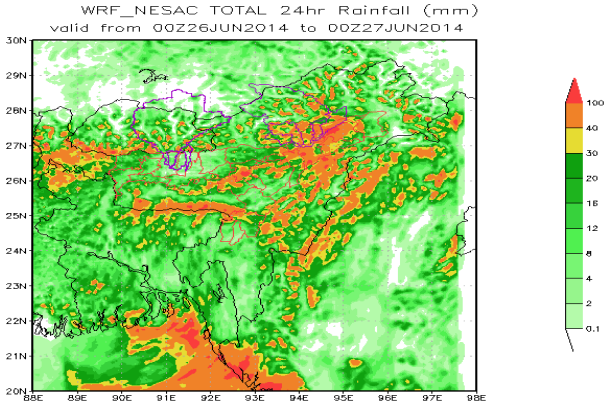
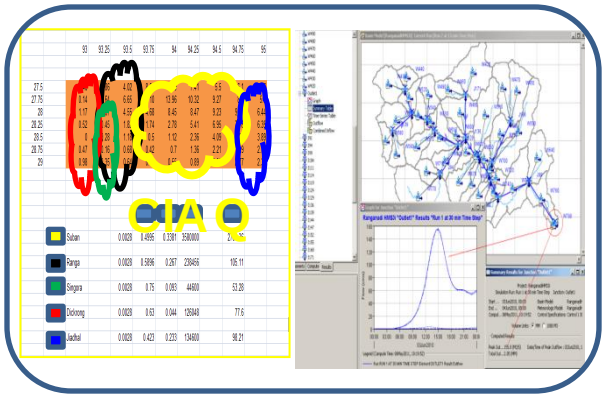
GIS BASED HYDRO-MET STREAM FLOW FORECASTING FOR EARLY WARNING OF FLOOD IN BRAHMAPUTRA VALLEY

AN OVERVIEW





By

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Govt. of India, Department of Space

Shillong, Meghalaya

Date: 09-03-2016

UNOOSA – NRSC, Hyderabad

Overall flood Management activities

- Weather watch using satellite data
- Rainfall data collection & analysis
- Run-off estimation
- Flood level/stage assessment
- Early warning
- Risk assessment
- Damage assessment
- Relief & Rehabilitation

TWO BROAD APPROACHES OF FLOOD FORECASTING

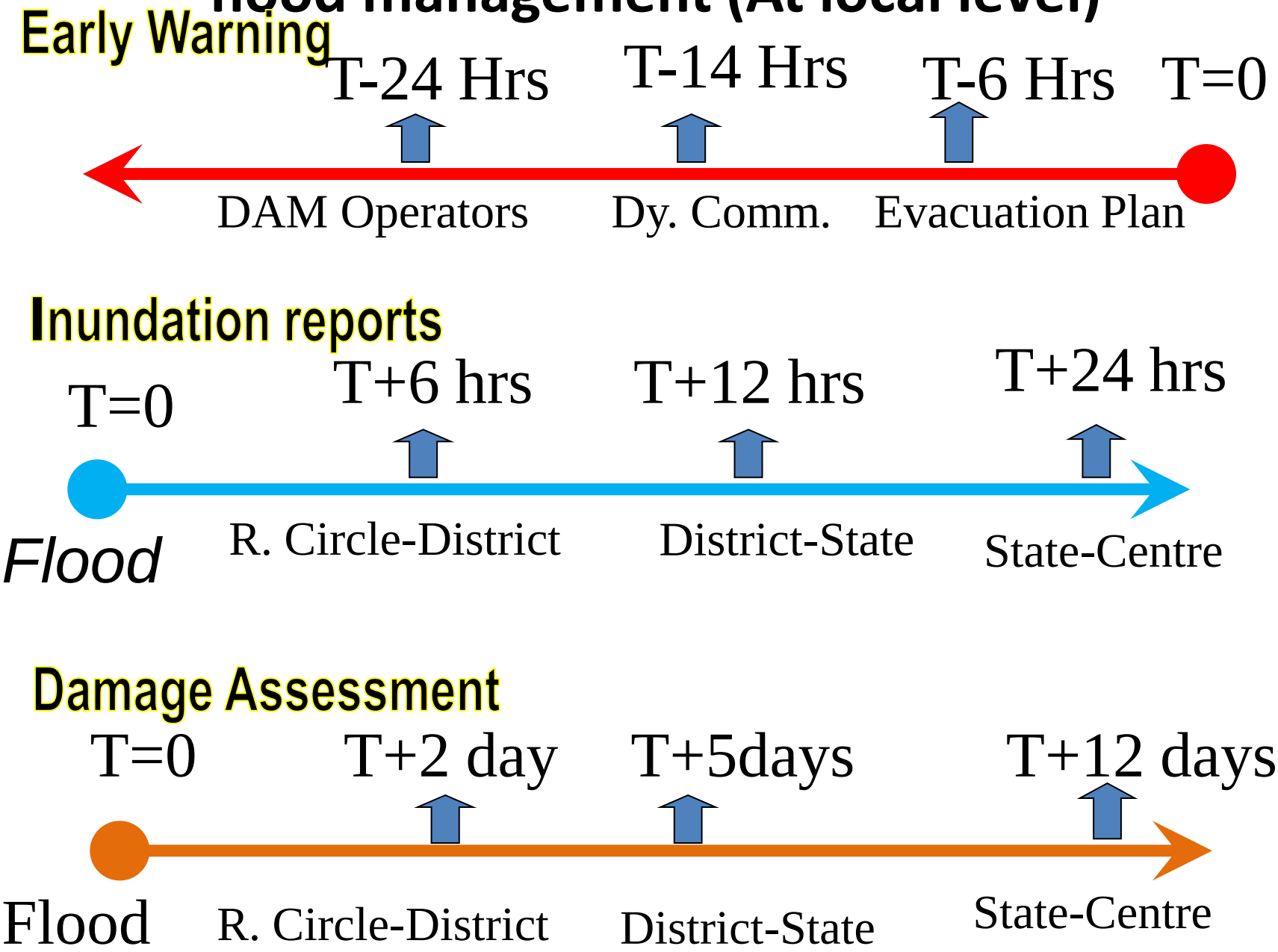
APPROACH 1:

- **Automatic Stage gauges at various locations in flood prone rivers**
  - Advantages:
    - Accurate and possibility for continuous monitoring of river stages and transmission of data through telemetry.
  - Drawbacks :
    - Very costly, manpower needs and continuous systems maintenance.
    - Not possible to predict spatial extent of the flood event.
    - Installation and maintenance problems in complex terrains + Security against theft

APPROACH 2:

- **Numerical Hydro-Met prediction system**
  - Combination of Numerical Weather prediction, Distributed Hydrological and Hydraulic Modelling, Synoptic weather monitoring and In-situ gauge monitoring

Time Dimension of Information Needs in flood management (At local level)



Major Components

FLOOD PREPAREDNESS (FORECASTING & EARLY WARNING):

METEOROLOGICAL COMPONENT

- **NUMERICAL WEATHER PREDICTION / FORECAST & SYNOPTIC WATCH**
  - Daily Weather forecast – WRF Numerical Prediction in NER domain
  - Real time satellite images and products – IMD , ISRO Kalpana-1, etc
  - Synoptic Weather Conditions Analysis & Advisory – IMD, AWS, etc

HYDROLOGICAL COMPONENT

- **HYDROLOGICAL MODELLING (Flood Discharge estimation & alert generation)**

  Distributed/Quasi-distributed /Lumped methods using forecasted WRF data

  Analysis of forecasted flood discharge with river water levels, threshold condition, etc

  Ground Reconciliation of current Flood level/stage with WRD-Assam, CWC, etc GD sites

DISSEMINATION of Flood Alerts (when threshold conditions are exceeded)

- SMS, E-Mails, Web dissemination etc

POST – FLOOD (Mitigation Component)

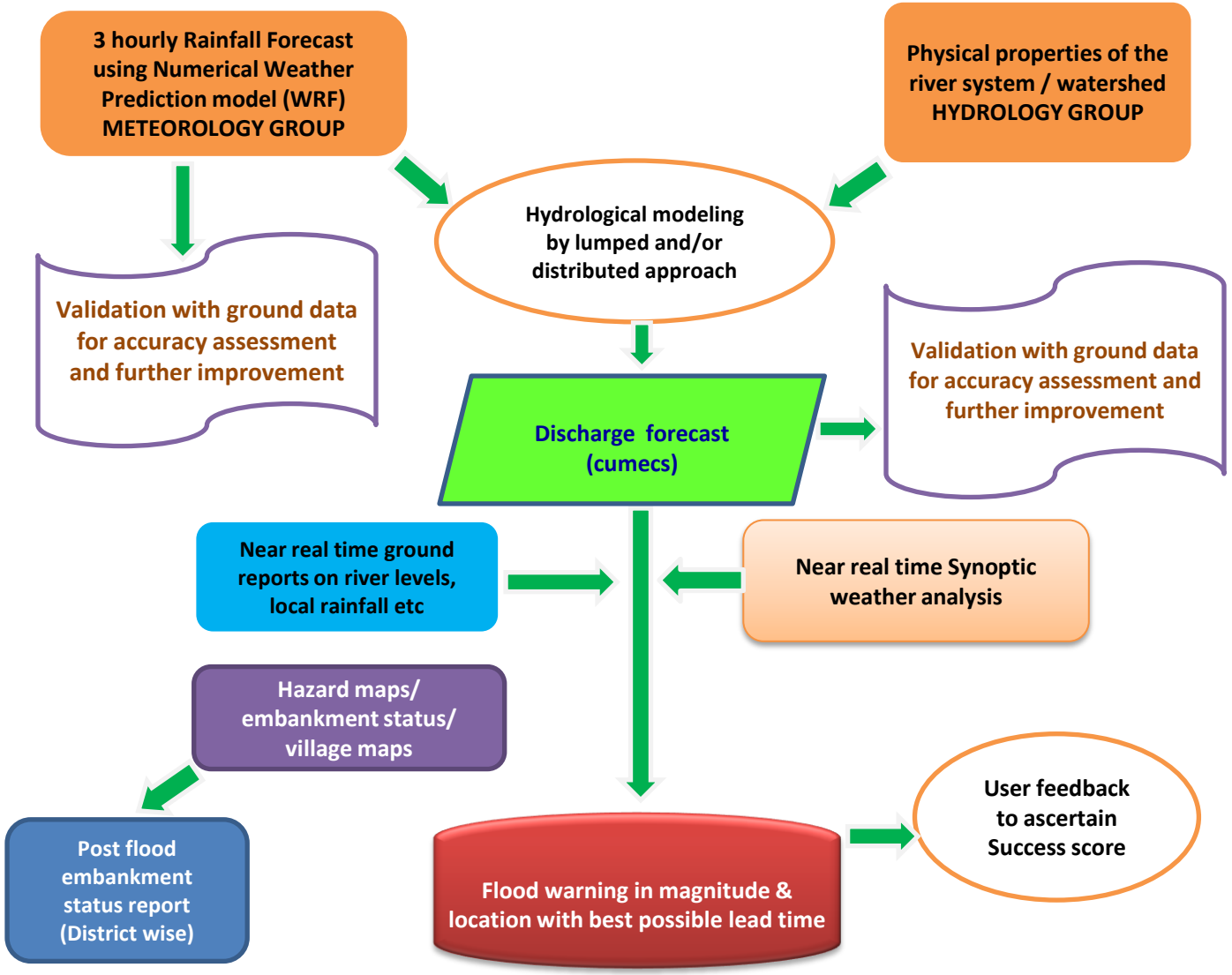
- River Embankment Breach Monitoring
- Flood Inundation Mapping (near Real-time)

OVERALL WORKFLOW & MAJOR COMPONENTS

MAJOR COMPONENTS

- **Meteorology Component**
  - ✓ Weather Research Forecast (WRF)
  - ✓ Synoptic weather forecasting
- **Hydrology Component**
  - ✓ Distributed hydrological model
  - ✓ Hydraulic Modelling
- **Embankment breach watch**
  - ✓ Pre-flood protection structures monitoring
  - ✓ Post-flood embankment breaches

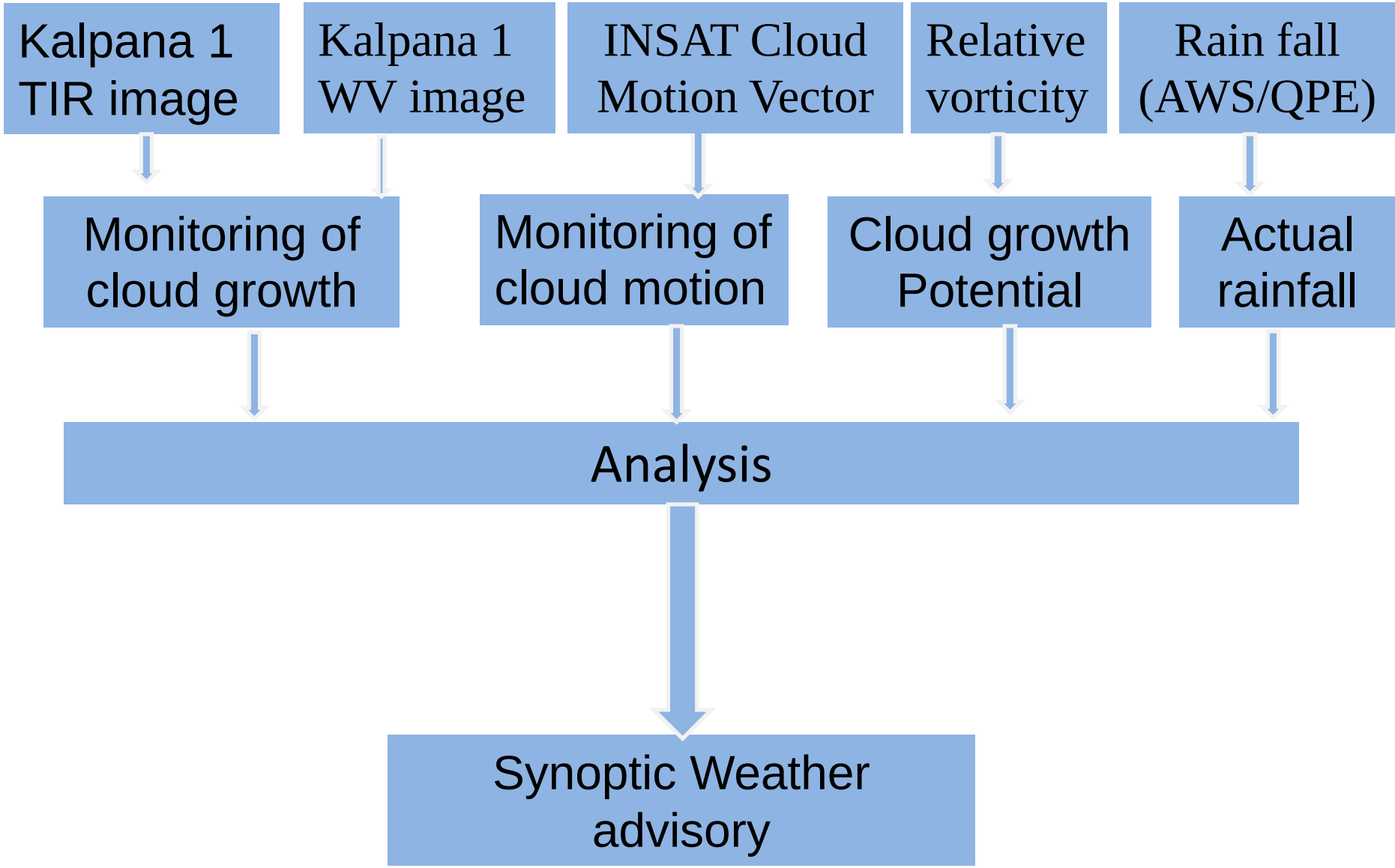
WORKFLOW CHART



What is Synoptic Weather Monitoring?

