concentrated over a short monsoon season of four months (June-September).As a result, the rivers witness a heavy discharge during these months, leading to widespread floods. About 40 million hectares of land in the country is liable to floods according to National Flood Commission, and an average of 18.6 million hectares of land is affected annually.

2.0 EARLY WARNING SYSTEM

2.1 Background

> ***"The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss"*** (UNISDR,2009)

Early Warning System (EWS) evolved about 2 to 3 decades ago. The needs for EWS started to arise in 1970s and 1980s when the prolonged droughts and famines in the West African Sahel and in the Horn of Africa occurred. Since its early development, EWS started to be used for other hazard (technological, hydrological, meteorological etc.) for societal risk and vulnerability reduction and towards sustainable development (ESIG-ALERT,2004).

In January 2005, the United Nations convened the Second World Conference on Disaster Reduction in Kobe, Hyogo, Japan. During this conference, an agreement called the “Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters” (HFA) was negotiated and adopted by 168 countries. The paradigm for disaster risk management was broadened from simply post-disaster response to a more comprehensive approach that also includes prevention and preparedness measures. HFA also stresses the need for, “identifying, assessing and monitoring disaster risks and enhancing early warning systems.” Following this agreement, efforts were underway to incorporate early warning systems as an integral component of any nation’s disaster risk management strategy, enabling governments and communities to take appropriate measures towards building community resilience to natural disasters.

EWS are increasingly recognized at the highest political level as a critical tool for the saving of lives and livelihoods, and there are increasingly more investments by national and local governments, international development agencies, and bilateral donors to support such systems.

2.2 Key Elements of Early Warning System

An early warning system mainly consists of four elements: Risk Knowledge, Monitoring and Warning Services, Disseminations and Communication and Response Capability

Fig.1: Key Elements of an Early Warning System

2.2.1 Risk Knowledge:

Risks arise when hazards and vulnerabilities appear together at a particular location. Assessments of risk require systematic collection and analysis of data and should consider the dynamic nature of hazards and vulnerabilities that arise from processes such as urbanization, rural land-use change, environmental degradation and climate change. Risk assessments and maps help to motivate people, prioritize early warning system needs and guide preparations for disaster prevention and responses.

2.2.2 Monitoring and Warning Services

Warning services lie at the core of the system. There must be a sound scientific basis for predicting and forecasting hazards and a reliable forecasting and warning system that operate 24 hours a day. Continuous monitoring of hazard parameters and contributing factors is essential to generate accurate warnings in a timely fashion. Warning services for different hazards should be coordinated with stakeholders and relevant agencies to gain the benefit of shared institutional, procedural and communication networks.

2.2.3 Dissemination and Communication

Warnings must reach those at risk. Clear messages containing simple, useful information are critical to enable proper understanding of warnings and responses in order to safeguard lives and livelihoods. Regional, national and community level communication systems must be pre-identified and appropriate authoritative mandates established. The use of multiple communication channels is necessary to ensure that as many people as possible are warned, to avoid failure of any one channel, and to reinforce the warning message.

Early warning communication systems are made of two main components (EWCII, 2003):

- Communication infrastructure hardware that must be reliable and robust, especially during the natural disasters; and
- Appropriate and effective interactions among the main actors of the early warning process such as the scientific community, stakeholders, decision makers, the public, and the media.

Many communication tools are currently available for warning dissemination such as Short Message Service (SMS), Email, Radio, TV, and web service.

Information and Communication technology (ICT) is a key element in early warning. ICT plays an important role in disaster communication and dissemination of information to organizations in charge of responding to warnings and to the public during and after a disaster.

Redundancy of communication systems is essential for disaster management, while emergency power supplies and back-up systems are critical in order to avoid the collapse of communication systems after disasters occur.

In addition, in order to ensure reliable and effective operation of the communication systems during and after disaster occurrence, and to avoid network congestion, frequencies and channels must be reserved and dedicated to disaster relief operations.

Dissemination of warnings often follows a cascade process, which starts at international or national level and then moves outwards or downwards in the scale, reaching regional and community levels (Twigg J., 2003). Early warnings may activate other early warnings at different authoritative levels, flowing down in responsibility roles, but all are equally necessary for effective early warning.

2.2.4 Response Capability

It is essential that communities understand their risks; respect and follow the warning and know how to react. Education and preparedness programs play a key role in reducing risks. It is also essential that disaster management plans are in place, resources allocated and standard procedures well practiced and tested. The community should be well informed on options for safe behavior, available escape routes, and how best to avoid damage and loss to property.

2.3 Flood Early Warning System

As the name indicates, Flood Early Warning System (FLEWS) is a system by which flood induced hazards can be minimized and prevented. Currently different organizations are working on flood forecasting and early warning at national, continental and global scale.

In a flood early warning system the most important input is real time hydro-meteorological observations provided by weather radar satellites and automatic hydro-meteorological station network (Billa et al.,2006; Budhakooncharoen, 2004). This real time data can be used in various ways to evaluate flood risks and issues of flood warning. Apart from real time data, probabilistic weather forecasts (Numerical Weather Prediction-NWP) are also playing an important role in providing input for hydrological models to generate warnings scenarios (Burger et al.2009; Thielen et al., 2010). Besides having forecasts of the most important input (precipitation), a model needs to be selected that characterizes and simulates the catchment responses for flood early warning.

2.3.1 Benefits of Flood Early Warning Systems

The development of flood forecasting and warning systems is an essential element in regional and national flood preparedness strategies, and is a high priority in many countries. Flood EWS are being considered as an alternative for dealing with flood problems, partly because these systems are less expensive compared to structural schemes. Despite the high priority accorded to flood warnings in flood risk management by governments, there is a lack of good data on the benefits and costs of these systems (Wallingford 2006).

The benefits of an early warning system can be calculated by assessing the possible savings of the quantity of flood damage to private and public assets resulting from action taken in response to the warning. This flood reduction benefit BEWS can be expressed as:

BEWS=Xwithout-Xwith

Where, Xwithout=without project economic flood damage; and

Xwith= economic damage if the project is implemented

The benefits of flood early warning systems come from the savings in flood damages. Floods are random events that cause damages and hence flood damages are also random or probabilistic events: the probability of any specific amount of flood damage depends on the probability of the flood event necessary to cause those damages. Determining flood damages combines a risk assessment in terms of the probability of future flood events to be averted, and a vulnerability assessment in terms of the damage that would be caused by those floods and, therefore, the economic savings to be gained by their reduction.

3.0 ABOUT ASSAM

3.1 Introduction

Assam, the gateway to the northeastern part of India, extending from $22^0 19'$ to $28^0 16'$ North Latitude and $89^0 42'$ to $96^0 30'$ East Longitude is situated between the foot hills of the Eastern Himalayas and the Patkai and Naga ranges. Assam is bordered in the North and East by Bhutan and Arunachal Pradesh. Along the south lie Nagaland, Manipur and Mizoram. Occurrence of flood has been an age-old phenomenon in the riverine areas of this region.

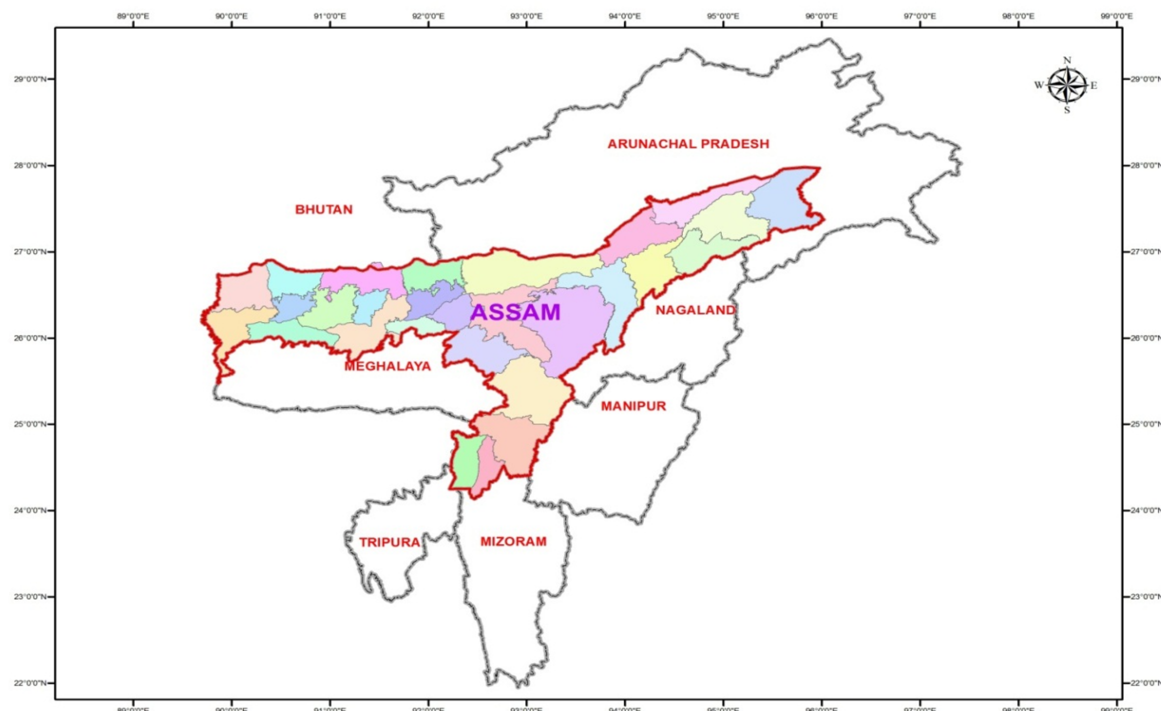


Fig.2: Assam and its neighbouring States

The frequency and intensity of floods has grown over the years primarily because of the increased encroachment of flood plains. Interestingly, while the number of deaths caused by flooding has decreased over the last decade, the number of affected populations and economic losses has not decreased significantly. While the State has come forward to take up mitigation measures like construction of raised platforms, embankments etc, floods still continue to be a menace in the State causing colossal damage to property and disrupting the livelihoods of the poor people in the State year after year. The rural population thus suffers from loss of crops and property due to annual flood, which affect their income and further increases their vulnerability to endemic poverty.

Assam, is in fact one of the poorest State with approximately 36% of the population living below poverty line. The state also lags behind in many other development indicators. Several factors are responsible, including poor infrastructure, remoteness, and inability to minimize the impacts of damages and loss of productivity from frequent flooding & other natural calamities.

3.2 Rivers in Assam

There are mainly two river systems in Assam i.e Brahmaputra River and Barak River

3.2.1 The Brahmaputra River

The Brahmaputra River, flowing through Assam from east to west over a length of approximately 650 kilometers is among the largest, most flood prone and most unstable rivers in the world. Its main branch originates in the Tibetan plateau, flowing from west to east as the Tsangpo River, and then turns south through the eastern Himalaya in a steep gorge as the Dihang River to enter the eastern part of Assam, where it is joined by other branches from the northeast to form the Brahmaputra. Near the western boundary of Assam, the river turns south to enter Bangladesh, where it is generally known as the Jamuna below the off take of the Old Brahmaputra. The characteristics of the river itself are very similar in Assam and Bangladesh. In Assam, however, the river lies in a well-defined alluvial valley ranging from 40 to 100 kilometers in width and bounded by mountains and hills, whereas in Bangladesh the environment is more deltaic in nature.

The basin of the Brahmaputra River is among the most flood prone in the world, followed closely by that of the Barak River. Floods affect an annual average of 0.8 million hectares of land, but in some years they affect more than 4 million hectares of Assam’s total area of 7.54 million hectares. Such extensive floods inundate a large number of villages every year in addition to destroying other infrastructure. The problem is further exacerbated by riverbank erosion, which destroys an annual average of about 8,000 hectares of riparian land along the Brahmaputra.