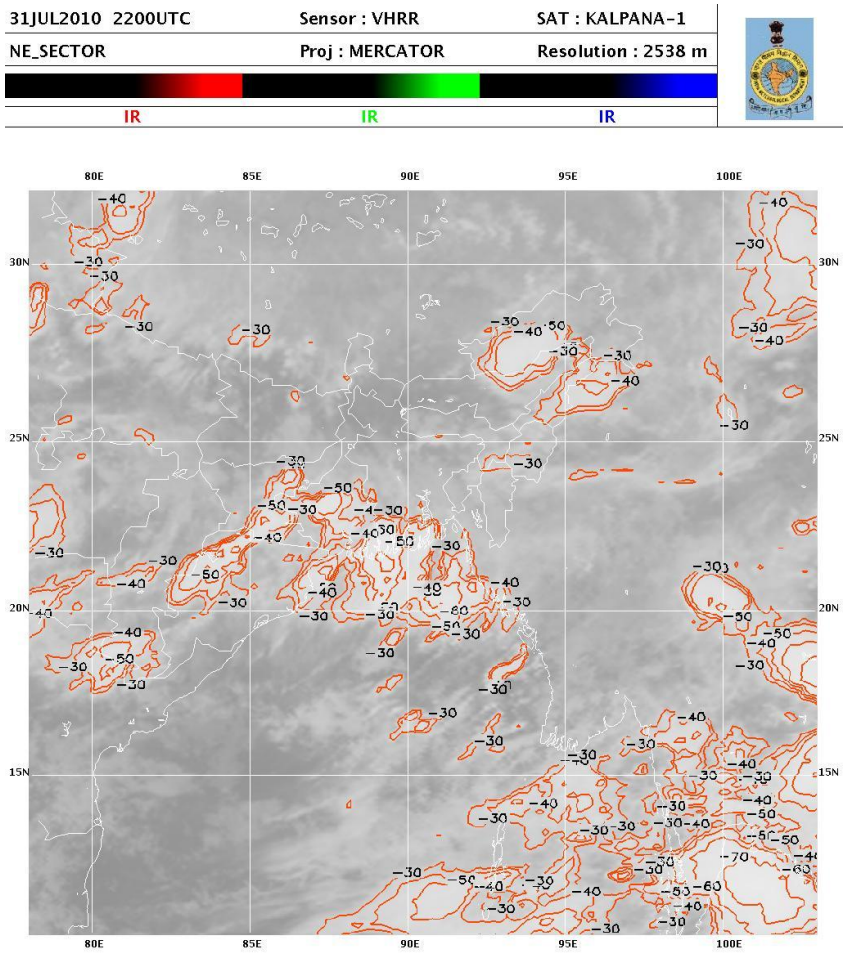
A meteorological observation made on the earth's surface in contrast with an upper air observation, at periodic interval of sky cover, state of the sky, cloud height, atmospheric pressure, temperature, precipitation, wind speed and direction etc. that prevails at the time of the observation or have been observed since the previous observation.

Synoptic Weather Advisory Flow Chart

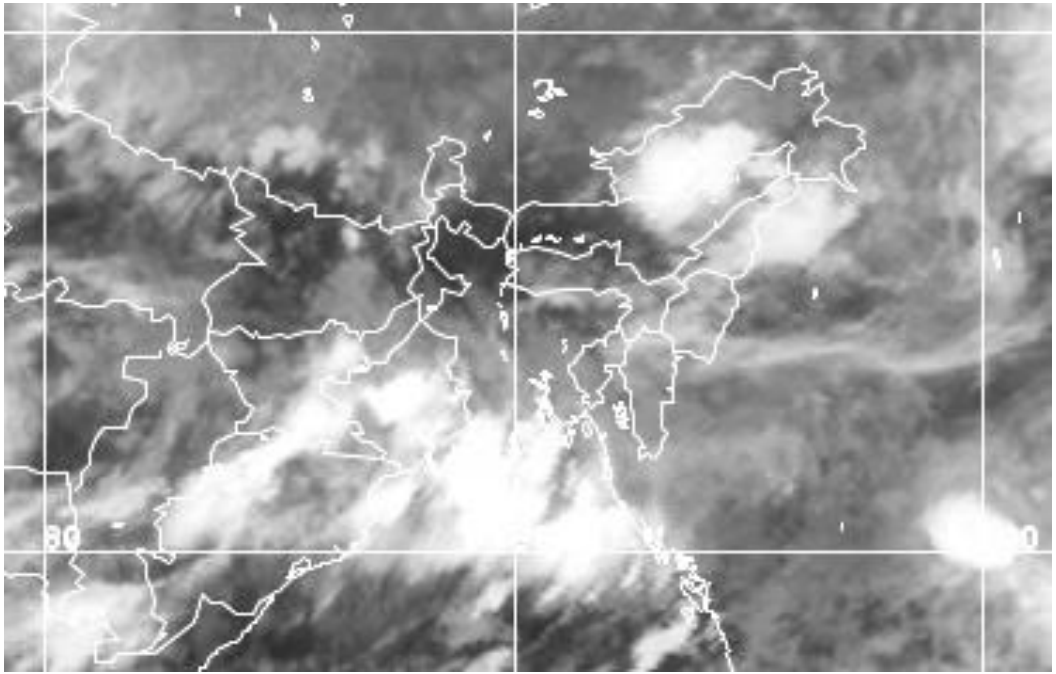


Monitoring of Cloud growth

Cloud top temperature from Thermal Infra Red (TIR) channel image



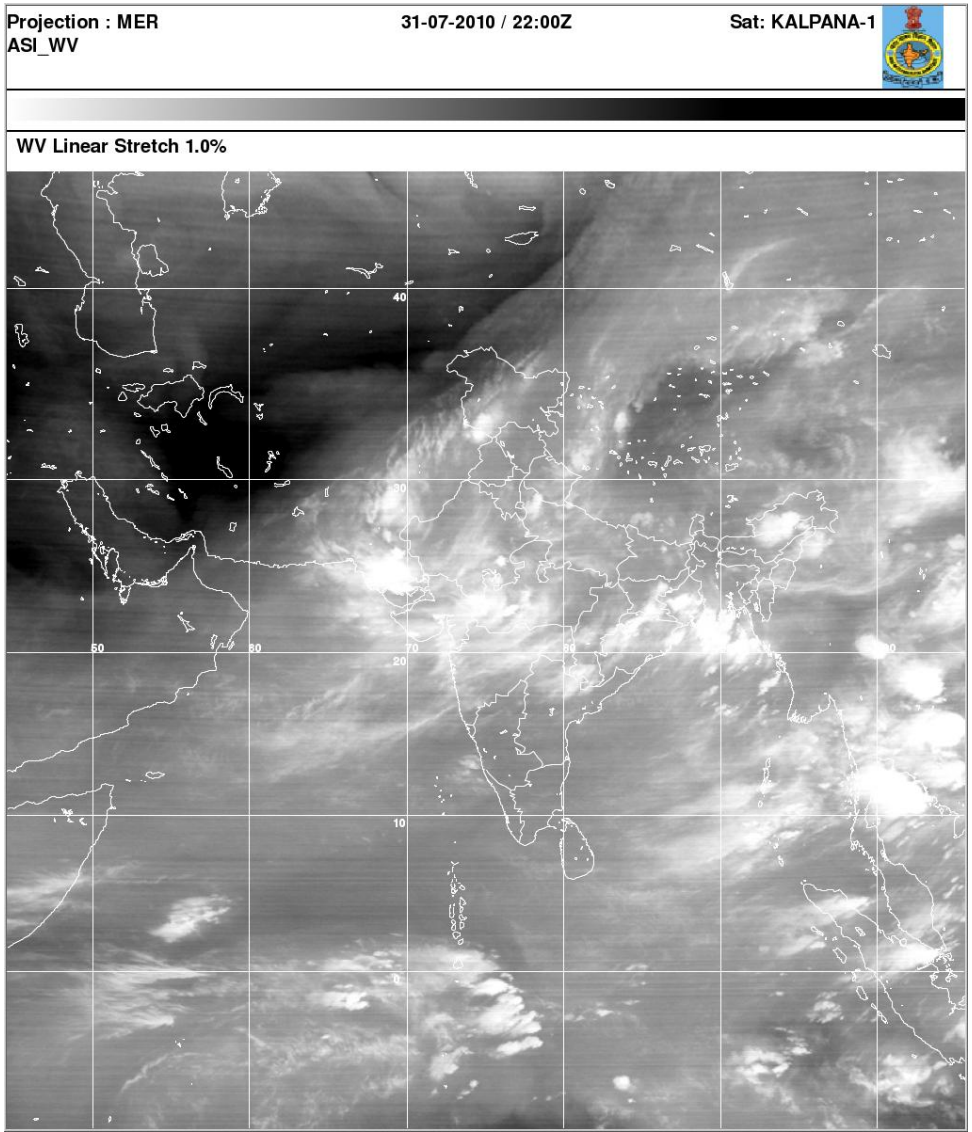
NER sector image is available with cloud top temperature (CTT). CTT value less than -40 °C indicates presence of cumulonimbus cloud (if not cirrus cloud), which normally gives heavy precipitation (apprx 25 mm/day)



Source of data: IMD (JPEG), MOSDAC (HDF), NOAA (JPEG)

Monitoring of cloud growth

Columnar moisture from Water Vapour (WV) channel image



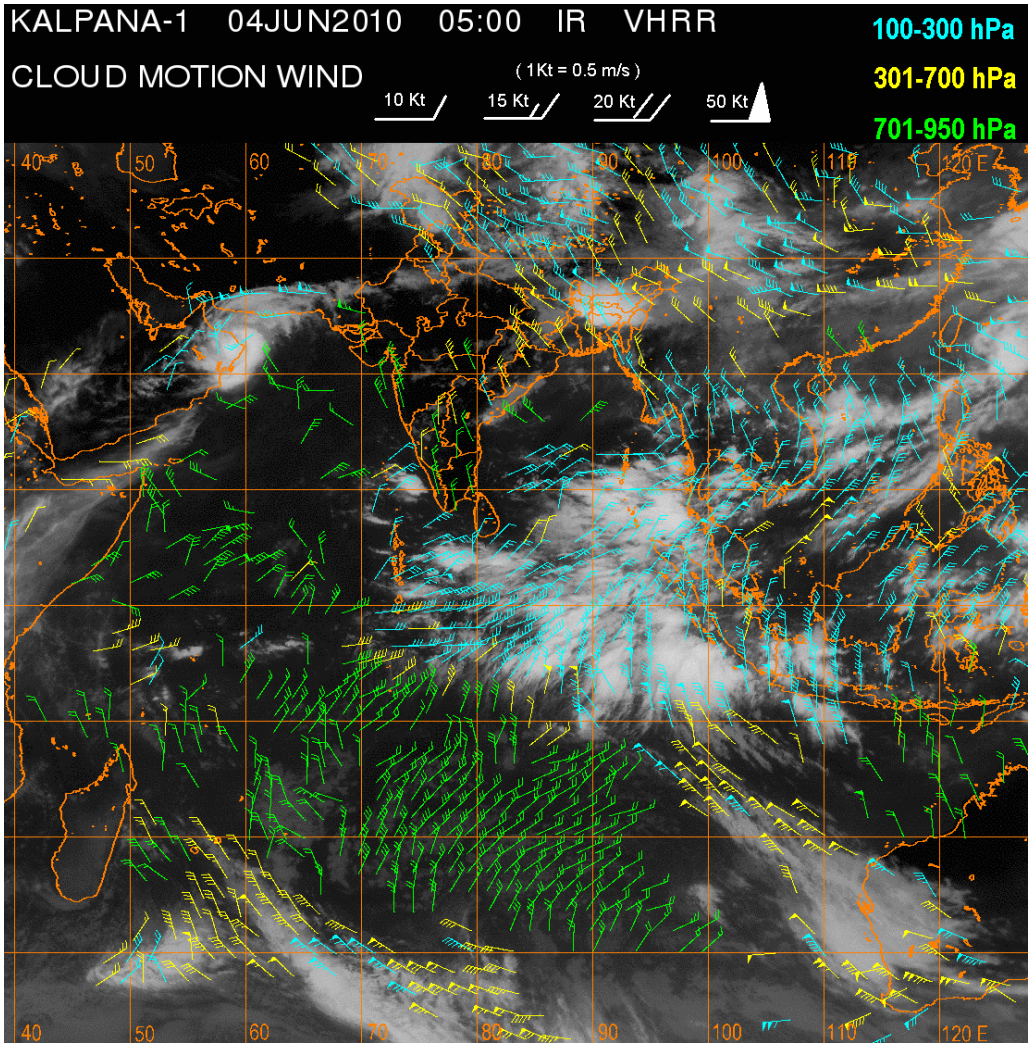
WV image provides information on total precipitable water vapor in the atmosphere column.

WV channel image helps in differentiating the cirrus clouds from cumulonimbus clouds.

Source of data: IMD (JPEG), MOSDAC (HDF), NOAA (JPEG)

Monitoring of cloud motion

Wind speed and direction from Cloud Motion Vector (CMV) images



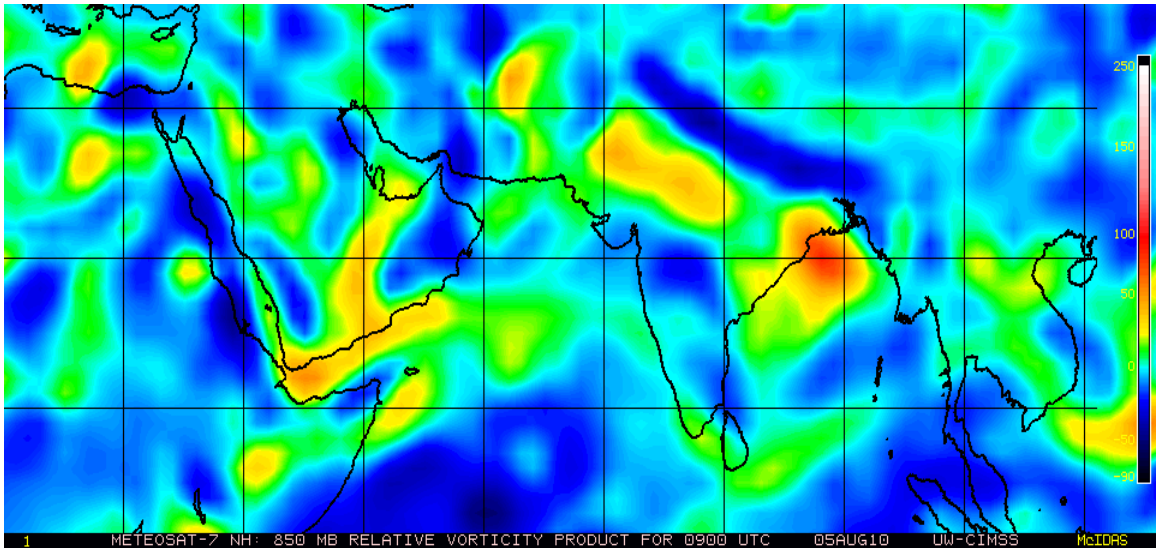
CMV Image is observed to assess the direction of motion of existing cloud during next 12 hours (approx).

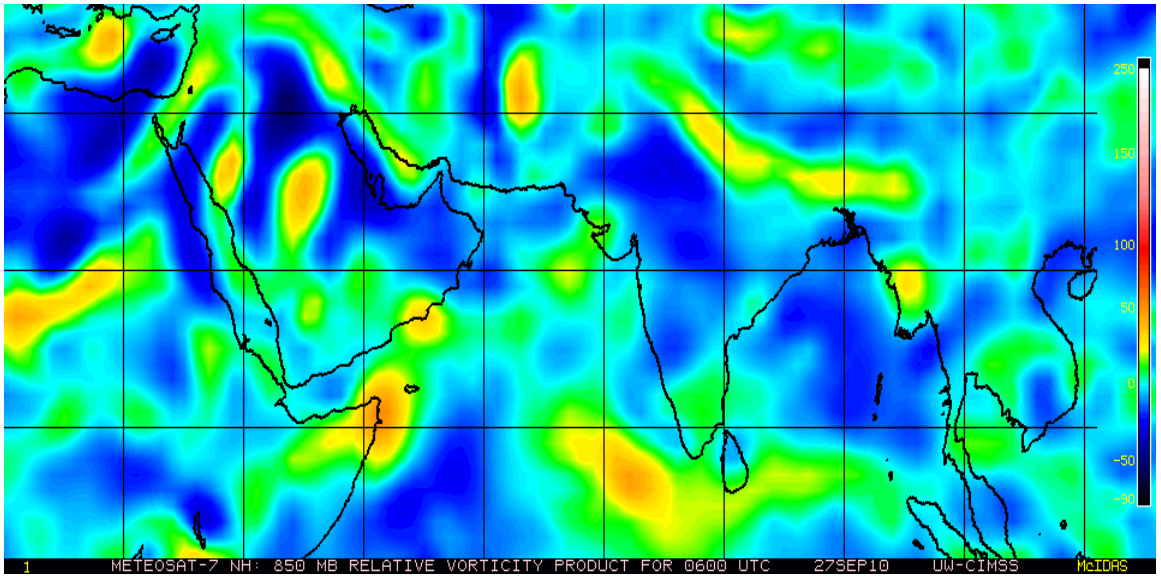
CMV gives the wind speed and direction at three levels.
Lower (0.5 - 3.5 km),
Middle (3.5- 8.0 km) and
Upper (8.0 -16.0 km) atmosphere.

Source of data: IMD (JPEG), MOSDAC (HDF), NOAA (JPEG)

Cloud growth potential

Relative vorticity: An indicator of cloud formation





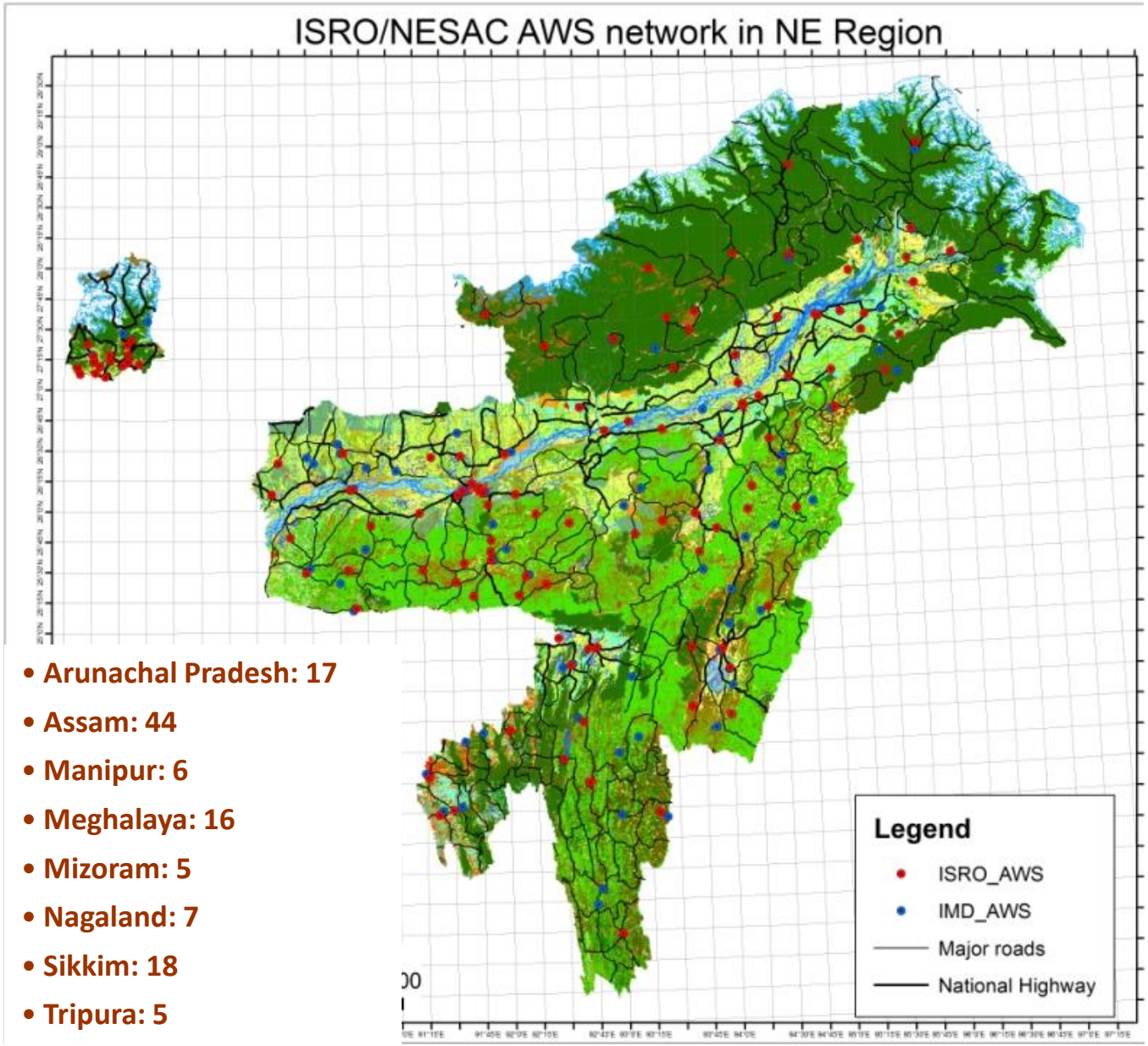
Relative vorticity indicates about degree of instability in the atmosphere (a condition conducive for convection)

During monsoon season, Strong vorticity normally leads to strong system formation, owing to steady moisture supply.

Source of data: Cooperative Institute for Meteorological Satellite Studies (CIMSS), Wisconsin University, USA.

AWS network in NER of India

- Temperature
- Atm. Pressure
- Relative Humidity
- Rainfall
- Sunshine duration
- Wind Speed
- Wind Direction



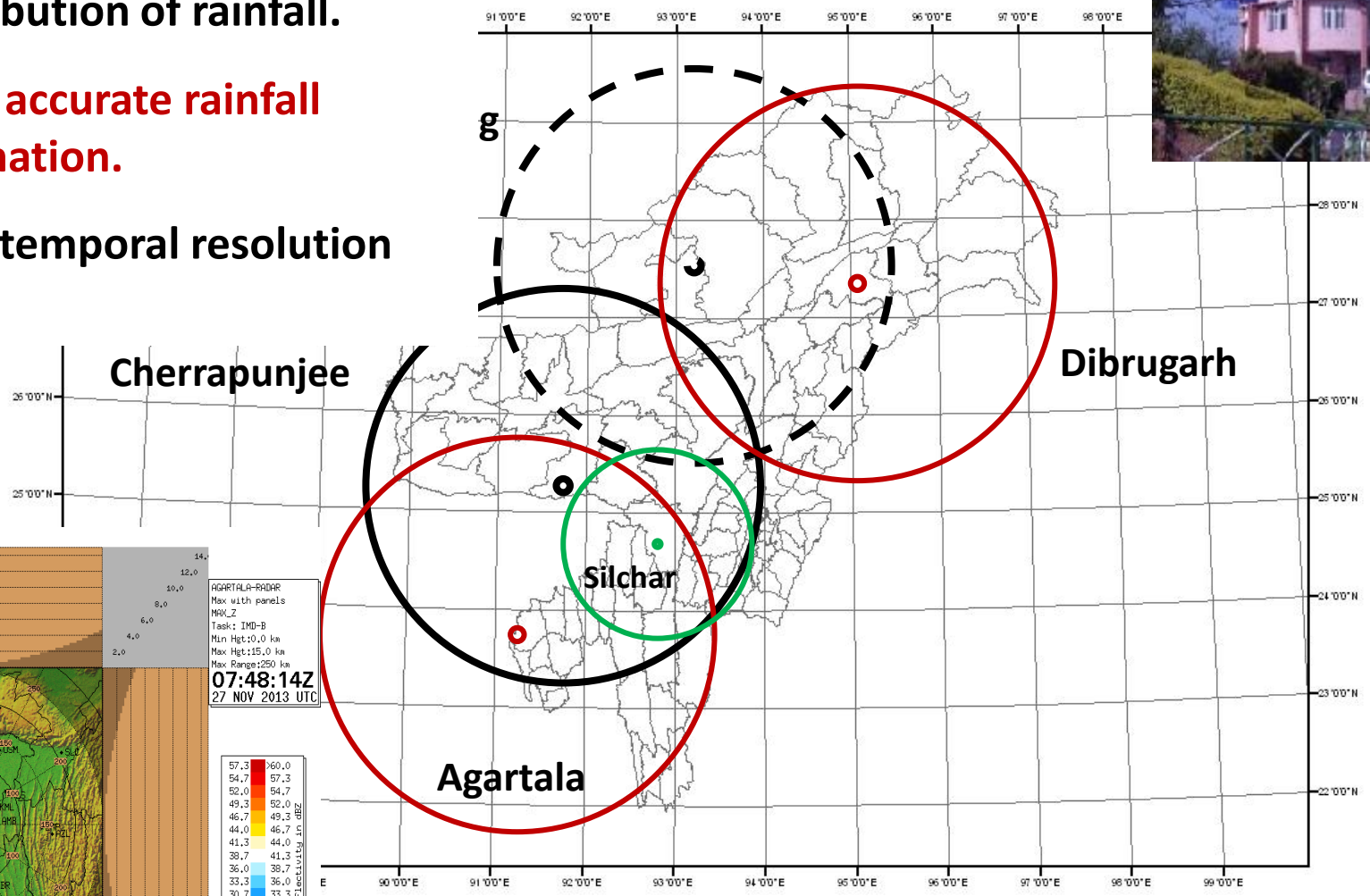
- Arunachal Pradesh: 17
- Assam: 44
- Manipur: 6
- Meghalaya: 16
- Mizoram: 5
- Nagaland: 7
- Sikkim: 18
- Tripura: 5

Flood forecasting using Weather Radars

High resolution Spatial distribution of rainfall.

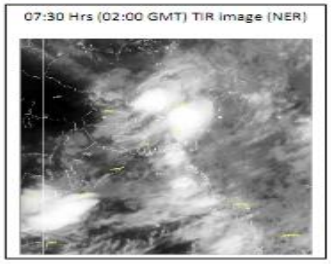
Near accurate rainfall estimation.

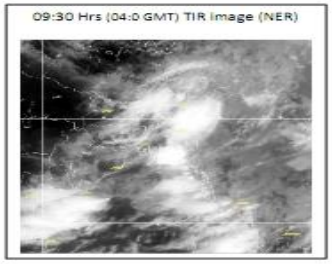
High temporal resolution

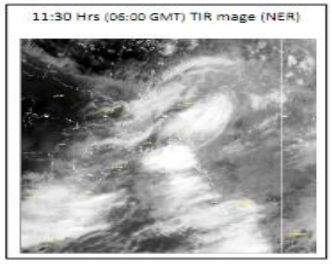


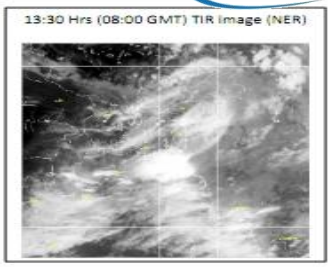
Synoptic Weather advisory

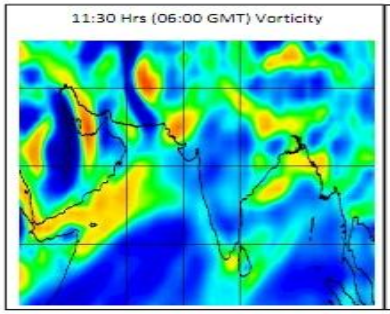
Synoptic weather advisory Bulletin as on 26th June, 2012

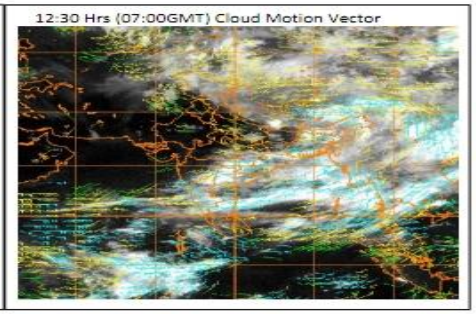


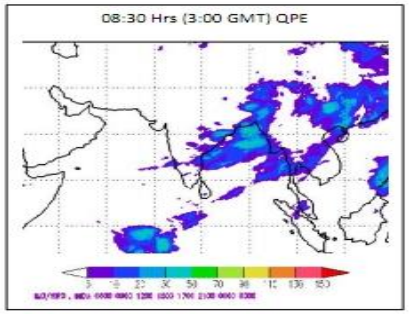












Past 24 hrs rainfall (mm) as on 14:30 Hrs

Lakhimpur, Dhemaji and Sivasagar				Barpeta, Nalbari, Baksa, Dhubri and Goalpara		Darrang Morigaon and Sonitpor		Barak Basin	
Station Name	Rainfall	Station Name	Rainfall	Station Name	Rainfall	Station Name	Rainfall	Station Name	Rainfall
Lakhimpur	14 mm	Basar	20 mm	Bongaigaon	159 mm	Mangaldoi	55 mm	Karimganj	NA
Dhemaji	26 mm	Mengio	4 mm	Rangia	80 mm	Silghat	NA	Hailakandi	NA
Itanagar	NA	Daporijo	NA	Nalbari	NA	Viswanath Ch.	NA	Silchar	23 mm
Ziro	23 mm	Koloriang	NA	Barpeta	NA				
Yazeli	NA			Dhubri	52 mm			Jowai	194mm
Passighat	155 mm	Sivasagar	12 mm	Goalpara	180 mm				
Seppa	25 mm								

Quantitative Precipitation Forecast (IMD) rainfall in mm

Basin	Rainfall	Basin	Rainfall (mm)	Basin	Rainfall	Basin	Rainfall
Subansiri	NA						

NA- Not Available

IMD weather forecast (based on 25th June 2012 midday) up to 0830 hours IST of 26th June, 2012: Rain/thundershowers would occur at most places over northeastern states.

Synoptic Weather and rainfall probability for next 12 hrs:

East Assam area: Moderate rainfall amounting 20-40 mm expected over the area.
West Assam area: Moderate to high rainfall amounting 20-50 mm expected over the area. Some places over the northern part may get rainfall more than 50mm in next 24 hours.
South Assam area: High rainfall amounting 30-50 mm expected over the area. Rainfall more than 50 mm expected over some places. Need to monitor critically.
Middle Assam area: Moderate rainfall amounting 20-40 mm expected over the area.
Jaintia Hills area: High rainfall amounting 30-50 mm expected over the area.

- All thearea needs to be monitor continuously.