The drainage areas of the river at the east and west ends of Assam are roughly 290,000 and 530,000 square kilometers. In its course through Assam, the long-term mean discharge rises from about 8,500 to 17,000 cubic meters per second as flows are augmented by 28 major tributaries on the north or right bank and 16 on the south or left bank. The northern tributaries drain the southern slopes of the Himalaya and together contribute much more water and sediment to the river than the southern tributaries.

Along its course through Assam, the gradient of the Brahmaputra reduces from roughly 0.2 to 0.1 meters per kilometer.

3.2.2 The Barak River

The Barak River rises in the Indian state of Nagaland at an elevation of approximately 2,300 meters and passes through the Manipur Hills of Manipur state, first in a southwesterly and then in a northerly direction, over a river length of nearly 400 kilometers. It then flows generally westward from Lakhipur through the Cachar Plains region of Assam over a river length of approximately 130 kilometers to enter Bangladesh near Bhanga. At the border it divides into the Surma River (flowing north from the bifurcation) and the Kushiyara River (flowing south from the bifurcation). On both the Surma and the Kushiyara, the international boundary follows the river center line for a certain distance, so that one bank of each river lies within India. The systems of both those distributaries (under different names) eventually reappear in lower Bangladesh as principal tributaries to the upper Meghna River.

Overall, the Cachar Plains area is roughly 55 kilometers wide from north to south and 60 kilometers long from east to west, but this area includes a considerable number of short spurs or ridges extending south from the Meghalaya Hills and a few longer spurs extending north from the Tripura Hills. A number of tributaries to the lower Barak lie in low depressions between those spurs and ridges, which are said to consist of laterite.

The drainage area of the Barak River is approximately 14,500 square kilometers where it enters the Cachar Plains and 25,000 square kilometers where it divides at the Bangladesh border. Of the approximately 10,500-square-kilometer increase across the Cachar Plains, alluvial floodplains constitute only about 4,000 square kilometers, the rest representing hill areas in the upper tributary basins.

At the entrance to the Cachar Plains near Lakhipur, the gradient of the river drops from about 0.33 meters per kilometer in the upstream hills to an average of less than 0.05 meters per kilometer across the plains to Bhanga. The total drop in water levels between Lakhipur and Bhanga is 6 meters or less.

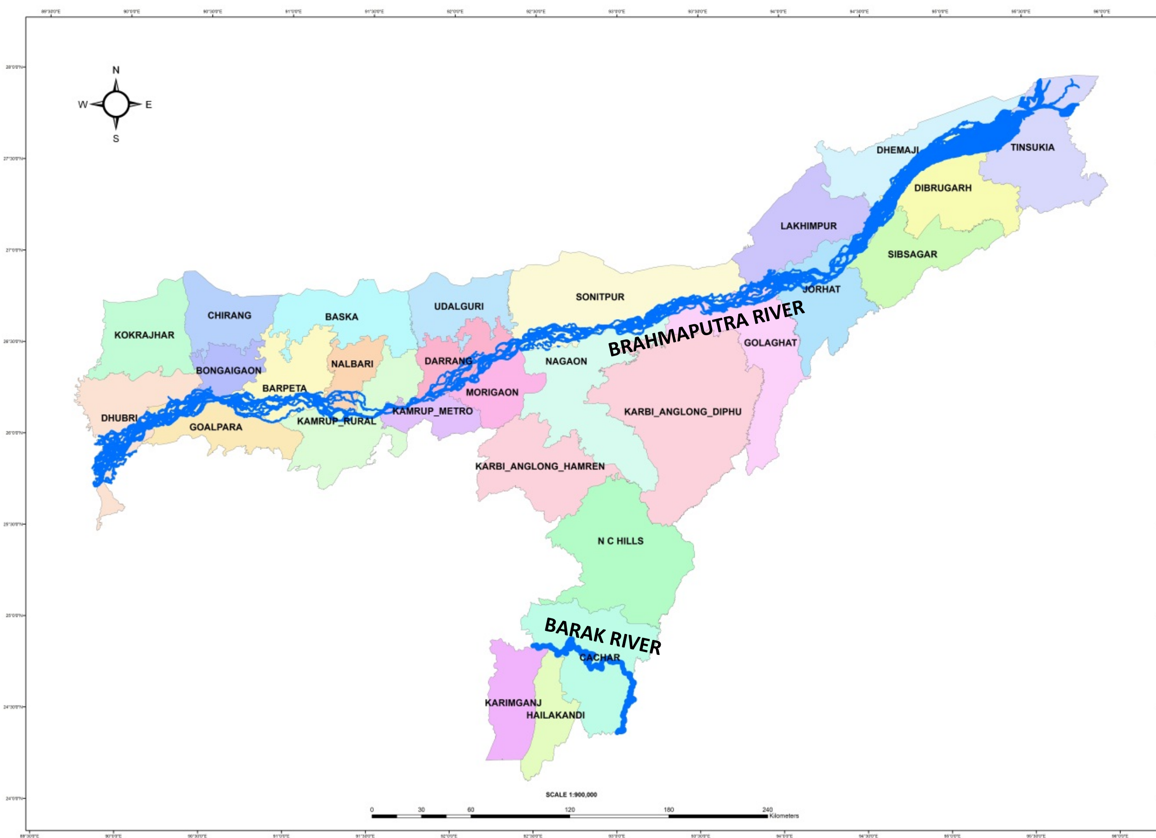


Fig.3: Major River Systems of Assam

4.0 DISTRICT-WISE FLOOD HAZARD INDEX

Flood Hazard Index (FHI) gives an idea on the severity of flood hazard. To find the severity of flood hazard for different districts of Assam, the flood hazard was classified into 5 categories based on the frequency of inundation and weightages were given to each category of the flood hazard zones. Weightages were also given as per the percentage of Flood Hazard Area for each district. Finally the Flood Hazard Index was calculated by multiplying the weightage given for different hazard category with weightages given for the Flood Hazard Area.

Table below shows the Flood Hazard Index for different districts of Assam. Based on the Flood Hazard Index derived for different districts, it is seen that Nalbari, Morigaon, Darrang, Lakhimpur and Dhemaji districts are the five most flood affected districts of Assam.

Sl.No	District	District Area (Hectares)	Total Flood Hazard Area (Hectares)	% Flood Hazard Area	Hazard Index
1	NALBARI	110586	51737	46.78	27
2	MARIGAON	149300	107834	72.23	25
3	DARRANG	155598	116294	74.74	21
4	LAKHIMPUR	289686	153527	53.00	19
5	DHEMAJI	252527	117417	46.50	19
6	BARPETA	213851	147591	69.02	18
7	SIBSAGAR	262656	122519	46.65	18
8	JORHAT	283134	121074	42.76	18
9	UDALGURI	197518	48867	24.74	17
10	NOWGONG	400002	191193	47.80	16
11	GOLPARA	200731	76987	38.35	16
12	KAMRUP®	306706	116849	38.10	16
13	BONGAIGAON	110160	41605	37.77	16
14	DHUBRI	271003	98753	36.44	16
15	DIBRUGARH	337731	117234	34.71	16
16	SONITPUR	527723	160450	30.40	16
17	GOLAGHAT	353499	104814	29.65	16
18	TINSUKIA	383365	74345	19.39	16
19	KARIMGANJ	185840	51968	27.96	15
20	HAILAKANDI	132892	32661	24.58	15
21	CACHAR	378136	92772	24.53	15
22	KAMRUP (M)	102705	21987	21.41	15
23	KOKRAJHAR	258923	33665	13.00	15
24	BASKA	262748	26191	9.97	
25	CHIRANG	188189	13167	7.00	
26	KARBI ANGLONG	1042757	46337	4.44	
27	NORTH CACHAR	486293	462	0.10	

Source: Flood Hazard Atlas for Assam State : NRSC, Government of India

5.0 FLOOD EARLY WARNING SYSTEM (FLEWS) IN ASSAM

5.1 Statement of Problem

Flood forecasting and early warning is used for alerting the likely damage center well in advance of the actual arrival of flood, to enable the people to move and also to remove the movable properties to safer places or to raised platforms specially constructed for this purpose.

Flood is an annual event in the State of Assam. More than 40 percent of its land surface is susceptible to flood damage. The total flood-prone area in the Brahmaputra valley is about 3.2 Mha. (Goswami, 2001). The Brahmaputra valley had experienced major floods in 1954, 1962, 1966, 1972, 1974, 1978, 1983, 1986, 1988, 1996, 1998, 2000, 2004 and 2007 & 2012 which clearly shows that floods are an annual event in the State. This affects a large section of the people of the riverine areas leaving them to cope with their annual losses.

Assam, inspite of suffering from annual flood events, unfortunately did not have a system of any early warning mechanisms that would alert the concerned districts/circles/villages from the occurrence of a disaster. The existing disaster management mechanism is primarily focused on strengthening rescue and relief arrangements during and after major flood disasters. Little work has been done in a scientific context on minimizing the incidence and extent of flood damage.

To minimize flood damage the basic approach is to prevent floodwaters from reaching the vulnerable centres. The Central Water Commission (CWC) under the Ministry of Water Resources issues flood forecasts and warnings.

However, CWC gives the water level of only the major rivers of the State which does not indicate the areas/villages where the flooding would occur and leaves the administrative machinery clueless as to which village or revenue circle should be warned /evacuated. The government felt an inadequacy in the early warning system and therefore thought for the development of a flood early warning system and/or decision tools which relies on hydrological modeling and the use of near real time data and consulted different stakeholders to find a solution to the problem.

5.2 Motivators for the Project initiative

The primary motivator for the project initiative was to alleviate the sufferings of the local populace from the long standing problem of floods. The Government of Assam felt the inadequacy of not having an effective early warning system to alert the administration and the population from the probable occurrence of a flood event for taking necessary measures to minimize the loss of human lives and mitigating the damage to properties.

5.3 Purpose & Priorities of the Initiative

The main purpose of the initiative was to develop a location specific early warning system which could help the administration in taking advance precautionary measures and issue flood alerts to those specific areas so that necessary measures can be undertaken by the people.

With this purpose the project was initiated keeping in view the following objectives

1) Issue of alert for possible flood situation in district/Circle level with best possible lead time.
2) Submission of annual periodic report on status of existing embankments.
3) Creating an environment of joint participation among all stakeholders in order to generate actionable product for management of flood in Assam
4) Development of optimum methodology for rainfall prediction from satellite based weather monitoring and numerical weather prediction models supported by insitu ground data.
5) Development of river specific rainfall-runoff models for forecasting of flood.
6) Development of inundation simulation for flood plain zonation.

5.4 The Project

On 14th June, 2008 a devastating flash flood occurred in Lakhimpur district of Assam affecting more than 3 Lakh of population and more than 75,000 Hectares of land thereby bringing untold suffering and misery downstream. This event of Assam drove the government to consult the different organisations like Indian Meteorological Department (IMD), Brahmaputra Board, Central Water Commission (CWC), Assam Remote Sensing Application Centre (ARSAC), Assam Water Resources Department (AWRD) and North Eastern Space Application Centre (NESAC) for developing a model which could provide location specific flood early warning advisory. Finally NESAC, Shillong decided to take up the responsibility of developing an effective flood early system as they were already working for development of a flow forecasting system for Ranganadi Dam site on a pilot basis for NEEPCO.

Subsequently the whole of Lakhimpur district i.e the rivers other than Ranganadi were taken up as a pilot exercise . This activity was decided to be taken up in project mode and was named as

Flood Early Warning System (FEWS) project which remained so till the monsoon of 2010. During a review meeting held on the 16th June, 2010 it was pointed out from NDMA that FEWS is an already existing terminology in United Nation Disaster Management Programme which stands for Famine Early Warning System. Hence the project name was changed to Flood Early Warning System (FLEWS).Further, the project which started with one district in 2009 was extended to another district in upper Assam namely Dhemaji and three districts of lower Assam namely Barpeta, Nalbari & Baksa in 2010. With the achievement of some success, the project was further extended to Cachar, Karimganj and Hailakandi districts of Barak Valley in the year 2011. With the increasing demand from the district administration of other districts the project was further extended to 6 more districts of Assam namely Dhubri, Goalpara, Morigaon, Sonitpur, Sivasagar and Darrang districts during 2012. The total coverage, therefore, as of till now is 14 nos. of districts.

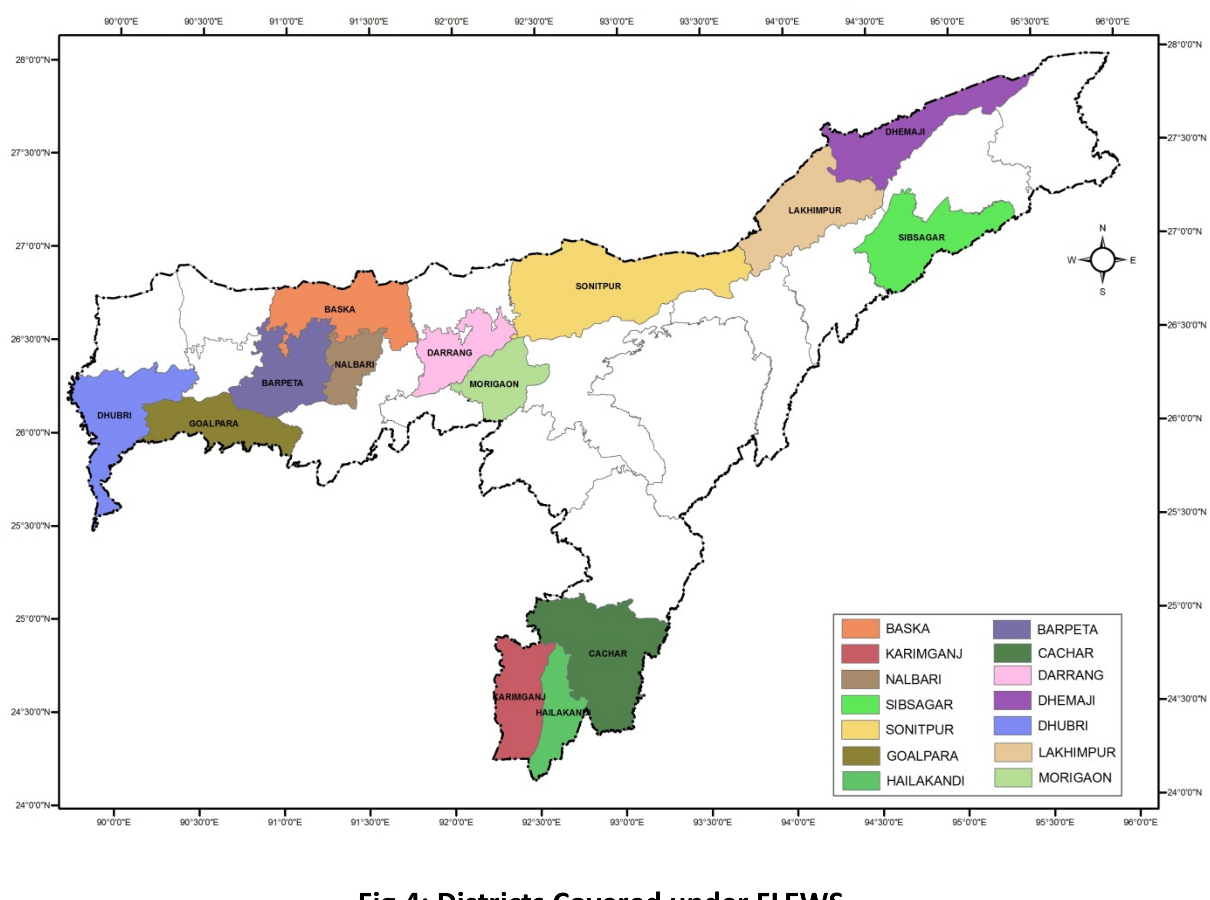


Fig.4: Districts Covered under FLEWS

5.4.1 Major Technical Components of the project.

(1) The meteorological components comprises of two major sub components of Weather Research Forecast (WRF) model for grid based rainfall prediction through numerical schemes and multi-parametric (CTT, CMV, Vorticity etc.) synoptic weather monitoring for overall probability of rainfall in a particular basin.

(2) The hydrological component comprises of a hybrid approach of a lumped grey box model known a Rational model in combination with a quasi distributed hydrological model known as the HEC-HMS in Arc-GIS platform. White the first approach provides the forecast of the peak value for a river basin, the distributed model provides the forecast for the daily hydrograph for that basin. Comparing both the forecast with the established flooding thresholds for that river, issue of flood warning is decided.

(3) The third component is the post flood identification of embankment breaches and general monitoring of embankments.

Figure 5 below depicts the overall methodology involving the three major components.

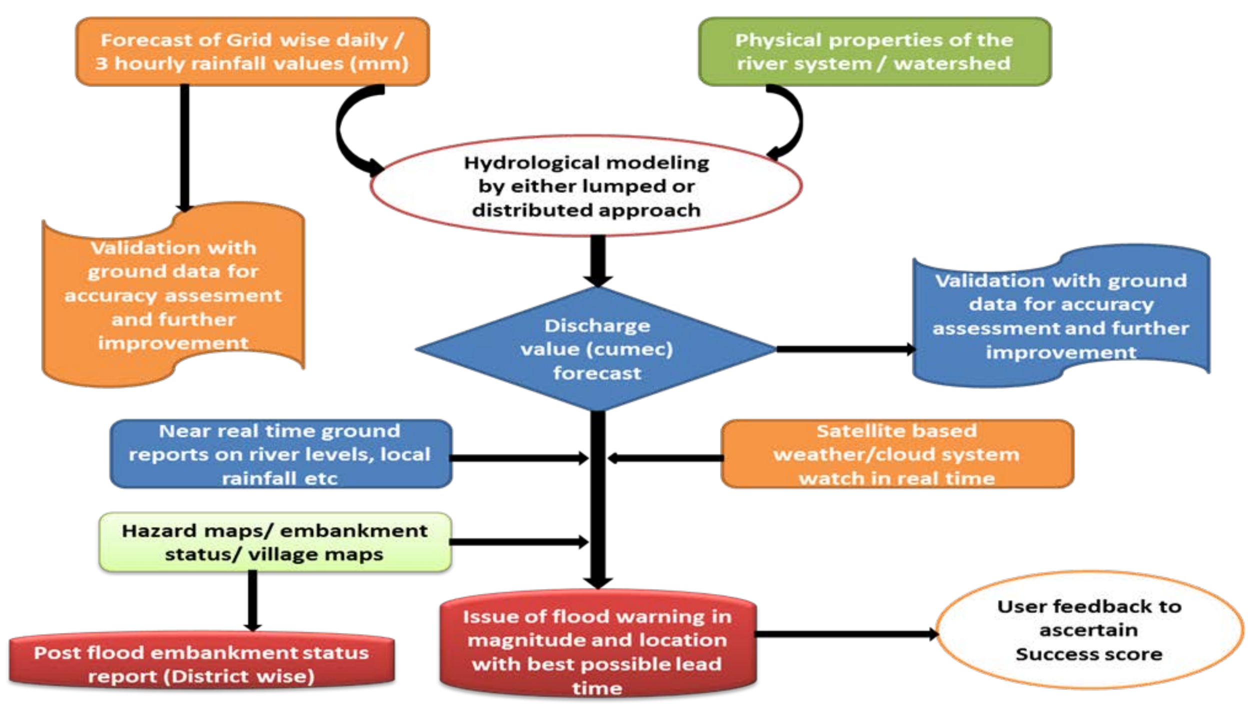


Fig.5: Flow chart of the overall methodology of FLEWS

5.4.2. The Meteorological Component

Numerical Weather Prediction

Numerical Weather Prediction (NWP) is the science of predicting the weather using models of the atmosphere and computational techniques. There are a number of NWP model to forecast meso-scale weather system andWeather Research and Forecasting(WRF) model is one of such which is extensively used worldwide due to its highly developed physics schemes and better time integration method to give improved forecast at shorter duration. It also includes a data Assimilation module called WRFDA where observed data can be fed to update the model's initial condition to generate realistic forecast. Figure 6 gives basic architecture of the WRF model.

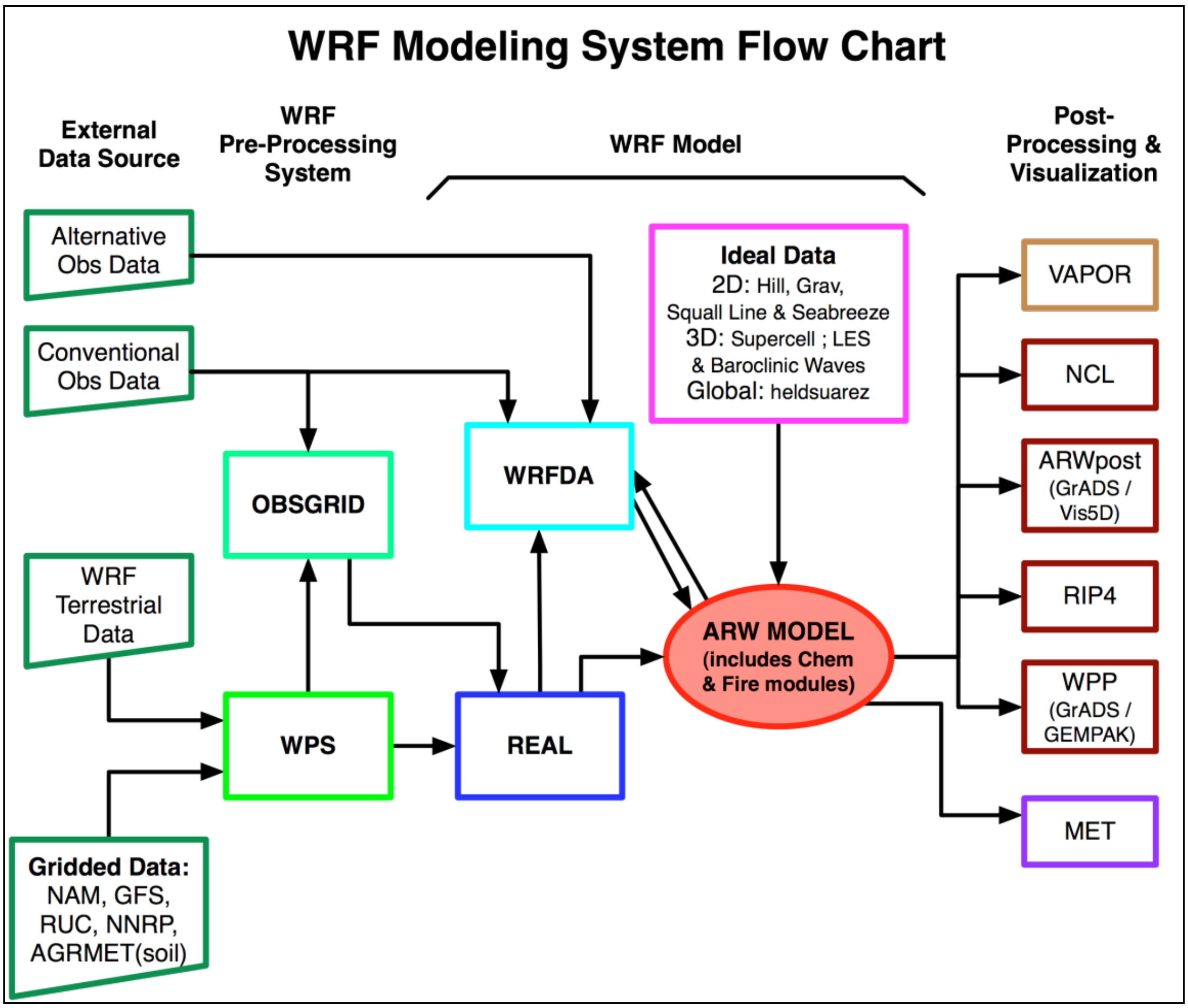


Fig.6: WRF Modeling system flow chart

The model is run at NESAC since 2010 initially at 27 km resolution without data assimilation. Subsequently the model resolution in space and time was improved to up to 3 km and 3 hours. Currently the model is run at nested domain of 27 km, 9 km, and 3 km (figure 7) for different areas of interest. Data from the network of automatic weather station (AWS) and satellite data based cloud motion vector were also assimilated in the model which have, over the years, improved the accuracy of forecast. The MM5 and ARPS models are also being used to investigate their relative ability to simulate different events, particularly intense and localized rainfall events. The high performance computers (HPC) at INCOIS, Hyderabad and at NARL, Gadanki have been used through remote access to operationally run the models during the Indian summer monsoon season.