Prepared by: Meteorology team, NESAC

NUMERACIAL WEATHER PREDICTION

PREPARATION OF SYNOPTIC CHART ON DAILY BASIS

OPERATIONAL RUN OF NWP MODELS

WRF

MM5

RAINFALL FORECAST

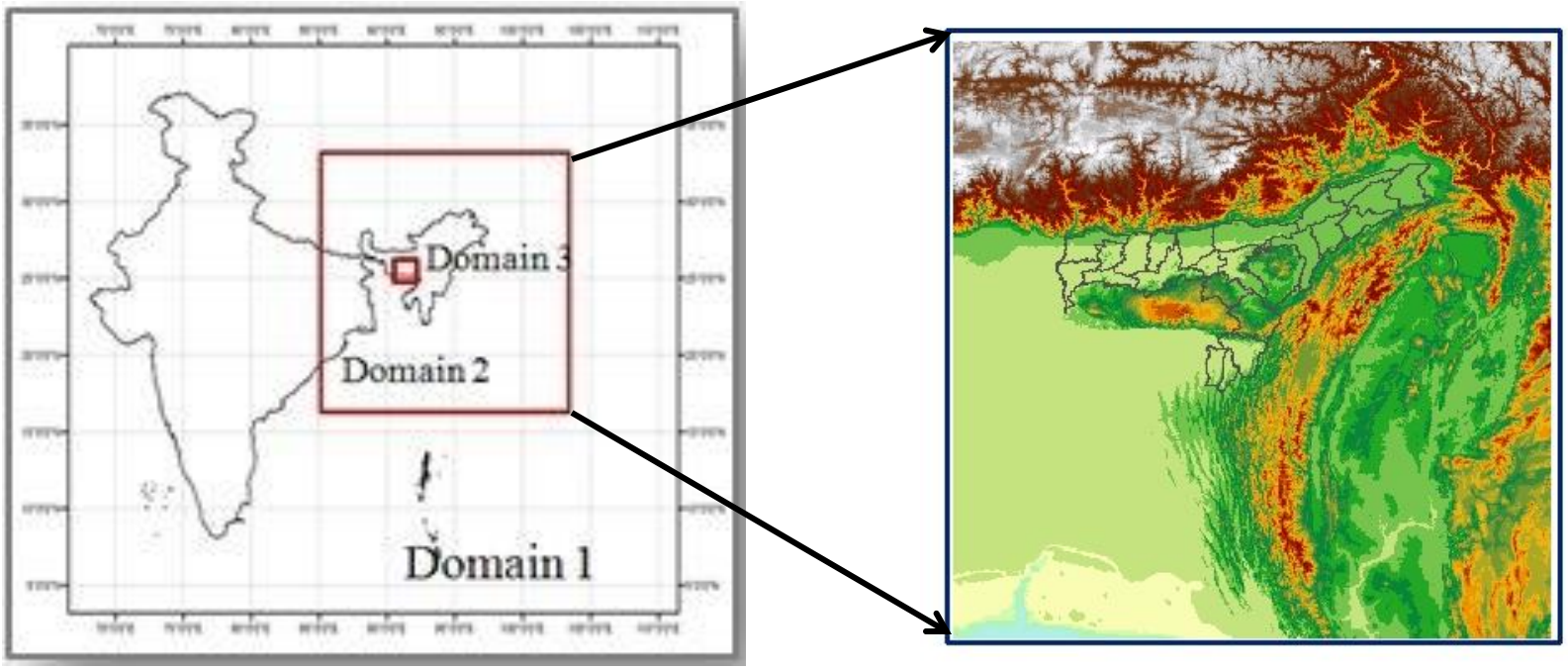
PREPARATION OF VARIOUS GRAPHICS AS WELL AS EXCEL PRODUCTS

GRADS
NCAR GRAPHICS
GRAPHER
SURFER
EXCEL
MATLAB

MODEL VALIDATION AS WELL AS R&D

WITH TRMM DATA
REAL TIME SATELLITE IMAGES
AWS DATA
KALPANA QPE

The NWP met model nesting



Central Lat Lon	**21°N 88°E**
Number of grids	**180 ×180 , 184 × 184**
Horizontal resolution	**27 km, 9Km, 3 Km**
Vertical levels	**36**
Time step	**120 sec**
Projection	**Mercator**

Components of the WRF model

- **Governing Equations**

(Vertical co-ordinates & Variables , Moisture inclusion, Map projection & Curvature)

- **Model discretization**

(Time integration, Spatial Integration, model domains)

- **Boundary Conditions**

(Initial boundary conditions, Lateral boundary conditions)

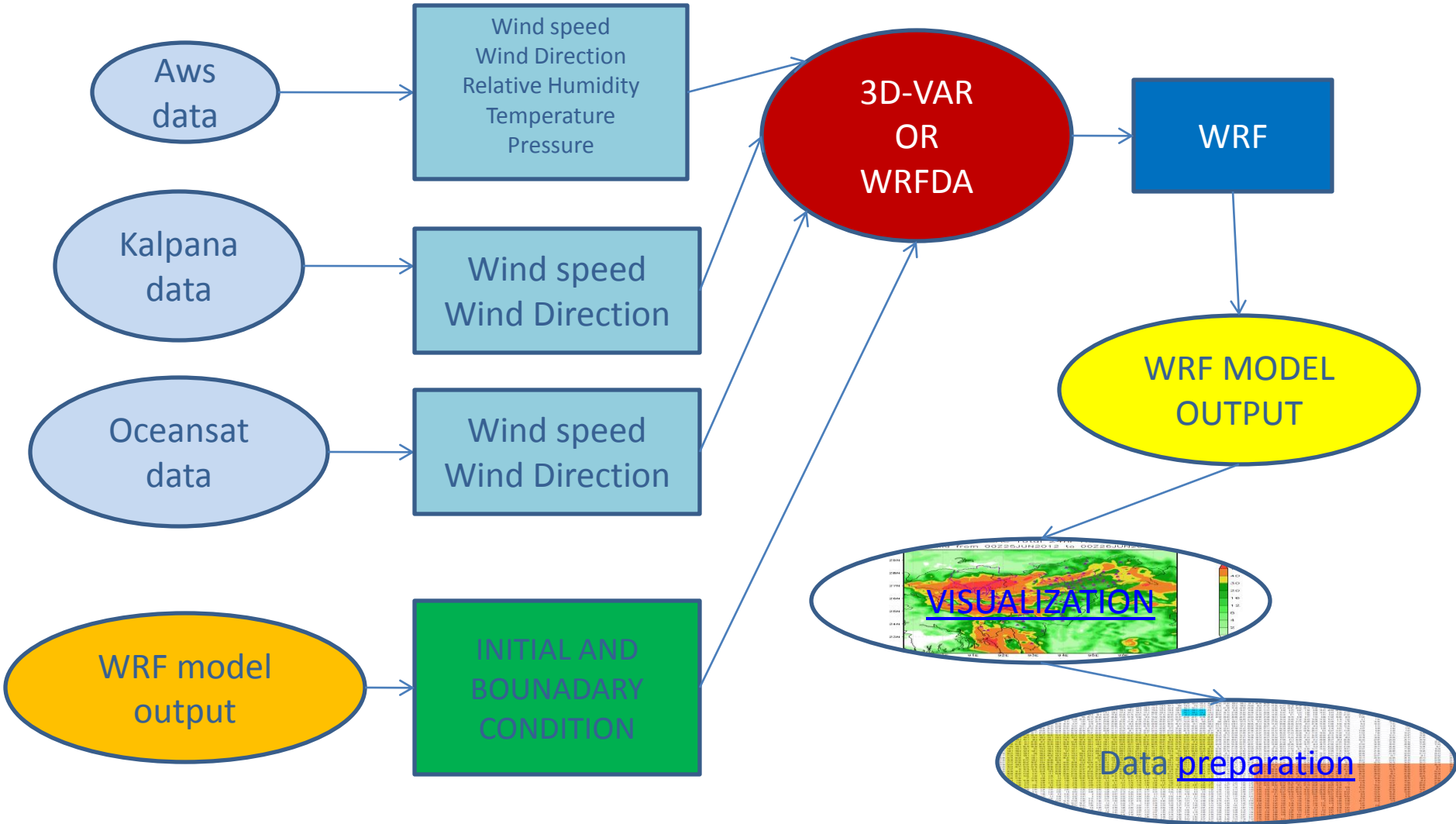
- **Model Nesting**

(Same level nests, Telescopic nests, Overlapping nests etc)

- **Variational Data assimilation**

(Wind speed, wind direction, Humidity, Temp, pressure etc. either from NASA GFS or AWS or Indian weather satellites Kalpana Meteosat and Oceansat-II)

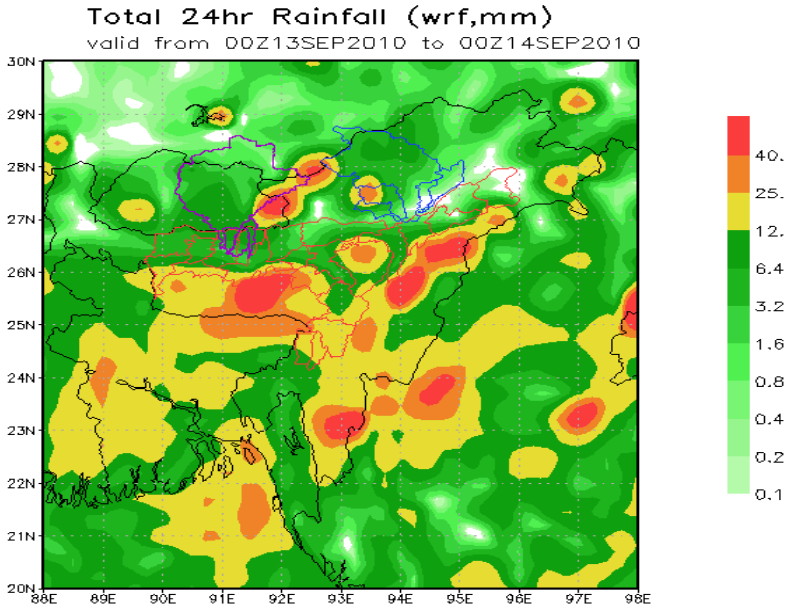
WRF MODEL SYSTEM FLOW CHART

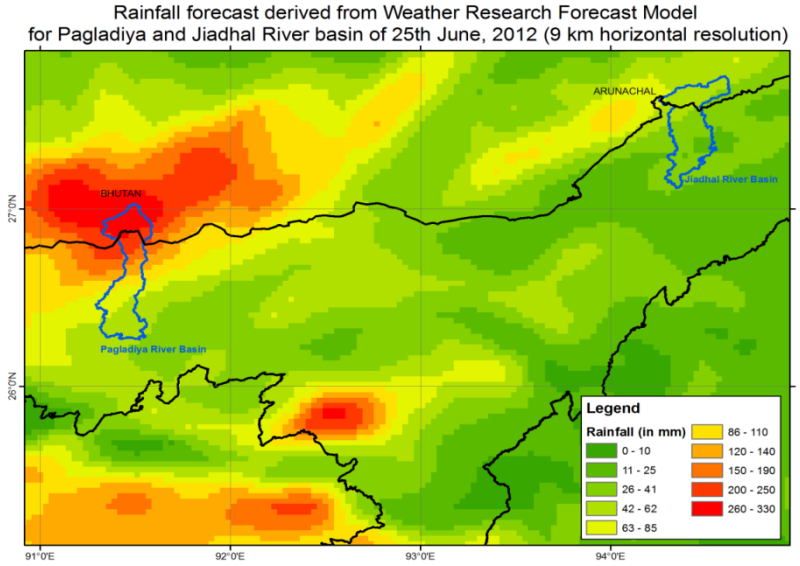


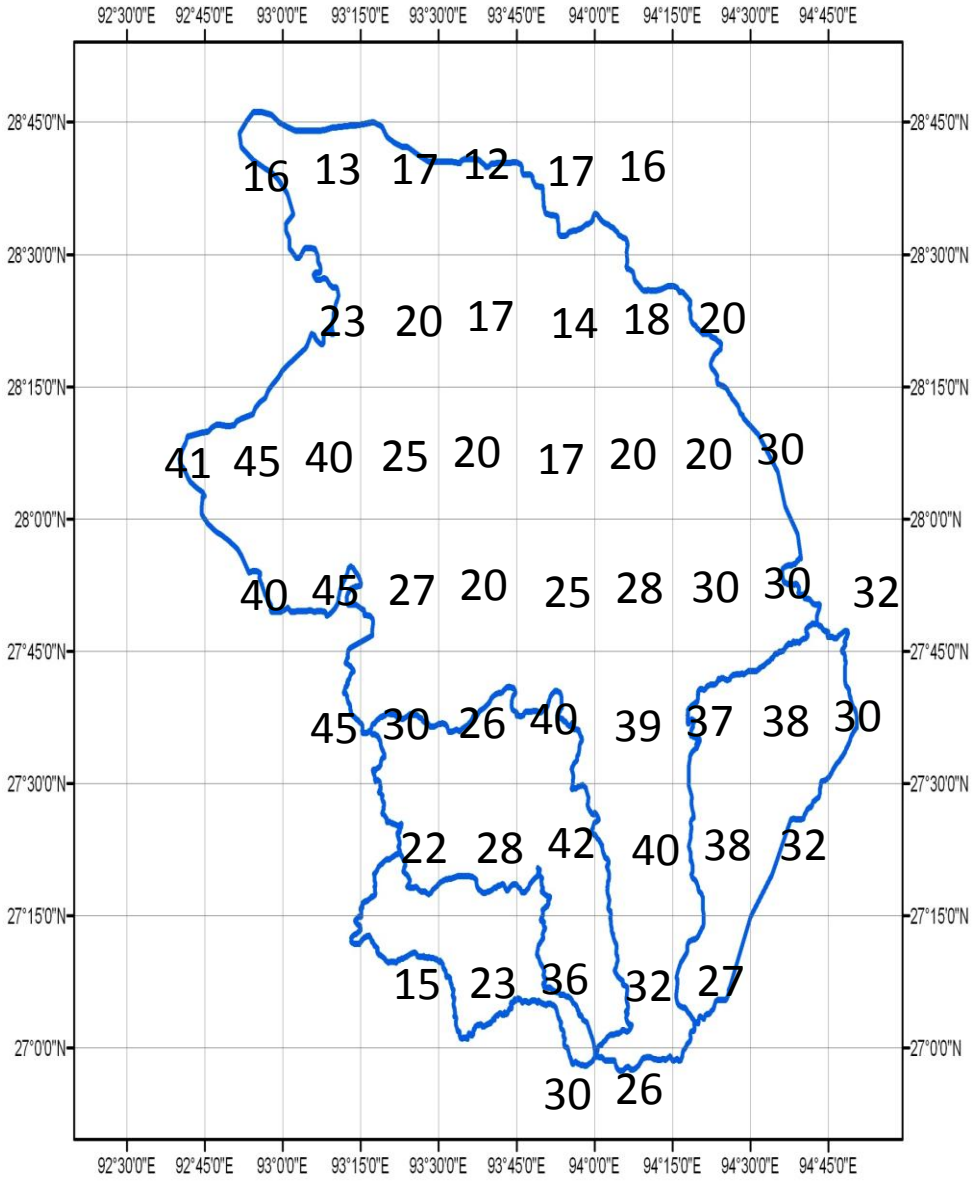
Some Schemes and configurations of different components of WRF model