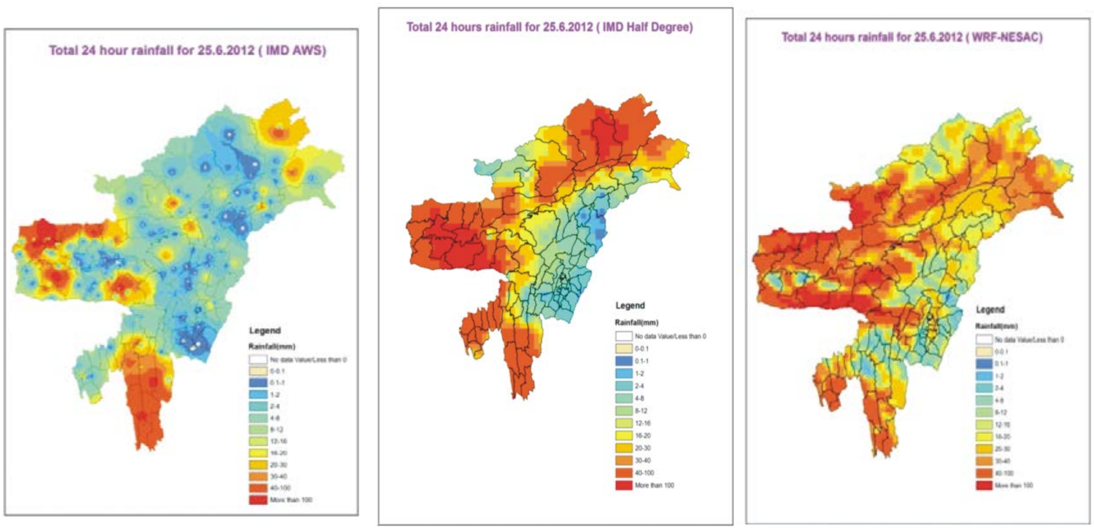


Fig.7: Total 24hr rainfall from IMD AWS data (left) IMD half degree gridded data (centre) and WRF model output

Synoptic Weather analysis

The synoptic weather analysis is being done to forecast rainfall for the basins under study. Since many of the basins under study is very small in size, Generally rainfall forecast is given at synoptic scale, but whenever intense rainfall is expected, meso and local scale forecast has also been given. The forecast was issued for four distinct regions (for the districts in eastern Assam area, western Assam area, central Assam area and Southern Assam area) over the NER. The preparation of synoptic weather report involves studying the cloud properties over and around the area, the prevailing wind speed and direction at different heights (pressure levels), the condition of the atmosphere in terms of its ability to allow or suppress convection, etc. Different data were used to analyze the synoptic weather condition for the project as mentioned above. The overall flow chart for preparation of synoptic scale rainfall forecast is shown in figure 8.

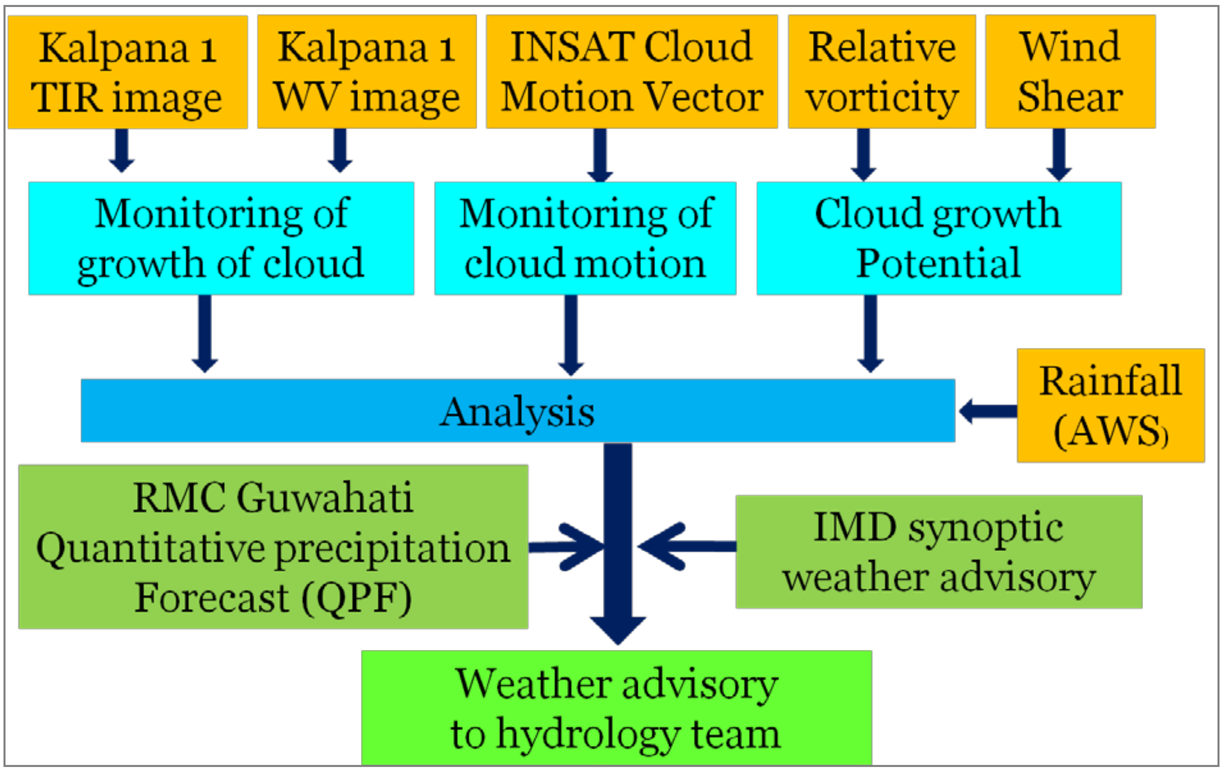


Fig.8: Methodology flow chart for synoptic and meso scale rainfall forecast

Information on cloud strength and columnar moisture content are collected from Kalpana 1 TIR and WV channel imagery. Successive imageries were analyzed along with wind vector at different level, 850 mb relative vorticity, wind shear, and wind divergence and convergence trends to forecast rainfall for the basins under study. The synoptic weather forecast proved very useful for flood forecasting, particularly flash flood forecasting. The rainfall forecast has been issued for different range bins like 0-10mm, 10-20 mm, 20-30mm, 30-50mm, and more than 50 mm.

The synoptic weather forecasting has helped in minimizing errors that could have happened because of overestimation or underestimation of NWP model based rainfall forecast. On a few occasions flood was forecasted successfully based on synoptic weather forecast only. The analog synoptic weather forecast is continued with improved parameterizations and extended coverage to cater to the districts included under the FLEWS projects. More parameters like convective available potential energy (CAPE) and wind shear tendency are monitored for better estimation of atmospheric instability that could lead to better forecast of intense and localized rainfall.

5.4.3. The Hydrological Component

The Rational model

One of the most widely accepted formula for calculation of peak discharge. This method assumes the duration of rainfall as equal to the time of concentration of the drainage area or the basin that produces the peak discharge.

The rational formula in its simplest form is

Q = C I A , Where

Q = Peak Discharge (Cubic feet per second)

C = Co-efficient of discharge which is the ratio between rainfall and runoff.

I = Average rainfall intensity for the time of Concentration (Tc) for a rainfall event.

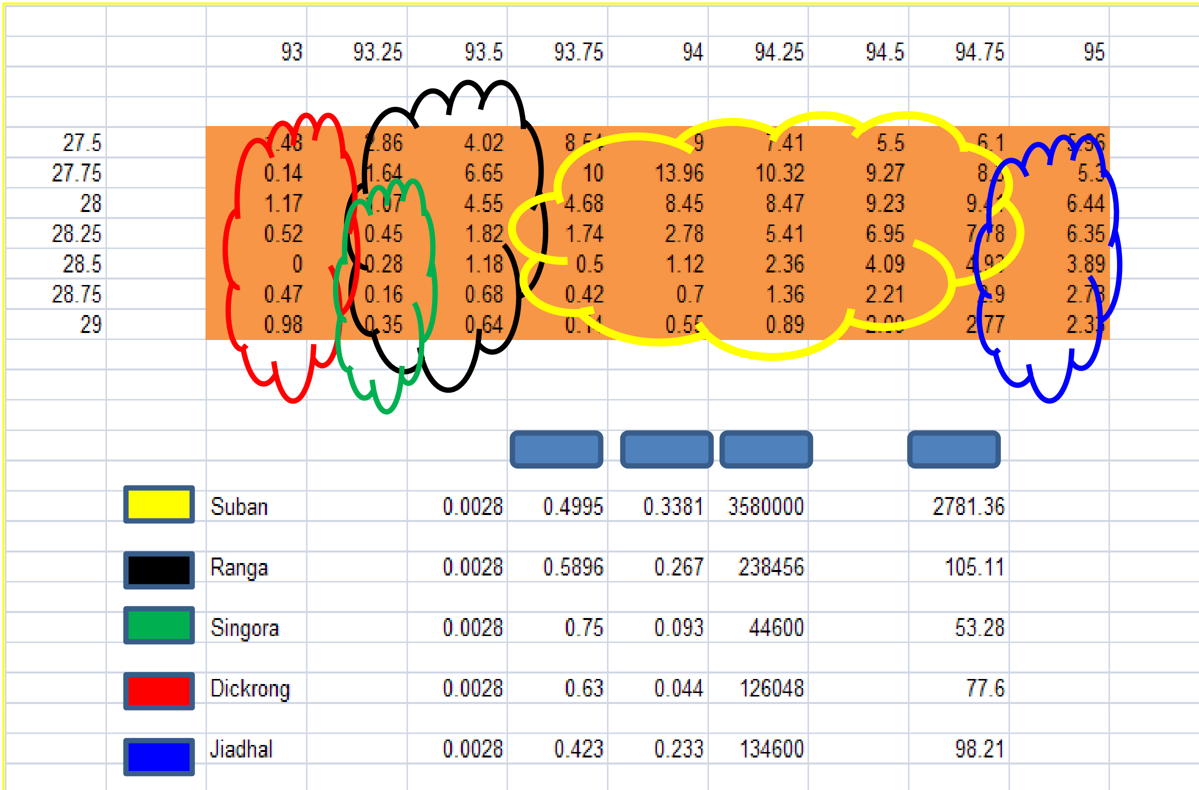
A = Area of watershed in Acres.

For Calculating Discharge in Cumec (Cubic meter per second) the formula becomes

Q = 0.0028 C I A, where I is in *mm/hr* and A will be in *Hectares*.

For a homogeneous drainage area in terms of soil and land cover, the co-efficient of discharge is generally taken as per the USDA C-value table.

Problem arises when there is heterogeneity of soil and land cover across the basin. It is preferable to segregate the basin into hydrologic response unit (HRU) based on soil and land cover to the extent possible rather than using a combined C-value. Moreover the antecedent moisture also plays an important role while deciding C-value. In the present study, different C-values have been applied during pre-monsoon and monsoon season from soil saturation point of view.



	93	93.25	93.5	93.75	94	94.25	94.5	94.75	95
27.5	[illegible]	[illegible]	4.02	[illegible]	[illegible]	[illegible]	5.5	6.1	[illegible]
27.75	0.14	[illegible]	6.65	10	13.96	10.32	9.27	[illegible]	[illegible]
28	1.17	[illegible]	4.55	4.68	8.45	8.47	9.23	[illegible]	6.44
28.25	0.52	0.45	1.82	1.74	2.78	5.41	6.95	[illegible]	6.35
28.5	0	0.28	1.18	0.5	1.12	2.36	4.09	[illegible]	3.89
28.75	0.47	0.16	0.68	0.42	0.7	1.36	2.21	[illegible]	[illegible]
29	0.98	0.35	0.64	[illegible]	[illegible]	0.89	[illegible]	[illegible]	[illegible]

Suban	0.0028	0.4995	0.3381	3580000	2781.36
Ranga	0.0028	0.5896	0.267	238456	105.11
Singora	0.0028	0.75	0.093	44600	53.28
Dickrong	0.0028	0.63	0.044	126048	77.6
Jiadhal	0.0028	0.423	0.233	134600	98.21

Fig.9: The rational model daily peak discharge forecast

The quasi distributed HEC-HMS model

This model have been developed by the Hydrologic Engineering Centre of the US army corps of engineers for studying natural hydrologic response of a system of streams or a watershed to a certain rainfall event. A physically based distributed hydrologic model forms the core of HEC-HMS. The model is designed to simulate the precipitation run-off processes of dendritic drainage systems of watersheds. The physical representation of the watershed is accomplished with a basin model. Different hydrologic elements are connected in a dendritic network to simulate run-off processes. A variety of methods are embedded for simulating infiltration losses, transforming excess precipitation into surface runoff, calculating base flow contribution to sub basin outflow, flow routing etc.

Two main components that are being used in the present study are the rainfall to run-off conversion component and the flow routing component. The first component is based on Soil Conservation services (SCS) curve number (CN) method which gives us the surface run-off at certain upstream locations where as the second component is based on Muskingum flow routing equations that gives us the corresponding flow at different downstream locations. The execution of both the above mentioned components is done in GIS platform. A number of flood related studies have shown that this model provide useful near accurate result.

The popular form of the SCS-CN method is

$Q = (P - Ia)^2 / P - Ia + S$

Where

Q is the runoff (m) and P is the rainfall (m)

S is the potential maximum soil moisture retention after beginning of runoff (m)

Ia is the initial abstraction(m) i.e the amount of water before runoff such as infiltration, rainfall interception by vegetation etc. Generally **Ia** is taken as **0.2 S**

In the curve number method the S and the curve number CN is related as

$S = (1000/CN) - 10$, where

The value of CN ranges from 30 to 100. Lower numbers indicates low runoff potential and higher numbers indicate increase in runoff potential. Low CN values also indicate good soil permeability.

The flow routing component is taken care of by the above mentioned Muskingum hydrologic routing. As the term "hydrologic" suggests, this method ignores the momentum equation and based solely on the continuity equation. The peak is attenuated as a result of diffusion caused by storage effect, which is given by

$$Q = x\, I + (1 - x)\, O$$

$$S = K\, Q$$

Where, K is the travel time between two channel sections and x is a dimensionless factor between 0.0 to 0.5 that weighs the influence of the inflow and outflow hydrographs on the storage within reach.

Substituting the storage equation into continuity equation yields

$O2 = C0I2 + C1\ I1 + C2\ O1$

Where

$$C_0 = \frac{Kx - 0.5\,\Delta t}{K - Kx + 0.5\,\Delta t}$$

$$C_1 = \frac{Kx + 0.5\,\Delta t}{K - Kx + 0.5\,\Delta t}$$

$$C_2 = \frac{K - Kx - 0.5\,\Delta t}{K - Kx + 0.5\Delta t}$$

The sum of all the three coefficients is 1.

The critical part of the calculation is to estimate suitable values of K and x. These values should be obtained by calibrating to available sets of measured inflow and outflow hydrograph data for the channel reach. In case of non availability of data, the value of x between 0.2 and 0.5 is recommended.

Once K and x are known for a channel reach, the computational procedure to obtain the outflow hydrograph is as follows

Step 1: Discretization of the inflow hydrograph in time increment of *Delta t*.

Step 2: Calculation of the three coefficients.

Step 3: Computation of the outflow hydrograph with Muskingum equation at the end of the channel reach.

Step 4: Repeating of step 3 till the end of the inflow hydrograph is reached.

Figure 6 & 7 below explains briefly the WRF data input into the quasi distributed HEC-HMS model set up and the HEC-HMS operational block.

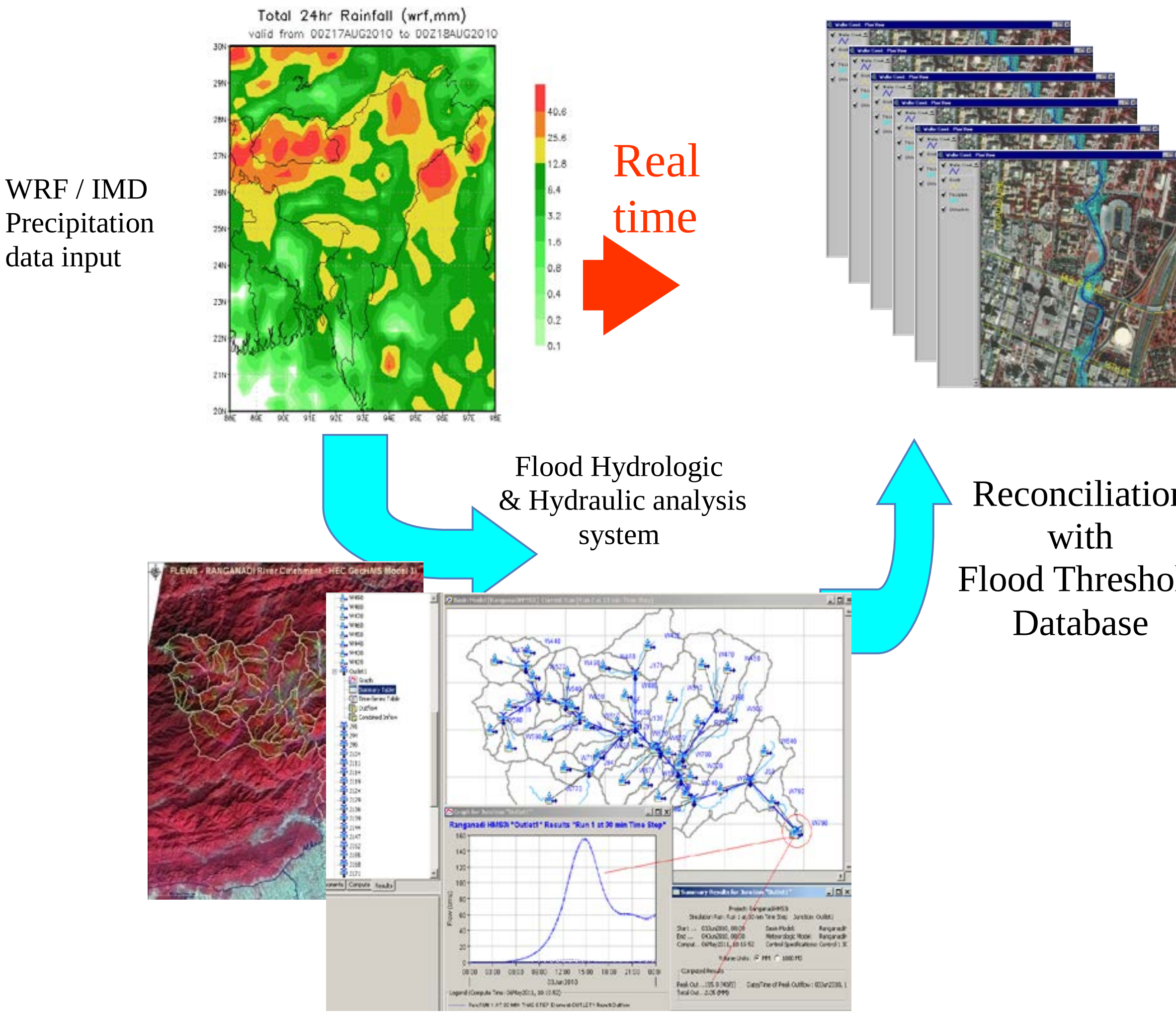


Fig.10: The HEC-HMS model set up

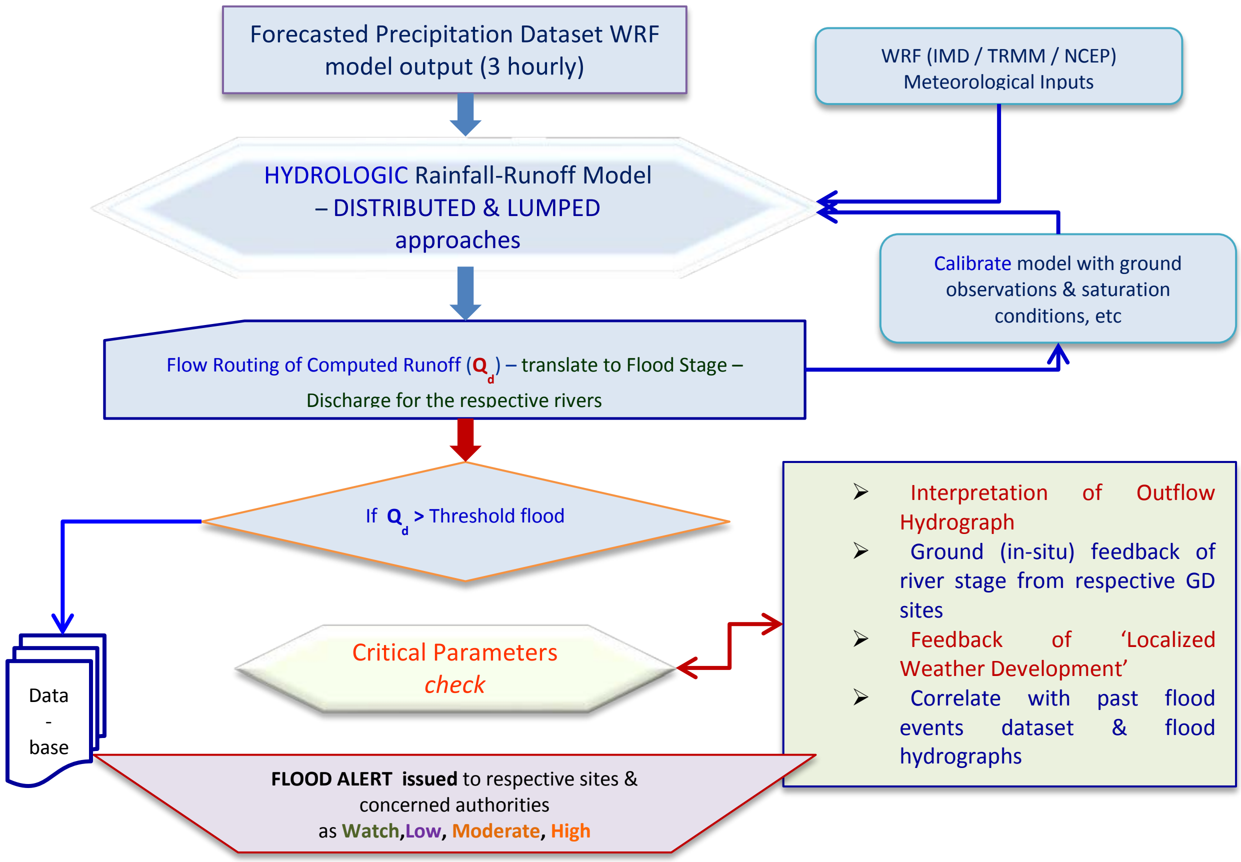


Fig.11: The HEC-HMS operational block

5.5 Generation and dissemination of Flood Early Warning

Once the peak discharge from the rational model and the daily outflow hydrograph from the HEC-HMS are computed and compared with flooding threshold and the synoptic weather monitoring advisory, warning are issued for the concerned river and its corresponding revenue circle.