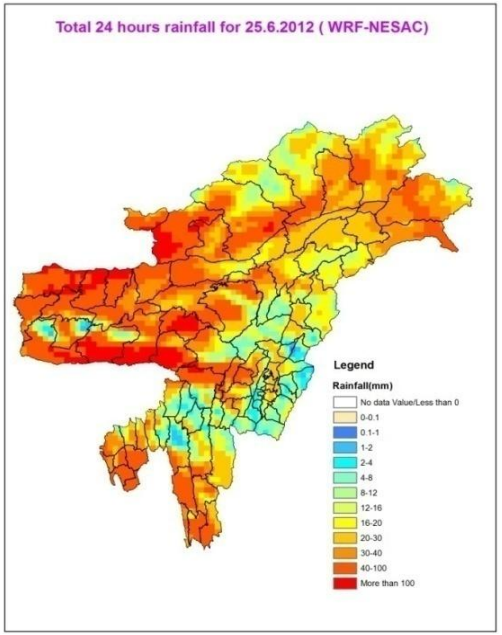
Central Lat Lon	25 ℃N 90 ℃E
Number of grids	80 ×85 , 109 ×106, 85×64
Horizontal resolution	9KM
Vertical levels	36
Time step	20 sec
Microphysics	Thompson graupel scheme
Long Wave Radiation	RRTM Scheme
Short Wave Radiation	Dudhia Scheme
Surface Layer Option	Monin Obukhov
Land surface Option	Thermal Diffusion
Cumulus Option	Kain Fritch (New Eta)
Time integration scheme	Third-order Runge–Kutta

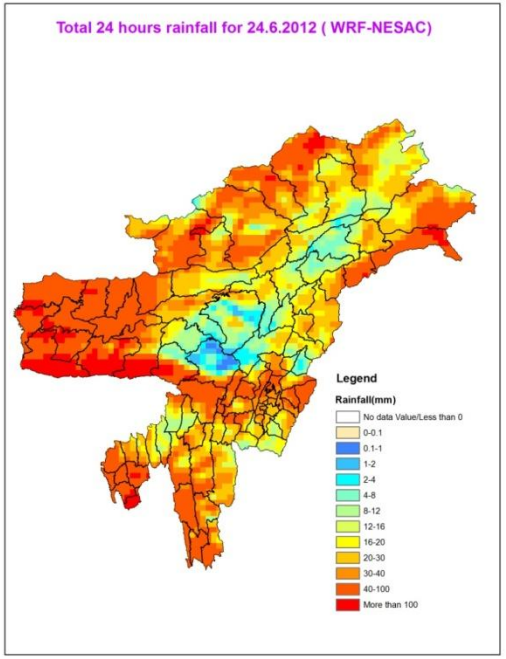
A sample WRF Output



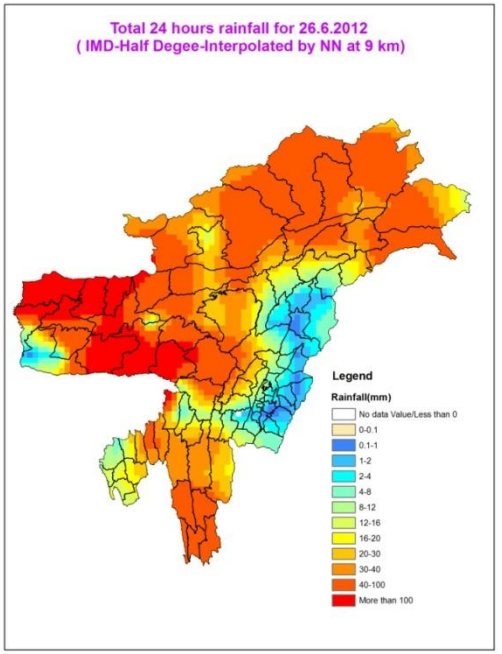


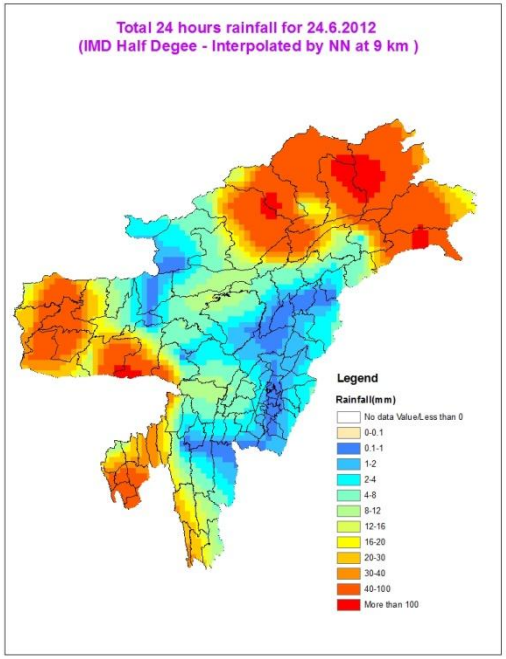




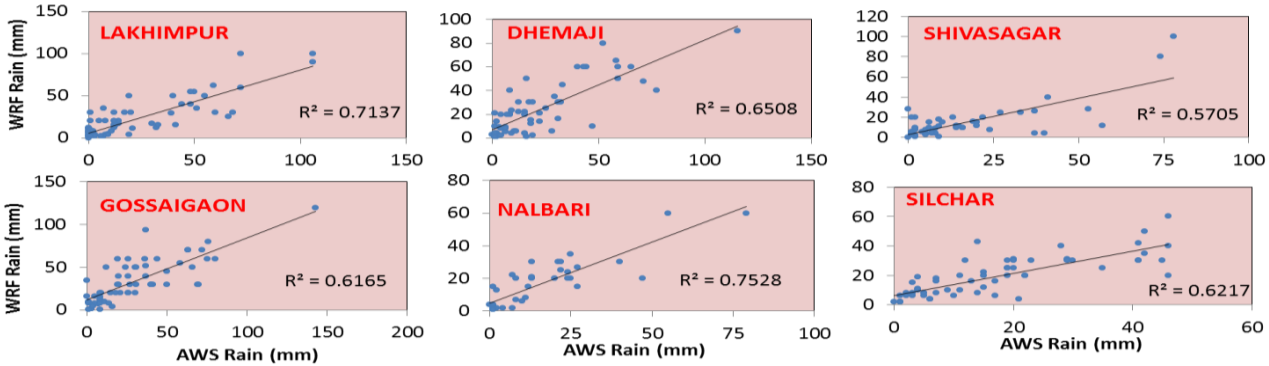


RAINFALL DATA COMPARISON WITH IMD HALF DEGREE DAILY MERGE SATELLITE GAUGE RAINFALL DATA

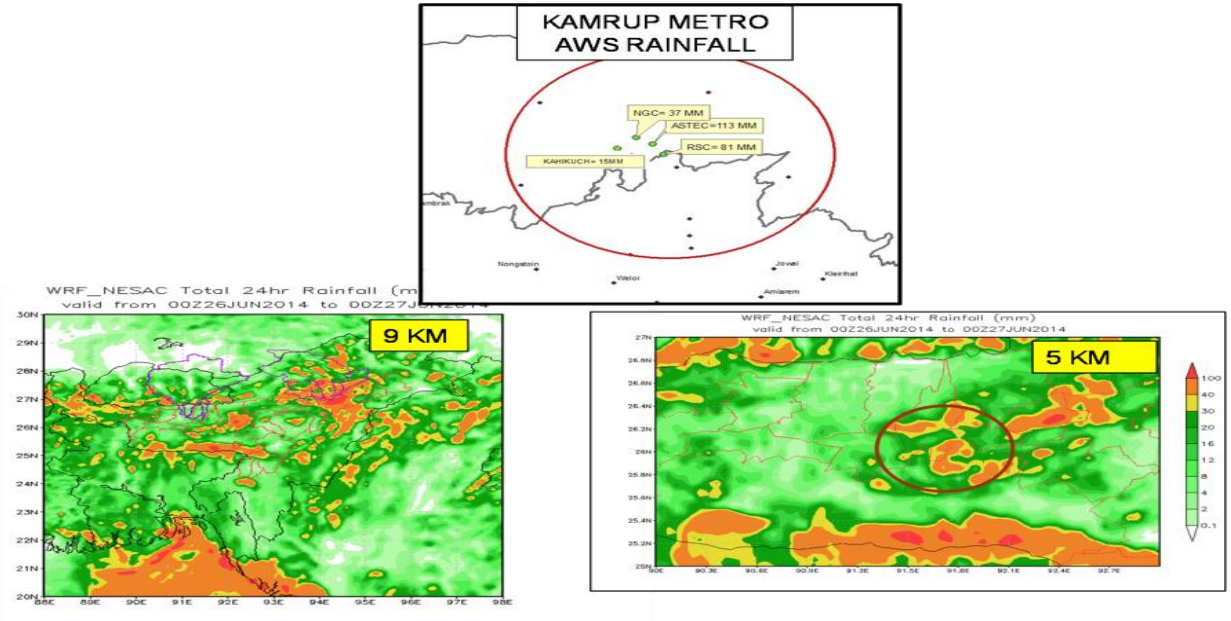




WRF Model Validation

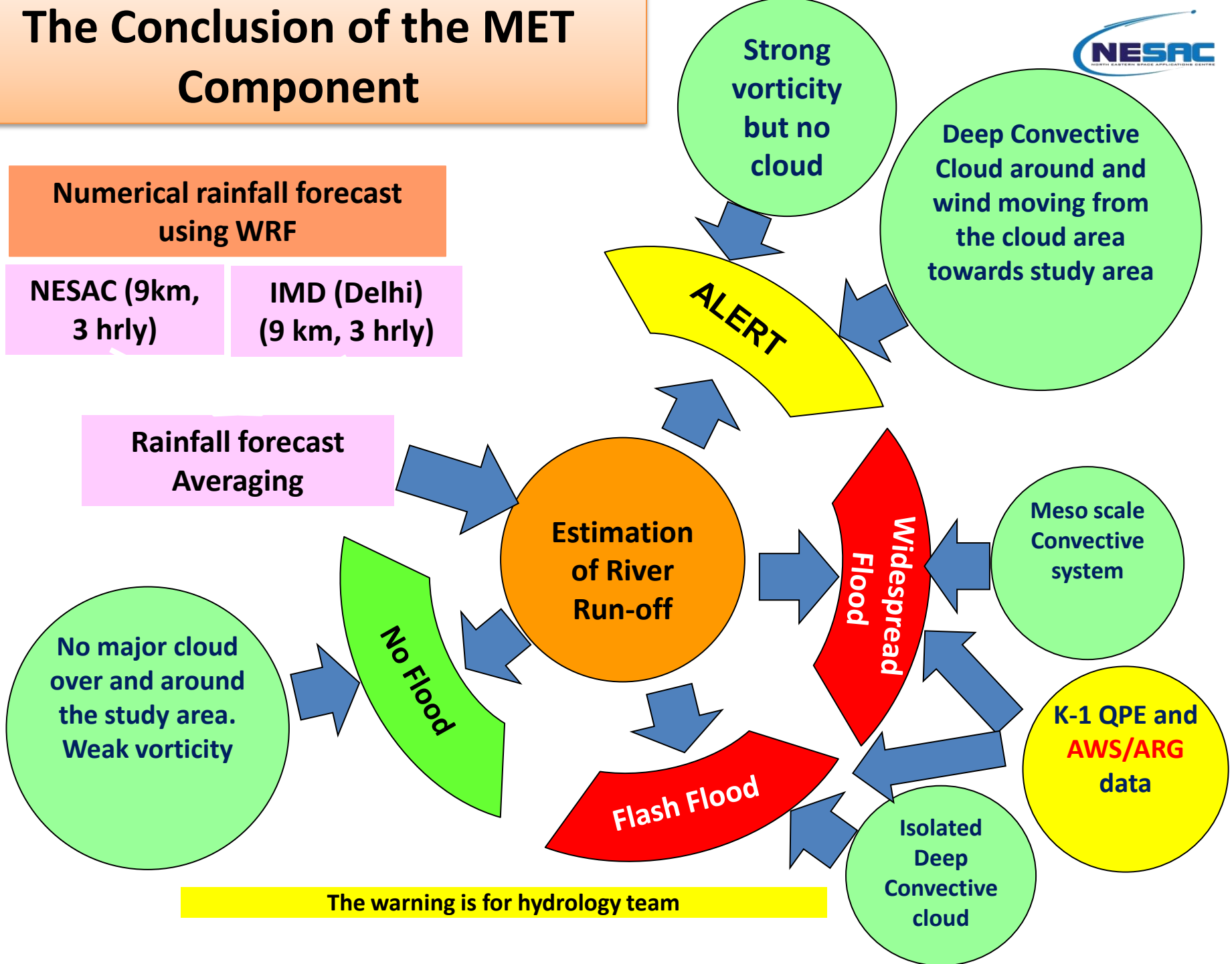


Comparison of daily accumulated WRF rainfall from June to August 2014 with AWS recorded rainfall for different stations located in Assam



WRF model forecasted rainfall on 26th June 2014 with 9km and 5km resolution

The Conclusion of the MET Component



A line of caution..!!!

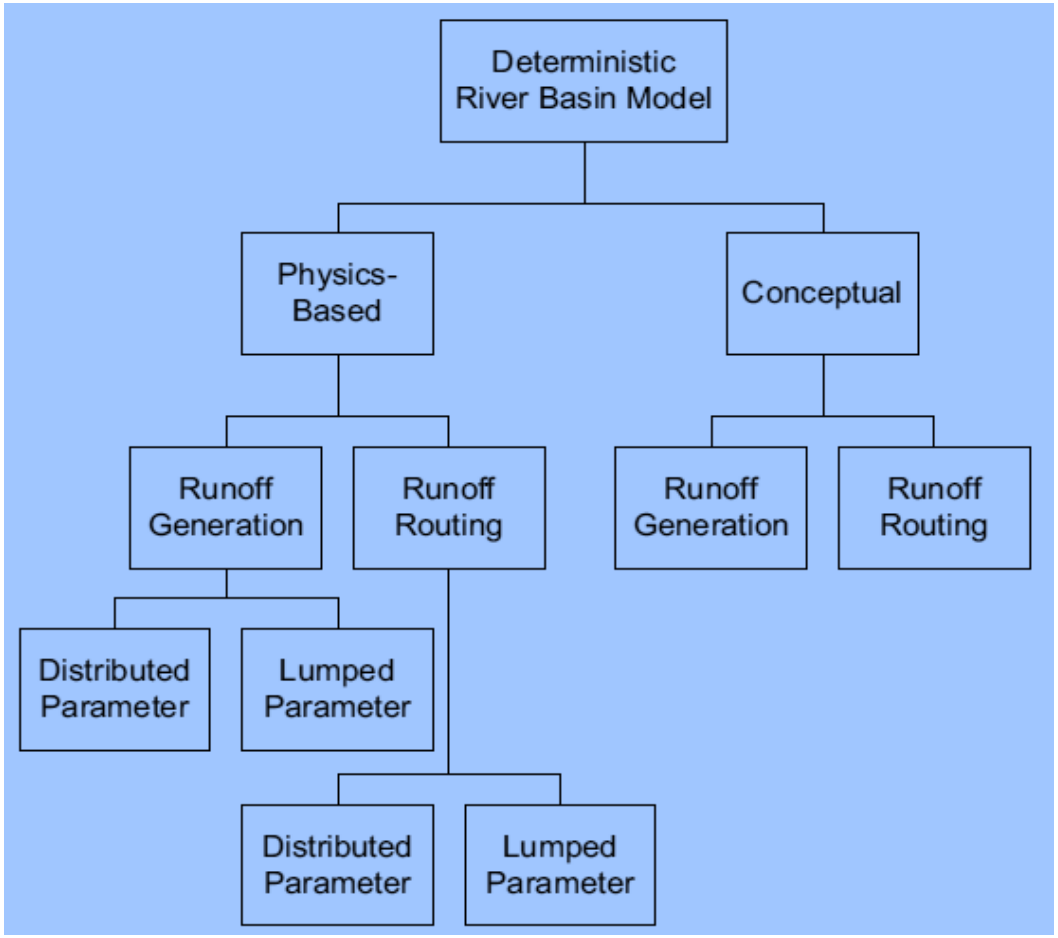
Rain is only a necessary condition for flooding and never a sufficient one.

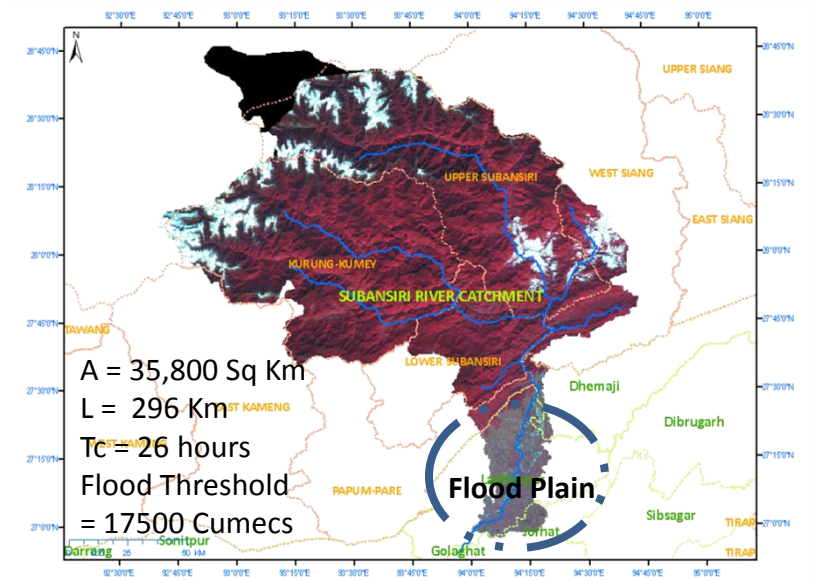
Correct forecasting of rain may not lead to correct forecasting of flood.

Incorrect assessment of rain is most likely to lead to incorrect forecasting of flood.

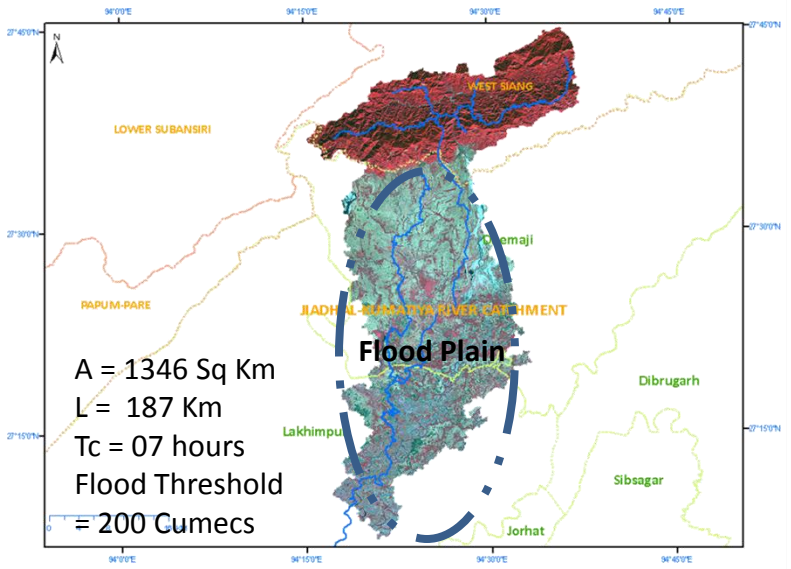
Distributed Model Representation

- It is useful to consider how physics-based distributed models fit within the larger context of hydrologic modeling.
- ***Deterministic** is distinguished from **stochastic** in that a deterministic river* basin model estimates the response to an input using either a conceptual mathematical representation or a physics-based equation.



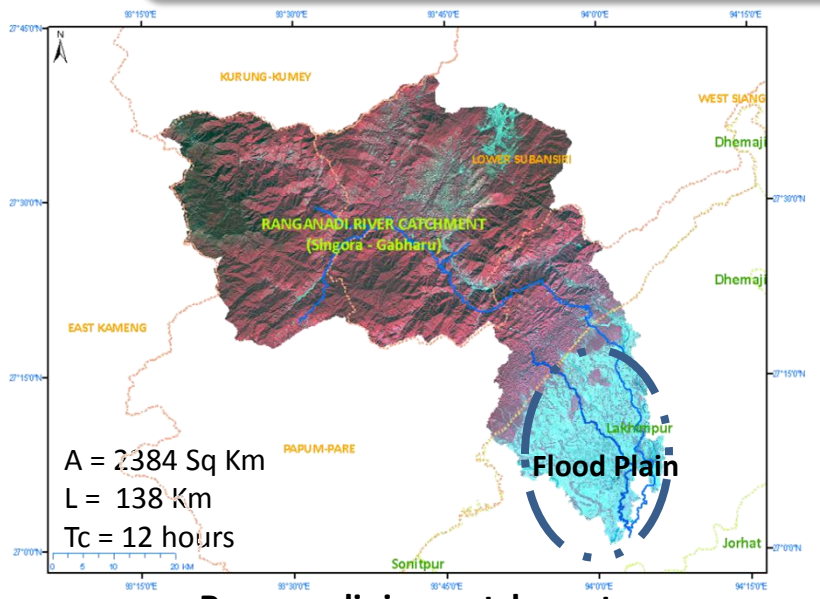


Subansiri river catchment

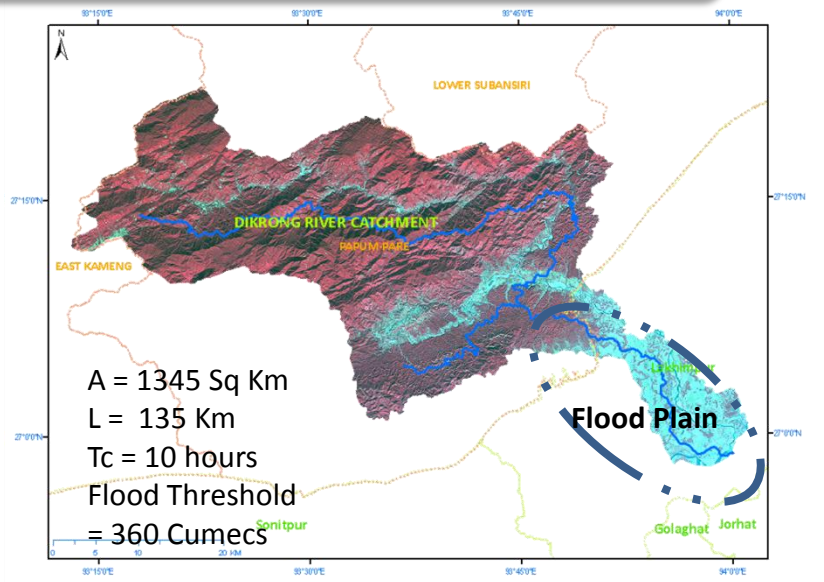


Jiadhal - Kumatia river catchment

Major river catchments delineated for Lakhimpur & Dhemaji district



Ranganadi river catchment



Dickrong river catchment

FLEWS - Distributed / Quasi Distributed Hydrological Model Building

Base Layer preparation – CN Grid
(integration of **land-use land-cover** & **soil** layer, assignment of hydrologic soil group and defined *Curve Numbers*)

DEM pre-processing
(reconditioning and fill sinks)

Stream processing
(streamline grid and segmentation)

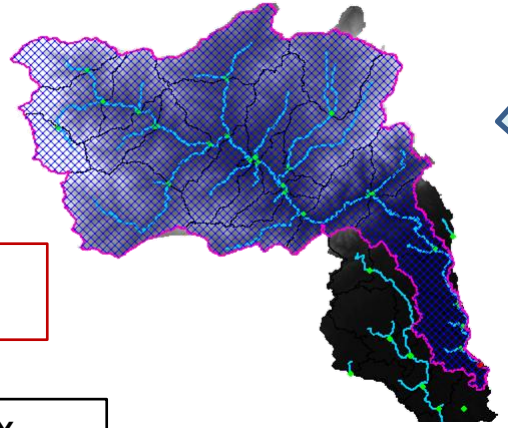
Catchment delineation

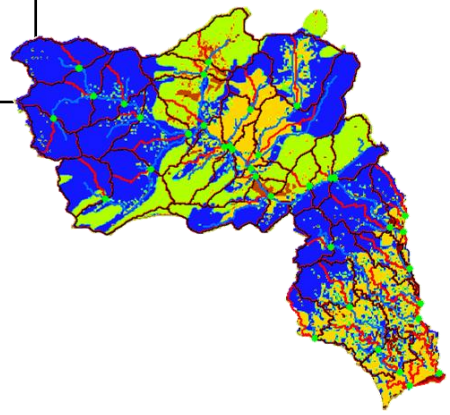
HMS Project layer generation

HMS process definition & morpho-hydrologic parameters
(sub-basin parameters with CN Grid raster, basin lag time, etc)

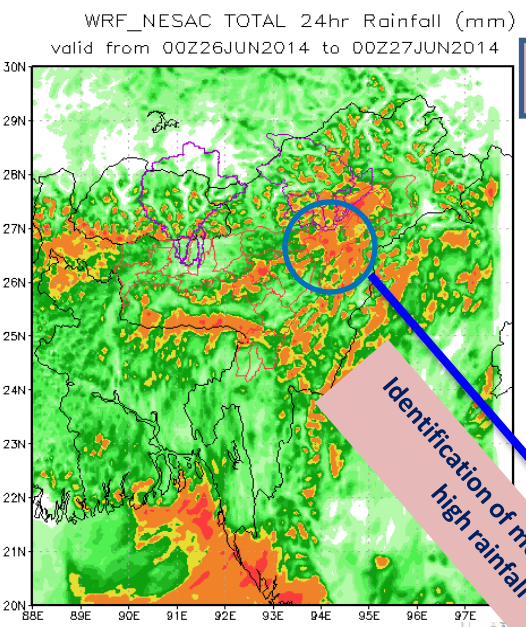
Hydrologic FLOOD Routing : Muskingum > Routing Parameters K and X assignment
Meteorological Data: Time series Rainfall data

***HMS MODEL RUN* & Computations (24 hourly Outflow Hydrograph, etc)**





The Rainfall-runoff model



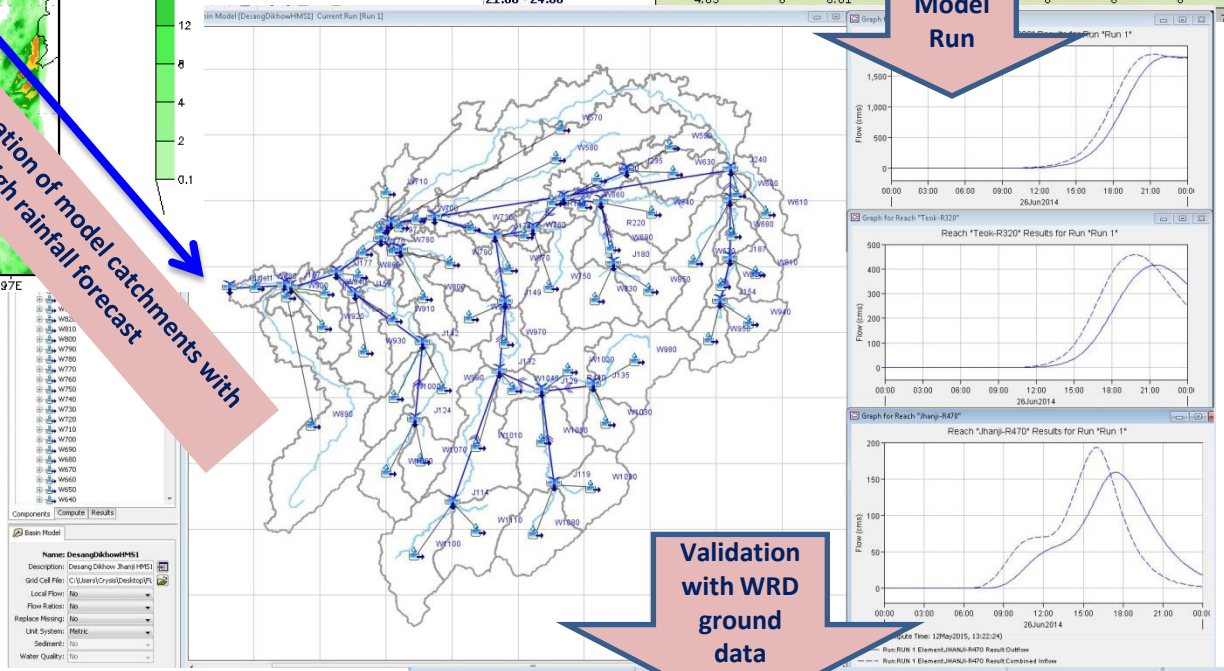
WRF rainfall Input for HEC-HMS

Identification of model catchments with high rainfall forecast

DISANG-DIKHOW-DORIKA-DIBRU Sub Basin - wise 3-hourly Precipitation (mm) 26.06.2014

Co-ordinates "Lat:Long" (centred)	26.86 N 94.24 E	26.55 N 94.42 E	26.71 N 94.42 E	26.86 N 94.42 E	26.24 N 94.59 E	26.40 N 94.59 E	26.55 N 94.59 E	26.71 N 94.59 E	26.86 N 94.59 E	27.02 N 94.59 E	26.24 N 94.76 E	26.55 N 94.76 E
SUB-BASINs (GeoHMS Codes) / TIME INTERVAL ↓	W880 W900	W890	W920 W930	W770 W840 W860	W1100	W1060 W1070	W990 W1000	W910	W780 W800	W700 W710 W720 W740	W1110	W1010 W1040
00:00 - 03:00	0	0	0	0	0.57	0.47	0.19	0	0	0	3.94	1.55
03:00 - 06:00	0	0.03	0	0	2.58	0.02	0	0	0	0	5.36	0.03
06:00 - 09:00	0	0.26	0	0	13.6	10.38	0.13	0	0	0	11.23	1.45
09:00 - 12:00	3.94	5.38	7.91	2.41	3.74	5.26	3.72	4.86	3.15	2.32	9.63	15.16
12:00 - 15:00	47.8	29.36	21.75	23.19	11.59	13.01	10.01	41.86	49.15	23.11	5.37	34.18
15:00 - 18:00	101.99	0.07	10.31	79.07	0.07	0.42	1.77	7.48	20.29	17.07	0.31	9.75
18:00 - 21:00	8.18	0	0.01			0	0	0.02	1.2	2.57	0.02	0
21:00 - 24:00	4.63	0	0.01			0	0	0	0	19.1	0.11	0