Figure 12 below explains the daily flow of events leading to the issue of flood early warning system. Two parallel formats of early warning, one brief alert message by SMS followed by a detailed message attached with relevant maps by email are generated by the FLEWS hydrology

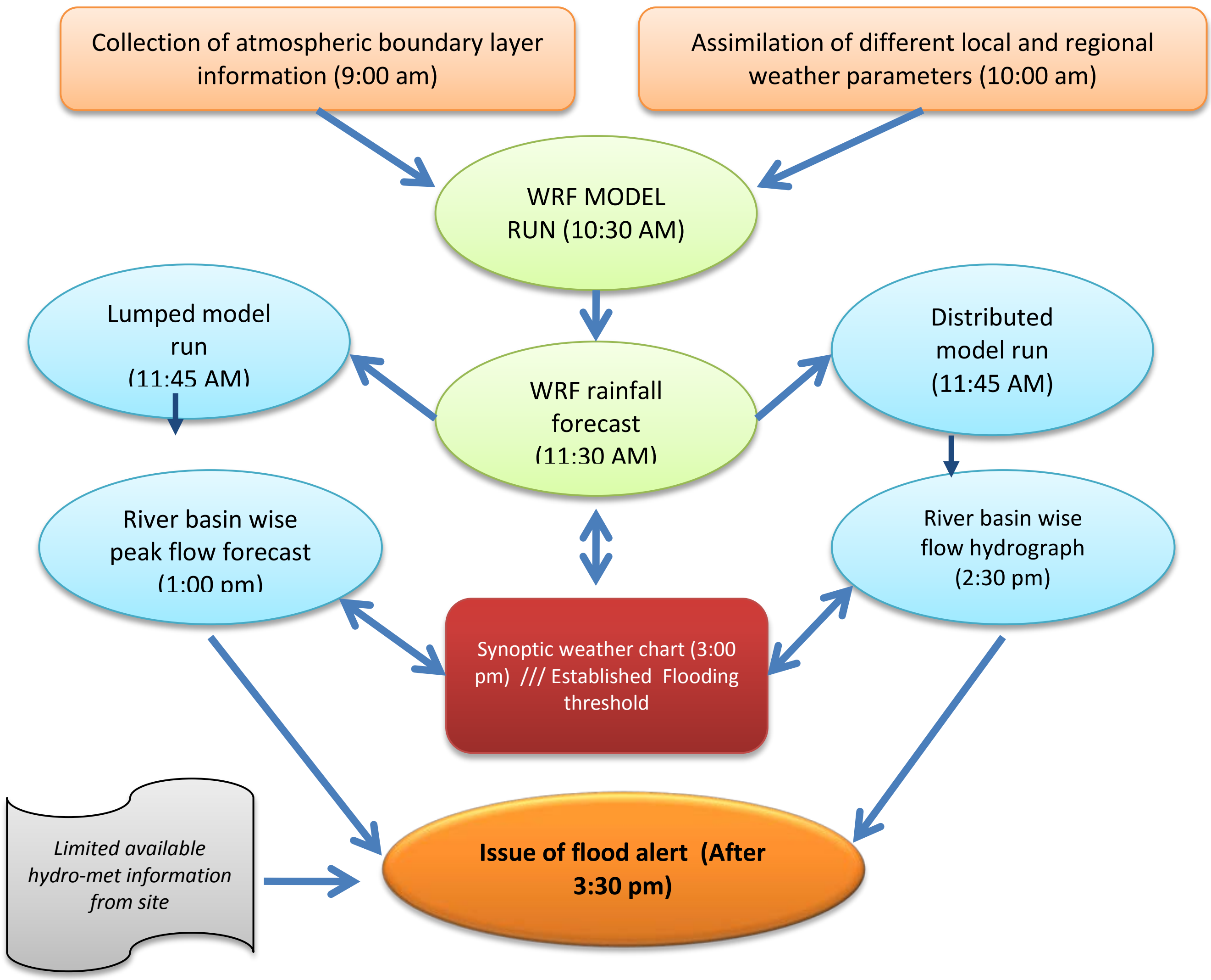


Fig.12: Daily flow of events leading to Flood Warning

team and disseminated to three concerned user groups (Comprising of ASDMA control room, Deputy Commissioners, ASDMA DPOs, NDRF etc) namely Upper Assam, Middle Assam/Barak valley and lastly Lower Assam. The dissemination part is taken care of by the FLEWS communication team of NESAC. The 24/7 ASDMA control room at Dispur, Guwahati further forwards the FLEWS alert to the grass root level (Circle officers and beyond) for ground preparatory actions in anticipation of an upcoming flood wave. Figure 13 below explains the user groups to whom both the SMS and email flood alerts are disseminated under FLEWS.

Figure 14 depicts the sample geospatial maps attached with the alert as a value addition for the geographical knowledge of the flood managers.

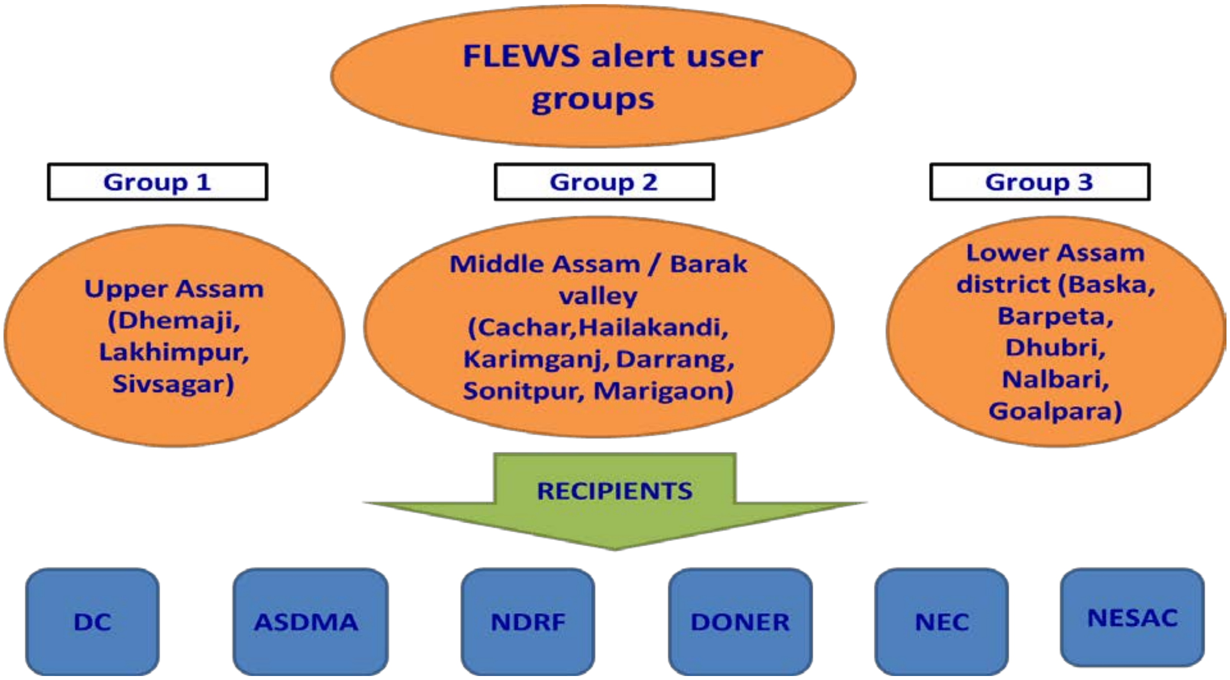


Fig.13: FLEWS alert user groups in 14 districts of Assam

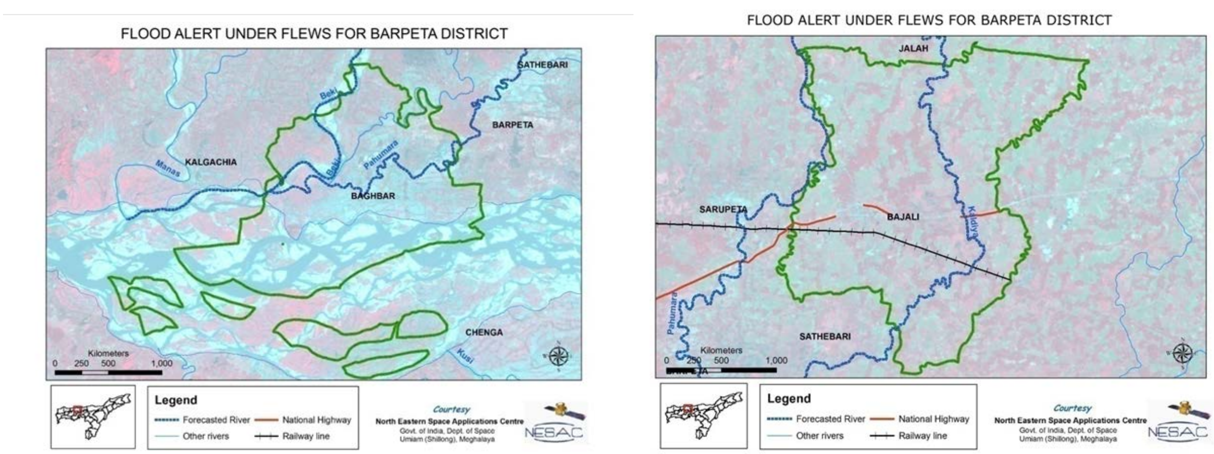


Fig.14: Sample flood alert maps of Baghbar and Bajali revenue circle of Barpeta district

5.5.1 Methodology for dissemination of flood warning alerts to districts

Once the Flood Warning alert is received at the State HQ., the same is disseminated to the District Deputy Commissioners and the District Project Officer (Disaster Management) for alerting the concerned Circle Officers, Water resource Deptt., PWD (Roads) Deptt., through SMS, phone/mobile and personnel messenger.

The flow chart for Flood Warning dissemination is shown in Figure 15

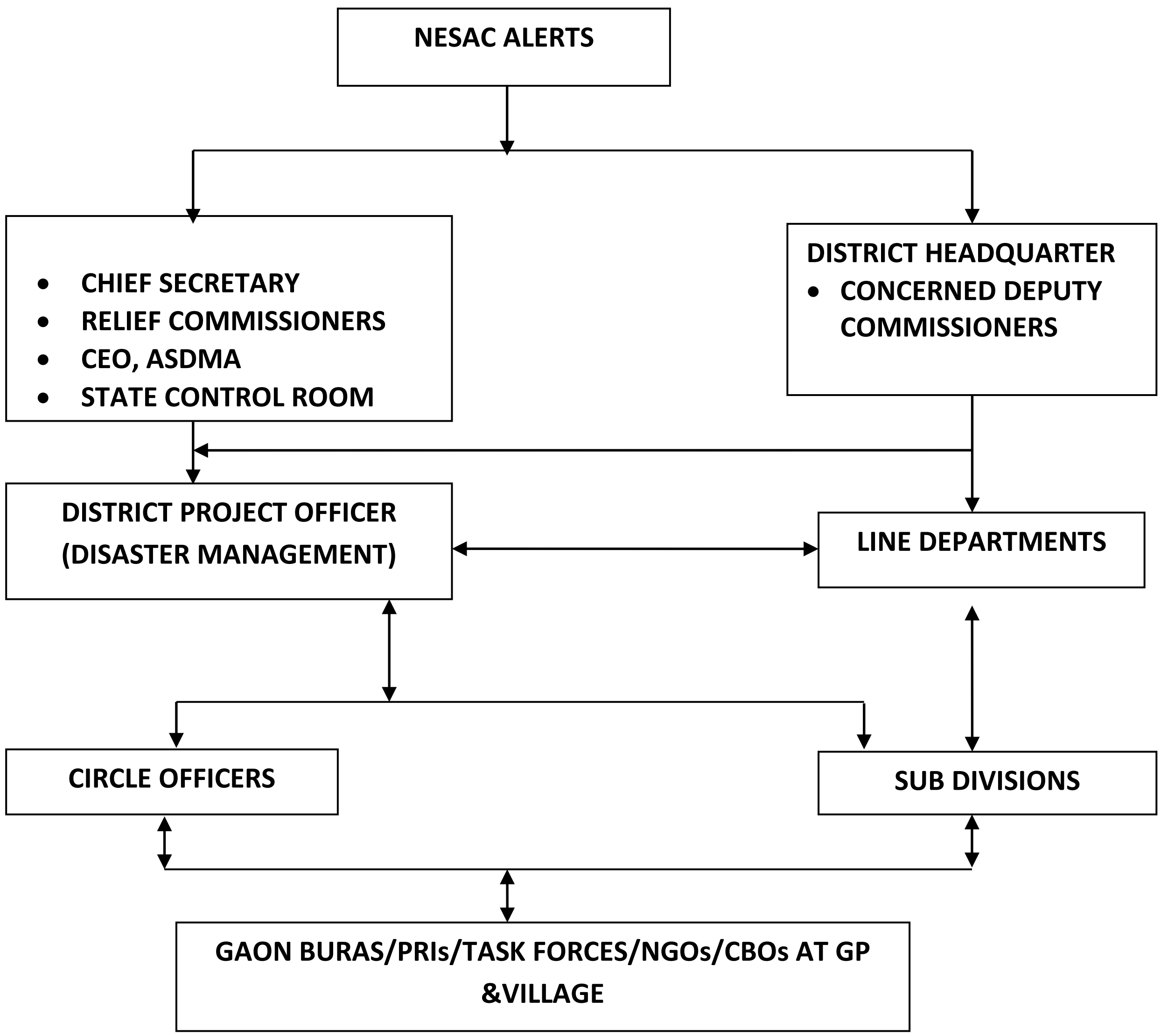


Fig.15: Flow Chart for Flood Warning Dissemination

6.0 ROLE OF DIFFERENT ORGANISATIONS /STAKEHOLDERS

FLEWS is an integrated effort of different stakeholders viz. IMD, CWC, NEEPCO, Water Resources Department, NESAC and ASDMA to achieve a common goal of effective management of flood in Assam. The Assam State Disaster Management Authority (ASDMA)took the lead role in bringing all the stakeholders together in a common platform for developing this system. Prior to development of FLEWS each stakeholders were working independently within their own domains for flood management and it was ASDMA that played the catalyst role in getting all on board and brought in the North East Space Application Centre to develop the location specific FLEWS model. Since then each department has been contributing significantly for effective implementation of the FLEWS and thereby making it a success.

The role of various stakeholders are as follows:

6.1 Assam State Disaster Management Authority(ASDMA)

- Initiating the dialogue with different stakeholders and keeping the momentum till the final result
- Convening periodic meeting with different stakeholders from time to time to ensure their active participation
- Providing all relevant data and maps to the concerned agency
- Review of embankment status pre and post flood season
- Dissemination of Flood Advisory to District Administration, Revenue Circle Officers and Gaon Buras
- Flood Inundation Monitoring from field data
- Validation of the flood advisories issued by NESAC
- Review meeting after the flood season for analyzing what went right and wrong with all stakeholders

6.2 North Eastern Space Application Centre (NESAC)

- Hydro Meteorological Data Collection & Analysis
- Monitoring of Embankment Breaches during pre and post flood
- Issue of Flood Warning Alerts during flood season

6.3 Central Water Commission (CWC)

- Dissemination of Daily water level for major rivers in Assam

6.4 Indian Meteorological Department (IMD)

- Daily weather forecast
- Supply of real time satellite images and products

6.5 Assam Water Resources Department (AWRD)

- Monitoring of Water Level for different rivers and dissemination of the field data

7.0 STRATEGIES ADOPTED FOR BRINGING ABOUT THE TRANSFORMATION AND ITS IMPACT

The first strategy in the establishment of FLEWS is the consideration of the flood prone districts on a basin or catchment. The early warning system has been viewed in the context of a river basin approach where upstream, midstream and downstream activities affect the time of concentration and volume of runoff as reflected in the shape of the hydrograph. Given the fact that most flood prone communities are aware that heavy rainfall intensities upstream may result to flooding in the downstream area, the FLEWS will systematize or enhance the existing coping mechanisms of communities.

The second strategy adopted in FLEWS is providing location specific early warning advisory bulletin. The warnings issued by NESAC provide information about the revenue circles and the probable villages that may be affected due to flood. This information is of great help to the administrative machinery for preparedness and response activity. The flood alert is also disseminated to the community through revenue circle officers and gaon buras.

The third strategy is the involvement of all the stakeholders under FLEWS as without their active participation FLEWS could have never been a success. To keep the stakeholders participation and involvements at an optimum level, stakeholders are continuously engaged in periodic reviews, meetings both at State and District levels.

8.0 UNIQUENESS OF THE PROJECT

I. This methodology of flood warning has probably been tried out for the first time in the country.

II. The project is an integrated approach to develop Flood Early Warning System. All stakeholders viz. IMD, CWC, NEEPCO, Brahmaputra Board, NESAC are taken into the system.

III. The FLEWS provides early warning of flood in magnitude (severity), location (revenue circle/group or cluster of villages) and probable time (within 12-24 hours range), high rainfall warning with location and time, pre and post monsoon status of embankment in various flood causing rivers etc.

IV. The alert for possible flood situation in district/revenue circle level is given with lead time of 7-18 hours.

9.0 EFFECTIVENESS OF FLEWS

As Central Water Commission gives the water level of only the major rivers of the State, leaving out the tributaries contributing to flooding, the administrative machinery was left clueless for issuing warning to the specific revenue circle or village. This problem has been resolved with the initiation of FLEWS project as the flood warnings are location specific i.e the revenue circle/cluster of villages that are likely to be inundated due to flood is identified. Apart from the location specific information the water level of minor tributaries monitored by different organisations are also taken into consideration under FLEWS. These combined information helps the administrative machinery in alerting the revenue circle officers and concerned gaon buras the rivers that are likely to cause flood so that necessary precaution can be taken by them in advance for preparedness and response activities for the people residing in those areas.

10.0 SUCCESS OF FLEWS

Though FLEWS was implemented on a pilot basis in Lakhimpur district during 2009 with only four major rivers, major flood events during July-August, 2009 were forecasted successfully.

In 2010, FLEWS was taken up in Lakhimpur district in operational phase and other four districts namely, Dhemaji, Barpeta, Baksa and Nalbari were taken up on a pilot basis. Success rate was improved from 25% to about 51%.

With five operational districts, three new Barak valley districts of Cachar, Karimganj and Hailakandi were added in pilot scale during the year of 2011 taking the total to 8 districts. Inspite of increasing number of districts, success rate further improved to about 60%. During 2011, most of the flood events were forecasted accurately. Out of 24 flood alerts comprising all 8 districts issued during the flood season of 2011, 19 times(79.16 %) water rise were recorded, 4 times (16.66 %) actual flood inundation took place, Only once (4.16 %) no flooding condition was reported.

With the increasing demand from District Administration of other districts FLEWS was further extended to six more flood prone districts i.e Sivasagar, Sonitpur,Darrang,Morigaon,Goalpara and Dhubri districts during 2012, thereby extending the FLEWS project to 14 districts (8 operational+6 pilot). Success rate further improved to about 65%.Altogether 64 flood alerts were disseminated during 2012, out of which flood was reported for 42 flood alerts.

The State Government has recognized the benefits of the FLEWS project and as it has proved to be an effective tool for decision making the project is being expanded to cover the entire State of Assam. For effective operationalization of FLEWS in all the flood prone districts of the State special funds are being earmarked from the current year.

10.1 Area affected, Population affected and Human Lives lost- A comparative analysis

While natural hazards may be inevitable, disaster losses, however, can be minimized through adequate disaster risk management. This has been amply demonstrated in the case of Floods for the State of Assam. After the setting up of the State Disaster Management Authority and the adoption of preparedness and mitigation measures like Flood Early Warning System (FLEWS), Use of Satellite imagery for embankment status, constant review and monitoring at the highest level, contingency planning etc, the damages and losses due to floods have come down considerably. In the year 2004 & 2007, percentage of population affected was 40.50 and 34.82 respectively which has come down to 8.16% in 2010, 2.92% in 2011 and 11.79% in 2012. It may be noted that the year 2012 saw two waves of high magnitude flood affecting all the districts of Assam. This reduction in losses has taken place while rainfall activity has remained more or less the same in 2004 and 2011 at 1524.9 mm and 1502.4 mm respectively. In the year 2010 & 2012, on the other hand, rainfall activity was much more than 2004 at 2107.6 mm and 1958.2 respectively.

Year	Area Affected (lakh ha)	Population Affected (lakh)	% Area Affected	% Population Affected	Human Lives lost
1984	15.2	56.8	19.38%	25.36%	90
1987	15.3	104.9	19.51%	46.83%	127
1988	38.2	84.1	48.70%	37.54%	232
1991	10	53.07	12.75%	23.69%	108
1998	13.24	69.57	16.88%	26.15%	125
2004	23.64	126.37	30.14%	40.50%	497
2007	15.04	108.67	19.17%	34.83%	134
2008	4.16	29.06	5.30%	9.31%	40
2010	-	25.46	-	8.16%	12
2011	-	9.12	-	2.92%	11
*2012	15.10	36.8	19.25%	11.79%	149

Source: CWC letter No 3/38/2011-FFM/465-556
**As per reports of the State Disaster Response & Information Centre*

10.2 VOICES FROM THE DISTRICTS

10.2.1 BARPETA

FLEWS 2012

Sl No	Date	Warning	Water Level	Result
1	03/06/12	Low Flood (12-36 hrs) (Beki and its Tributaries)	Rising	Breach gap at Sarthebari, Kaldia river
2	14/06/12	Low to Moderate (72 hrs) (Chaulkhowa,Kaldia,Pahumara,Beki & Manas)	Rising	Breach gap at Kaldia river,Deojara) Flood in Barpeta,Sarupeta,Bajali RC caused due to Chaulkhowa,Kaldia,Pohumara
3	24/06/12	Moderate 24-48 hrs (Beki,Pahumara, Kaldia & Nakhanda)	Rising	Flood in Bajali & Sarupeta caused due to Pohumara & Kaldia
4	26/06/12	Moderate (Extension of Previous Warning) 48 hrs (Chaulkhowa,Brahmaputra,Kaldia,Beki)	Rising	Flood in Sarthebari,Barpeta,Chenga,Kalgachia & Baghbar RC due to Chaulkhowa,Brahmaputra,Kaldia,Beki

FLEWS 2012

Sl No	Date	Warning	Water Level	Result
5	12/07/2012	Low (24-48 hrs) Beki, Pohumara, Kaldia	Rising	Flood in Sarthebari,Barpeta,Chenga,Kalgachia & Baghbar RC due to Beki, Pohumara, Kaldia & Morachaulkhowa
6	17/07/2012	Low (24 to 48 hrs) Beki,Pohumara,Kaldia,Bhellengi	Rising	Flood affected in Sarthebari,Baghbar,Barpeta,Chenga and Kalgachia Rev. Circle due to Beki,Pohumara,Kaldia,Bhellengi & Morachaulkhowa
7	23/08/2012	Low to Moderate (72 hrs) Beki,Pohumara,Kaldia& Nakhanda	Rising/ Falling	No Flood
8	20/09/2012	Low to Moderate 24-48 hrs (Beki,Pohumara,nakhanda & Brahmaputra)	Rising	Flood in Barpeta, Bajali,Chenga,Kalgachia & Baghbar RC due to Beki,Pohumara,nakhanda& Brahmaputra

In 2012 FLEWS

- Total Warning= 8 nos
- Accurate Result= 7 nos
  - » (Breach Gap 2 nos)
  - » (Flood occurrence 5 nos)
- Note: However, in one case there was no flood but, Water Level was rising.