Model Run

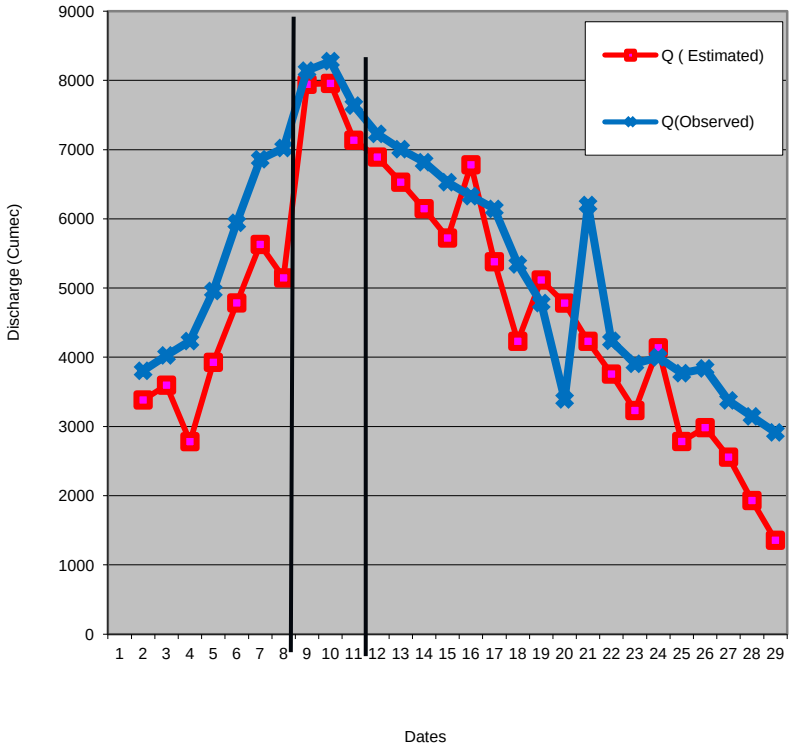


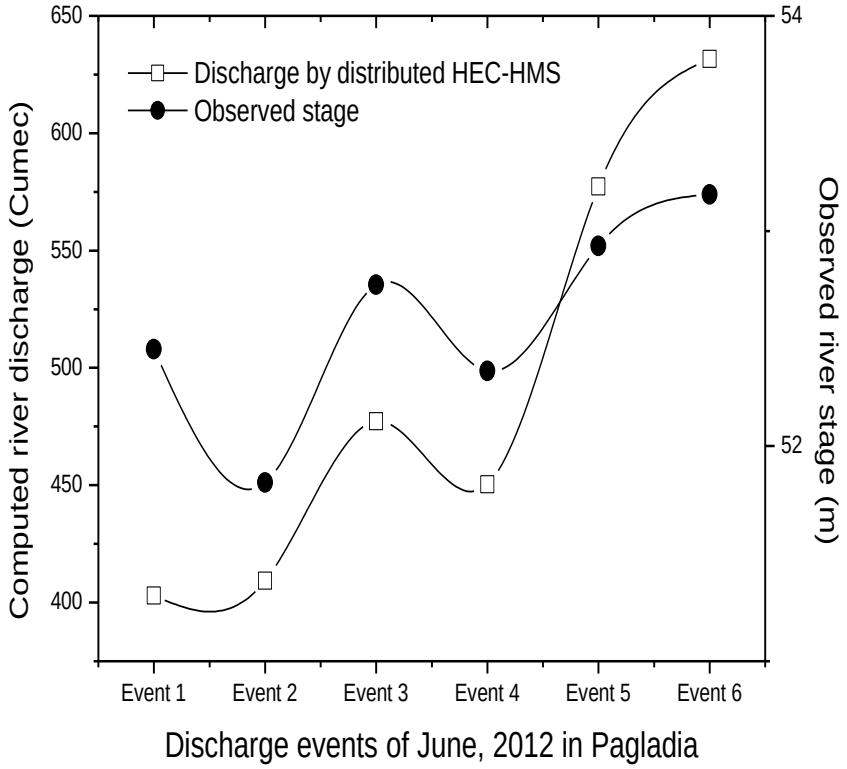
Validation with WRD ground data

JORHAT DISTRICT					
RIVERS	Bhogdoi	Jhanji	Brahmaputra	Dhansiri	
G/D SITE	A.T Road Crossing	A.T Road Crossing	Nematighat	Numaligarh	
DANGER LEVEL	89	93.83	85.04	------	
DATE	Water Level (MSL)	Water Level (MSL)	Water Level (MSL)	Water Level (MSL)	
June 25, 2014	88.4	90.78	85.38	75.79	Rising
June 26, 2014	88.3	91.23	85.42	75.67	Falling
June 27, 2014	88.30	93.73	85.35	75.76	Steady

HEC-HMS Model Validation

Comparison of Estimated and observed discharge for Subansiri river at Chouldhuaghat during August, 2014



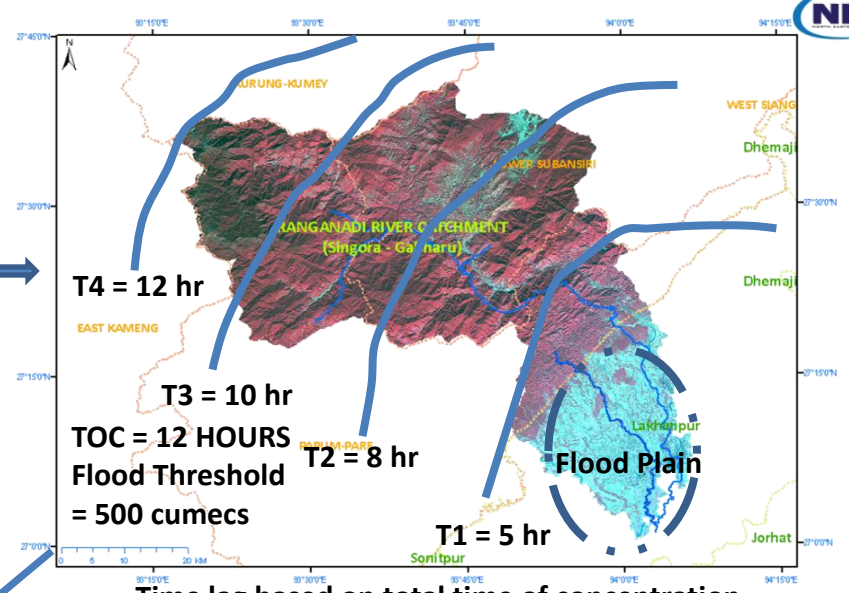


Discharge events of June, 2012 in Pagladia

	93	93.25	93.5	93.75	94	94.25	94.5	94.75	95
27.5	1.48	2.86	4.02	8.54	9	7.41	5.5	6.1	5.3
27.75	0.14	1.64	6.65	10	13.96	10.32	9.27	8.3	5.3
28	1.17	1.07	4.55	4.68	8.45	8.47	9.23	9.41	6.44
28.25	0.52	0.45	1.82	1.74	2.78	5.41	6.95	7.78	6.35
28.5	0	0.28	1.18	0.5	1.12	2.36	4.09	4.93	3.89
28.75	0.47	0.16	0.68	0.42	0.7	1.36	2.21	2.9	2.73
29	0.98	0.35	0.64	0.14	0.55	0.89	2.09	2.77	2.33

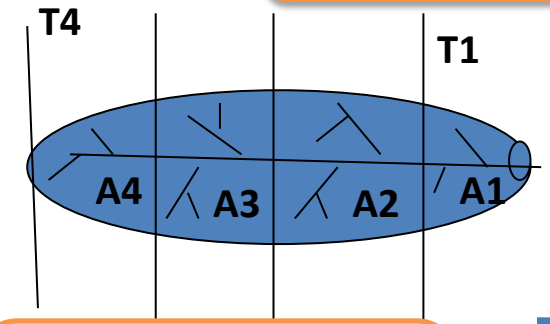
Suban	0.0028	0.4995	0.3381	3580000		2781.36
Ranga	0.0028	0.5896	0.267	238456		105.11
Singora	0.0028	0.75	0.093	44600		53.28
Dickrong	0.0028	0.63	0.044	126048		77.6
Jiadhal	0.0028	0.423	0.233	134600		98.21

Rainfall from WRF (Forecast) & AWS (Insitu)



Time lag based on total time of concentration

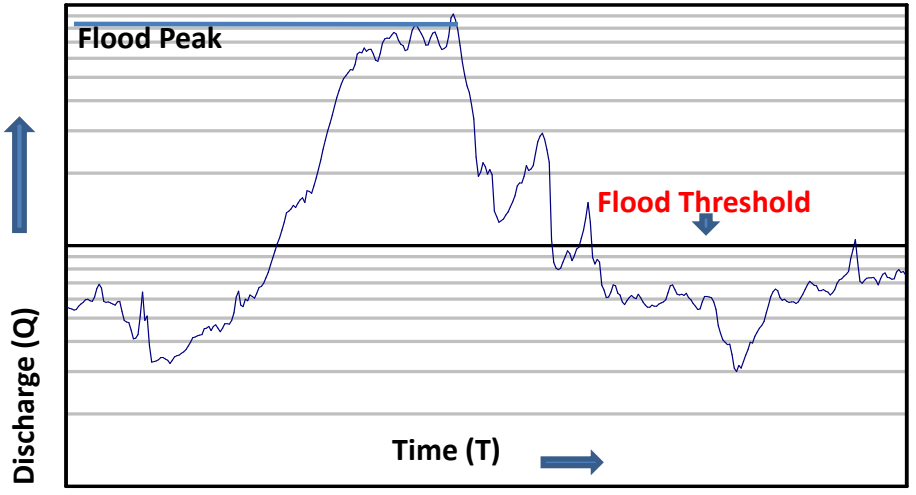
The Rational Method of forecasting flood peak



Q (Cumec)

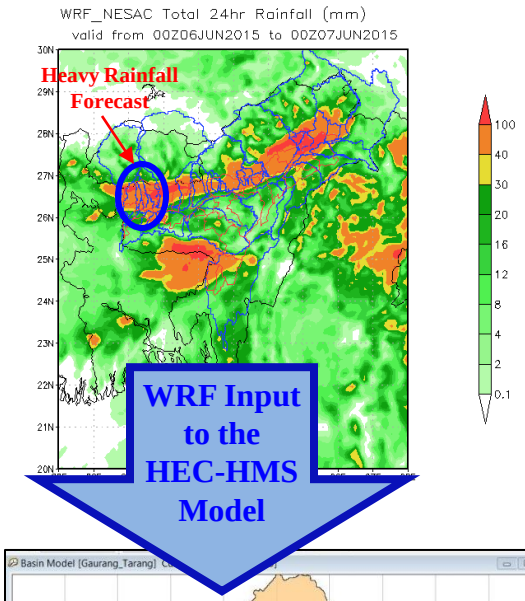
Q1 = .0028 C I A1 at T1
Q2 = Q1 + .0028 C I A2 at T2
Q3 = Q2 + .0028 C I A3 at T3
and so on…….

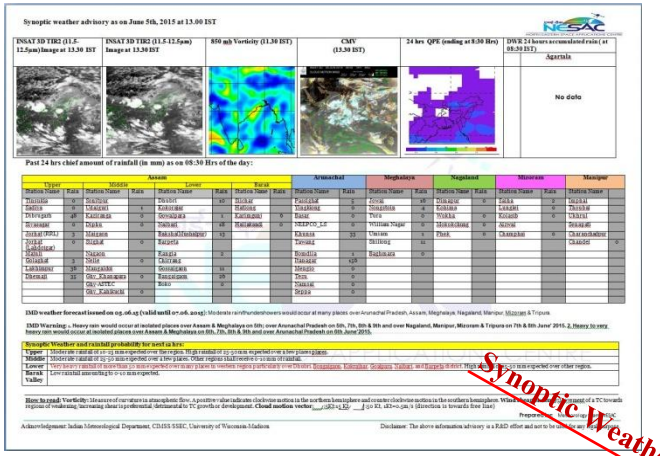
Flow accumulation with time in Rational model