Case Study

1. **Warning was received on26/06/12 from FLEWS about moderate flood in the following 48 hrs in river Brahmaputra, Kaldia, Beki & Morachaulkhowa)**

   Due to heavy rainfall at Up stream the water level rose briskly and flood occurred in Sarthebari, Barpeta, Chenga, Kalgachia & Baghbar RC. The Breach Gap occurred in the river embankment at Pazarbhanga village under Barpeta Rev. Circle on 27th June 2012 around 11:40 P.M

   Due to the advance alert mechanism, the Officials of the District Administration could inform the community through Circle staffs, keep boats on stand by and also evacuate the community to a safer place and inform the concerned departments for necessary action.

10.2.2 DHEMAJI

The Flood Early Warning received from NESAC turned out to be accurate during the last monsoon in respect of the Flash Flood that occurred on 15th July 2012 at Jiadhal, Kumatia ,Gainadi river of Dhemaji , Gogamukh and Sisiborgaon Revenue Circle (accuracy 100 %).

The early warning for 22nd July was 50% accurate and for 19th August it was 66.6% accurate. The severe flood of 12th Sept which affected large portion of the entire Dhemaji Revenue Circle was correctly predicted.

After receiving the alert messages from NESAC, the District Administration prepared itself to face the situation and immediately informed the people residing near the dykes and other low lying area as they are more vulnerable. Proactive measures were also taken by the SDRF and IWT personals. The Deputy Commissioner himself rushed to the worst affected spot at Betalung and inspected the rescue operation

10.2.3 GOALPARA

As soon as the message is received, the same is communicated to Deputy Commissioner and as per his direction the message is transmitted to the concerned circle officers and Water Resource Department through mobile phone network.

The concerned circle officer then percolates the message to the mandal (field level revenue functionary) of the respective villages. The concerned mandal then communicates with the village head and takes stock of the situation. If situation arises, the village head takes necessary arrangement to alert the respective community. Few circle officers transmit the message to the concerned Police Station or Police outpost .The Officer In Charge of the concerned Police Station then conveys the message to the village defence party who then starts to keep vigil on the river.

The Water Resource Department on receipt of the early warnings, conveys the message to their field functionaries. The field level functionary then keeps vigil over the weak embankments and takes remedial measure accordingly.

10.2.4 NALBARI

Utilization of the warnings issued under FLEWS project:

Once the alert is received from ASDMA, all Heads of Departments are alerted by W.T. /VHF message and the Circle Officers via SMS etc.

The Heads of Departments then alert their staff to remain prepared according to their flood contingency plan and inform the concerned officers for any un-toward incidents related to flood.

Simultaneously, the Circle Officers inform the Village Disaster Management Committees and the LR staff to remain extra vigilant regarding any breach or overtopping and inform the authorized person immediately if there is any breach or overtopping. The Boat Owners are also informed that their boats may be required for Evacuation purposes.

10.2.5 LAKHIMPUR

COMPILATION OF FLOOD ALERT FOR 2012

Sl. No.	Date of Flood Alert	Period of Flood Alert	Water level of vulnerable rivers (in meters) within the period of Flood alert with their Trends {W/L- Water Level, D/L- Danger Level)
1.	19-09-2012	24-36 hours.	Dikrong- 86.90m W/L {86.60 D/L) Rising Trend at 8 am on 20/09/12 Pabha- 92.30m W/L {91.97m D/L)) Receding Trend at 8 am on 20/09/12 Kakoi- 93.83m W/L {93.39m D/L) Receding Trend at 8 am on 20/09/12 Durpang-112.14m (112.32 D/L) Rising Trend at 8 am on 20-09-12
2.	12-09-2012	24-48 hours.	Dikrong- 87.02m W/L {86.60 D/L), Rising Trend at 8 am on 13-09-12 Pabha- 92.45m W/L {91.97 D/L), Rising Trend at 8 am on 13-09-12 Kakoi- 94.27m {93.39 D/L), Receding Trend at 8 am on 13-09-12 Singra- 93.21m W/L (93.16 0/L), Rising Trend at 8 am on 13-09-12 Ranganadi- 94.45m W/L (95.02 0/L), Receding Trend at 8 am on 13-09-12
3.	24-08-2011	24-36 hours.	Dikrong- 86.82m W/l(86.60 D/L) Rising Trend at 8 am on 25-08-12 Pabha- 91.90m W/L (91.97 D/L) Receding Trend at 8 am on 25-08-12 Kakoi- 94.07m W/L (93.39 D/L) Receding Trend at 8 am on 25-08-12 Durpang -112.02m W/L {112.32 D/L) Standing Trend at 8 am on 25-08-12 Singra- 92.86m W/L (93.16 D/L) Receding Trend at 8 am on 25-08-12

4.	19-08-2012	24-48 hours.	Dikrong- 86.58m W/L (86.60 D/L) Rising Trend at 8 am on 20-08-12 Pabha- 91.60m W/L (91.97 D/L) Receding Trend at 8 am on 20-08-12 Kakoi- 93.27m W/L {93.39 D/L) Rising Trend at 8 am on 20-08-12 Durpang -111.34m W/L {112.32 D/L) Receding Trend at 8 am on 20-08-12
5.	18-07-2011	24-48 hours	Dikrong- 86.92 W/L, {86.60 D/L), Rising Trend at 8 am on 19-07-12 Kakoi- 93.42m W/L (93.39 D/L) Receding Trend at 8 am on 19-07-12
6.	15-07-2012	24 hours.	Oikrong river - 87.17m W/L, (86.60 0/L), Rising Trend Rising Trend at 8 am on 16-07-12 Pabha- 91.95m W/L (91.97 0/L), Receding Trend Rising Trend at 8 am on 16-07-12 Kakoi- 94.03m W/L (93.39 0/L), Receding Trend Rising Trend at 8 am on 16-07-12 Ourpang -111.90m W/L (112.32 0/L), Receding Trend Rising Trend at 8 am on 16-07-12
7. .	25- 06-2012	24-48 hours	Oikrong river - 86.85m W/L, (86.60 0/L), Receding Trend at 8 am on 26-06-12 Pabha- 92.25m W/L (91.97 0/L), Receding Trend at 8 am on 26-06-12 Ranganadi- 94.80m W/L (95.02 0/L), Receding Trend at 8 am on 26-06-12 Brahmaputra -79.77m W/L (79.30 0/L), raising Trend at 8 am on 26-06-12
8.	24-06-2012	24-48 hours	Oikrong - 87.45m W/L, (86.60 0/L), Rising Trend Rising Trend at 8 am on 25-06-12 Pabha- 92.70m W/L (91.97 0/L), Rising Trend Rising Trend at 8 am on 25-06-12 Kakoi- 94.65m W/L (93.39 0/L), Rising Trend at 8 am on 25-06-12

9.	14-06-2012	24-48 hours	Oikrong river - 86.97m W/L, (86.60 0/L), Rising Trend Rising Trend at 8 am on 15-06-12 Pabha- 92.40m W/L (91.97 0/L), Rising Trend Rising Trend at 8 am on15-06-12 Kakoi- 94.42m W/L (93.39 0/L), Rising Trend at 8 am on 15-06-12 Singra- 92.21m W/L (93.16 0/L}, Rising Trend at 8 am on 15-08-12
10.	06-06-2012	24-48 hours	Oikrong river - 86.85m W/L, (86.60 0/L), Rising Trend Rising Trend at 8 am on 07-06-12 Pabha- 91.90m W/L (91.97 0/L), Receding Trend Rising Trend at 8 am on 07-06-12 Kakoi- 93.27m W/L (93.39 0/L), Receding Trend at 8 am on 07-06-12
11.	03-06-2012	24-48 hours	Oikrong river - 86.60m W/L, (86.60 0/L), Receding Trend Rising Trend at 8 am on 04-06-12 Pabha- 91.95m W/L (91.97 0/L), Receding Trend Rising Trend at 8 am on 04-06-12 Kakoi- 93.35m W/L (93.39 0/L), Rising Trend at 8 am on 04-06-12
12.	25-05-2012	24-48 hours	Oikrong river - 86.82m W/L, (86.60 0/L), RecedingTrend Rising Trend at 8 am on 26-05-12 Pabha- 91.75m W/L (91.97 0/L), Receding Trend Rising Trend at 8 am on 26-05-12 Kakoi- 93.17m W/L (93.39 0/L), Receding Trend at 8 am on 26-05-12

Percentage of successful early warning - 85 %
Executing strategies adopted by the district:

(1) The District Project Officer (Disaster Management) is the nodal officer for the information dissemination of FLEWS warning. He apprises the Deputy Commissioner, Addl. Deputy Commissioner (DM) and other key stake holders like Circle Officers, Water Resource Deptt., PWD (Roads) Deptt., National Disaster Response Force about probable flood vulnerability, through SMS and phone, mobile / personnel messenger.

(2) The Water Resource deptt. as well as the PWD (State and Rural Roads) maintains a strong liaison between their officials and their manpower at the field level and the District Administration is kept well informed on any emergency situations that may have arisen.

(3) The services of DIPRO for issuing press release for informing the public on making them aware about warnings (only in case of emergency)is utilized.

(4) Ice breaking exercise between National Disaster Response Force (NDRF) and Circle Officers, NDRF and Water Resources department officials conducted to make best use of information received from FLEWS.

(5) The Circle Officers who are also the Response Officers of the Quick Response Teams (QRT) (at the Circle Level) mobilize their respective QRTs and give directions for prompt action in the field.

11.0 MILESTONES

Following are some of the important milestone the FLEWS project has been able to achieve:

(a) This methodology of flood warning has probably been tried out for the first time in the country.

(b) From a small beginning in only one district of upper Assam in 2009, presently 14 districts are under this project in 2012.

(c) Majority of the significant flood events in the concerned districts under FLEWS has been successfully forecasted with lead time ranging from 7 hrs to 18 hrs.

(d) It has been officially recognized by user department that in spite of being heavy rainfall years, loss of life and property has been reduced from 2009 onward. Warning issued under FLEWS during these situations has been recognized as useful.

(e) This project has been able to bring all line departments such as CWC, IMD, Brahmaputra Board, Assam Water Resources department etc under a single umbrella of joint participation and accountability to achieve a common goal of effective management of flood in Assam. Govt. of Assam is further requesting NESAC to extend FLEWS to all flood prone district of Assam.

(f) Because of the recent success of FLEWS and at the behest of NDMA, New Delhi both Govt. of West Bengal and Bihar has officially communicated with NESAC for technical collaboration for pilot implementation of FLEWS in their respective states.

12.0 LESSONS LEARNT

The lessons learnt based on the feedback from the FLEWS implemented districts are:

1. The methodology of FLEWS needs to be developed further in order to attain better accuracy. This can be achieved by
    - Establishment of telemetry based real time monitoring system.
    - Establishment of scientifically designed hydro-met monitoring station network in all the major flood prone river basins.
    - Smooth flow of inter departmental data
2. Flood resilient life style practices should be sensitized through awareness campaign.
3. Increase in the lead time
4. Improving the warning dissemination process as the dissemination of the flood alerts are limited to the Deputy Commissioner and Revenue Circle Officers only
5. Develop Standard Operating Procedures (SOP) on the functions and responsibilities of the stakeholders

13.0 CONCLUSION

The district administration for those districts under FLEWS has welcomed the early warning and participated in it with great commitment. Flood is an annual event for the State of Assam and therefore the FLEWS help the administration in not only giving early warning but also in reducing the losses. Sustainability of the project is ensured as the project is being expanded to cover the entire State and also because it has proved to be an effective tool for decision making.

The model developed by North East Space Application Centre for Flood Early Warning which has an accuracy rate of around 60% needs to be developed further for which infrastructure for IMD & CWC in terms of increase in rain gauge stations specially in the upper reaches and increase in river gauging stations is required to be undertaken by Government of India. Further the Flood Early Warning System needs to be extended to cover all the flood hazard districts of Assam which will allow individuals exposed to hazard or agencies involved in the management of disaster to take action to avoid or reduce their risk for effective response.

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