Forecasted flood hydro-graph for issue of warning

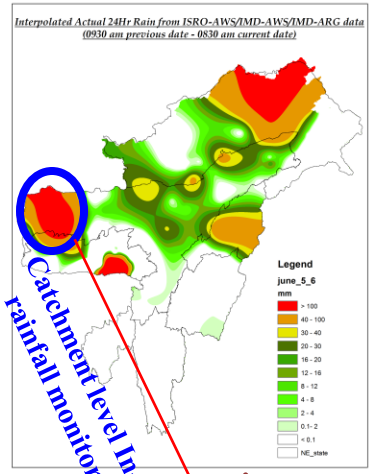
FLEWS Alert : DSS & Dissemination





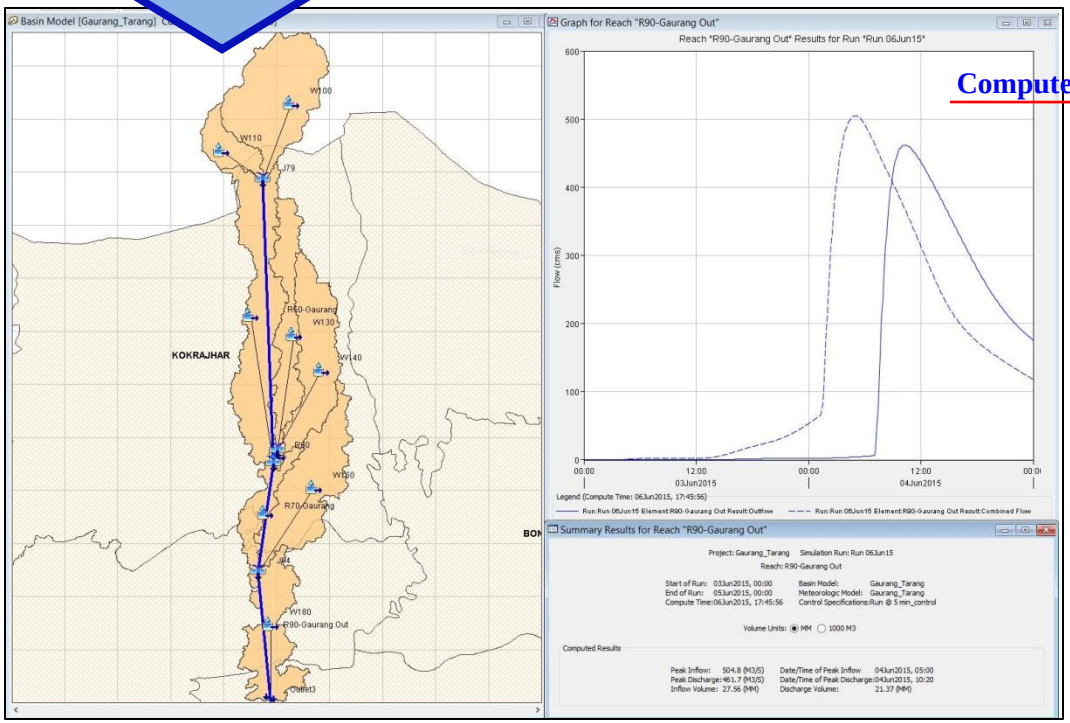
Synoptic Weather Prediction

Observed ground rainfall



Catchment level In-situ rainfall monitoring

Alert uploaded in ASDMA website *(being implementing agency)*



Computed high discharge peak

FLOOD ALERT

E-mail & SMS

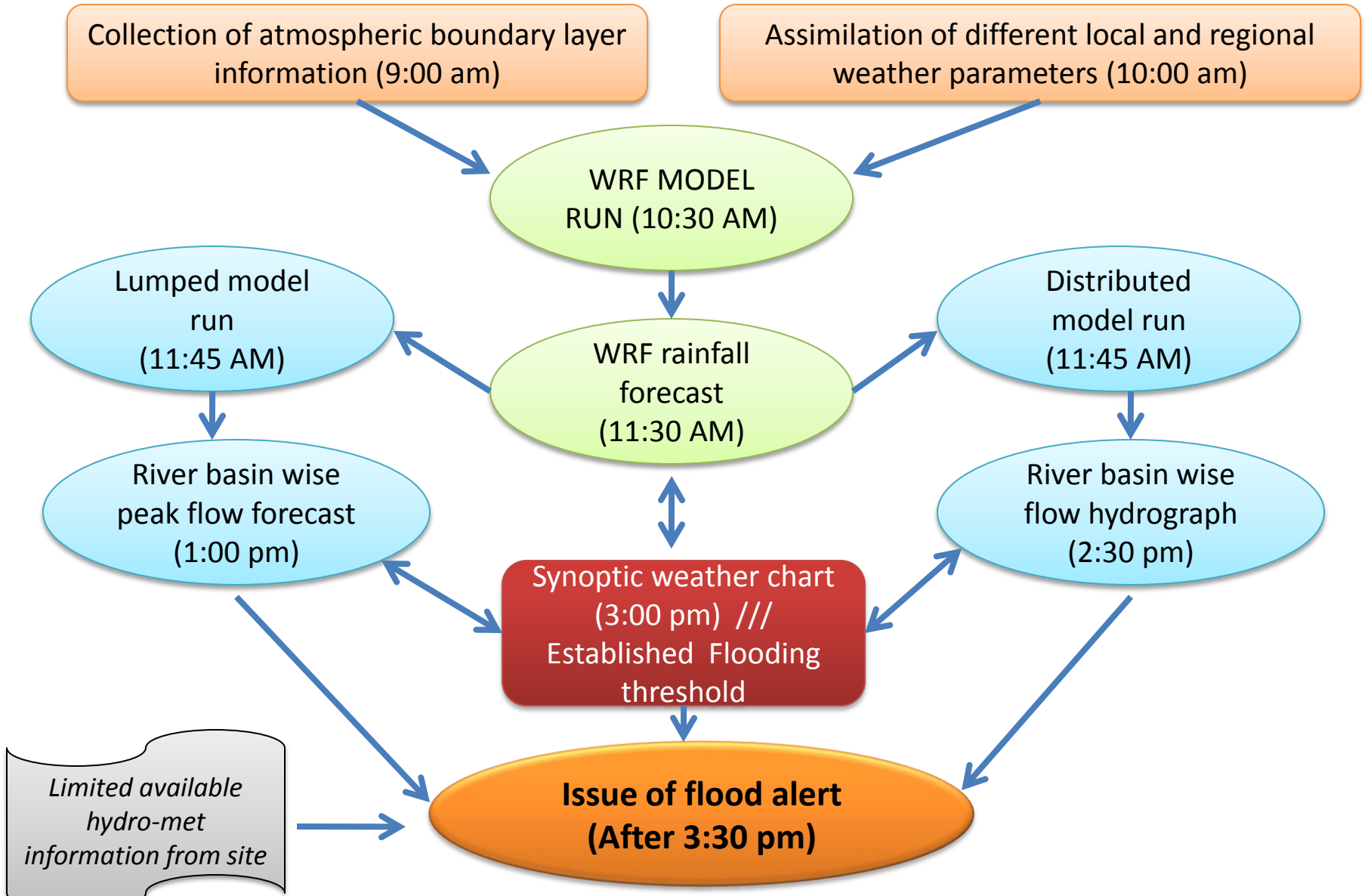
Alert Recipients

- ASDMA
- Disaster Control Room
- District Administration
- IMD

Calibration & Validation of Discharge

Daily water levels for rivers falling under Kokrajhar District							Ph. No.	03661270657	Rising
Rivers/ Date	Gourang	Champamati	Sonkosh	Modati	Garuphella	Saralbhanga		Below WL	Falling
WARNING LEVEL	41.85	64.52	47.50	44.90	51.50				
Danger Level	42.85	65.52	48.50	45.90	52.50	------	RAINFALL(mm)	Above WL	Steady
DATE	Water Level (MSL)	Water Level (MSL)	Water Level (MSL)	Water Level (MSL)	Water Level (MSL)	Water Level (MSL)	Water Level (MSL)	Above DL	
June 5, 2015	41.39	58.12	47.53	43.76	50.55	63.53	0.2		
June 6, 2015	42.26	59.66	47.77	43.93	50.64	64.47	245.2		
June 7, 2015	41.91	58.56	47.95	44.84	50.69	64.02	49		
June 8, 2015	41.43	63.92	47.76	44.47	50.8	63.92	67		
June 9, 2015	41.49	63.82	47.67	44.1	50.87	63.89	130.6		
June 10, 2015	41.73	63.97	47.7	44.21	51.04	63.89	80.6		
June 11, 2015	41.66	63.93	47.75	44.31	51.16	63.9	71.4		
June 12, 2015	41.73	63.97	47.71	44.21	51.04	63.89	80.6		
June 13, 2015	41.28	63.76	47.65	43.75	51.18	64.27	11.8		

Daily flow of Events leading to Issue of flood alert



ACTIONABLE ALERT FORMAT AS ISSUED

From: **FLEWS ASSAM**<flews.nesac@gmail.com>

To: asdma ghy <asdmaghy@gmail.com>,
Disaster Managememt control room <statedmcontrolroomassam@gmail.com>,
Nandita Hazarika <nandita.hazarika@gmail.com>,
b_ren <b_ren@rediffmail.com>,
Jayanta Dutta <mail2dpojayanta@gmail.com>,
P K Deka <dc-barpeta@nic.in>

FLOOD EARLY WARNING SYSTEMS (FLEWS)
NORTH EASTERN SPACE APPLICATIONS CENTRE

LOW to MODERATE Flood Alert - BARPETA

Dated : **15 August 20145(1615 hrs)**

Respective All Concerned,

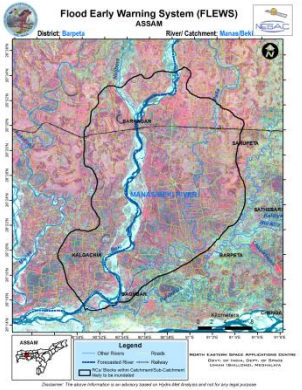
FLEWS Hydrological & Meteorological Analysis (with forecasted dataset) indicates a probable **LOW to MODERATE Flood situation** with the details specified as under:

District(s) : BARPETA
Rivers/Catchments : Beki, Pahumara, Kaldiya with SubTributaries
Revenue Circles/Blocks likely to be affected : Barpeta, Sarupeta, Baghbar, Bajali, Sarthebari,Barnagar, Kalgachia RCs
Validity : *24 - 48 hours*

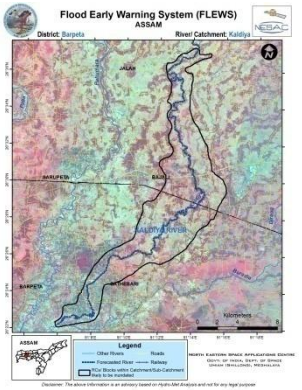
Pl refer to the attached Alert Maps for more spatial information.
This alert has the approval of Director, NESAC.

Regards,
FLEWS TEAM
North Eastern Space Applications Centre
Department of Space, Government of India
Umiam - 793 103, Meghalaya (India)

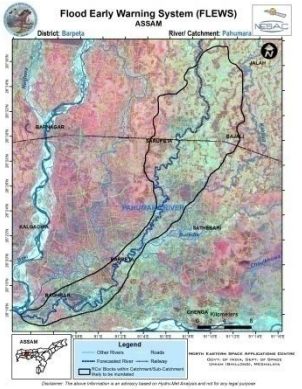
Disclaimer: The above information/advisory is based on Hydro - Met Analysis and not to be used for any legal purpose.



Beki River



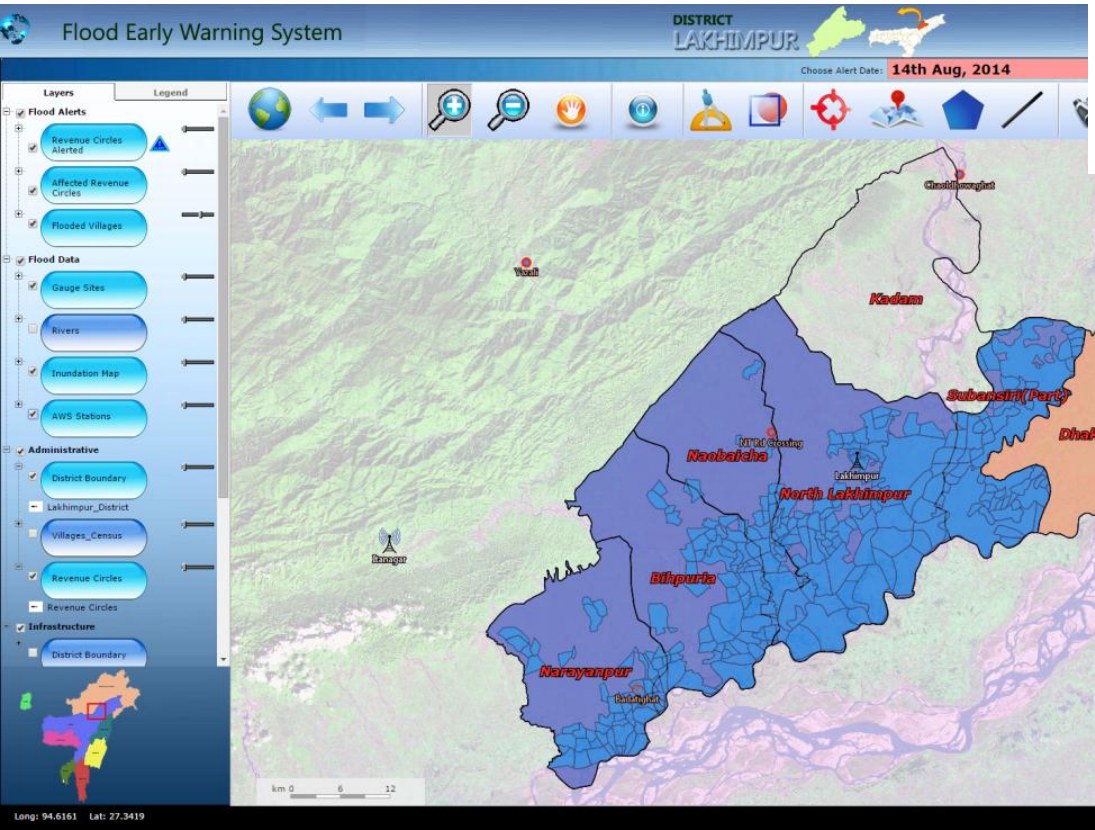
Kaldiya River



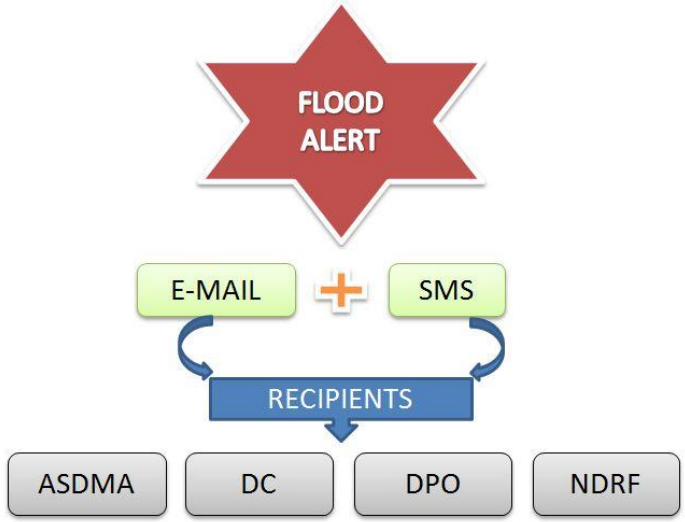
Pahumara River

ALERT DISSEMINATION MODES

- E-mails
- SMS
- Web-enabled decision support system with dynamic update interface to provide support to the user community (Planning phase)



FLOOD ALERT IN THE FORM OF GROUP SMS/E-MAILS



Assam Tribune...

www.assamtribune.com/s

Flood alert in Meghalaya

SHILLONG, Aug 16 – The North Eastern Space Application Centre (NESAC) has sounded flood alerts in low lying areas of Meghalaya's West Garo Hills district after incessant rains lashed the region in the past 48 hours.

"The Flood Early Warning System of NESAC has issued alert that there could be flood in Phulbari area of the district in the next 48 hours in view of the incessant rains in the region and in Upper Assam area," West Garo Hills District Deputy Commissioner Pravin Bakshi said today.

Government of Assam
te Disaster Management Authority
FLOOD REPORT

tion as on Today i.e. 7th June , 2015

Situation as on 7th June, 2015	
Puthimari at N. H. Rd. Xing (Kamrup).	
06	
Barpeta, Sonitpur, Dhemaji, Kokrajhar, Bongaigaon, Lakhimpur	
10	
rpeta, Sarthebari.	
elamara, Gohpur.	
emaji, Sissiborgaon.	
krajhar, Dotma.	
ngtol.	
wboicha.	
	20 (Barpeta), 44 (Sarthebari).
	06 (Thelamara), 02 (Gohpur).
	07 (Dhemaji), 04 (Sissiborgaon).
	10 (Kokrajhar), 02 (Dotma).
	09 (Dangtol).
	04 (Nowboicha).

FLOOD REPORTED

Government of Assam
Assam State Disaster Management Authority
FLOOD REPORT
Flood Situation as on Today i.e. 15th June, 2015

PARTICULARS	Situation as on 15th June, 2015		
Rivers flowing above Danger Level	Brahmaputra at Nematighat (Jorhat) & at Dhubri (Dhubri) River Jia Bharali at N.T.Rd. Xing (Sonitpur)		
No. of Districts Affected	11		
Name of Districts Affected	Barpeta, Sonitpur, Dhemaji, Lakhimpur, Kokrajhar, Tinsukia, Darrang, Dibrugarh, Goalpara, Kamrup (Metro), Morigaon.		
No. of Revenue Circles affected	24		
Names of Revenue Circles affected	Barpeta	06	Barpeta, Sarupeta, Sarthebari, Baghbar, Chenga, Kalgachia
	Sonitpur	04	Thelamara, Tezpur, Halem, Gohpur
	Dhemaji	02	Dhemaji, Sissiborgaon
	Lakhimpur	01	Nowboicha.
	Tinsukia	01	Sadiya
	Darrang	03	Mangaldai, Patharighat, Sipajhar.
	Dibrugarh	01	Dibrugarh West
	Kokrajhar	01	Bagribari
	Goalpara	03	Balijana, Lakhipur, Matia.
	Kamrup (M)	01	Chandrapur.
	Morigaon	01	Mayong.
	Total	24	

NO FLOOD REPORTED

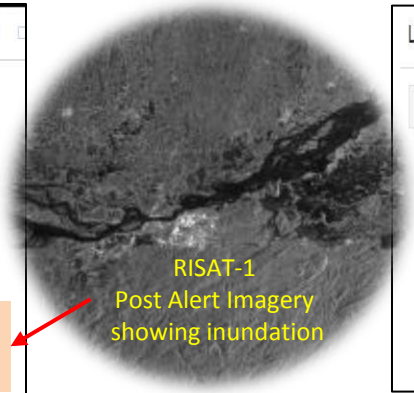
DMA Collaborative Flood Early Warning Project, 2015

ma, Shyam, Rekha, Dr, Nilesh, partho, goswamikasturi., kksarma

ible "Low" flood situation as per following details.

District	Kokrajhar
Revenue Circle	Kokrajhar, Dotoma
Rivers	Gaurang, Sonkosh
Date & Time of Issue	06.06.2015; 18:50
Validity of alert	24-36 hrs

ABSOLUTE SUCCESS



RISAT-1
Post Alert Imagery
showing inundation

Low Flood Alert for Bongaigaon District under Flood Early Warning System (FLEWS) Project, 2015

Flood Early Warning System (FLEWS), 2015 <flews.nesac@gmail.com>
to asdma, Disaster, Nandita, b_ren, anantasamant, diganta, Amaljit, Dipsma, Shyam, Rekha, Dr, Nilesh, partho, goswamikasturi., kksarma

Respected all concerned,

Our recent hydro-meteorological analysis reveals a probable "Low" flood situation. as per following details:

District	Bongaigaon
Revenue Circle	Bongaigaon, Sidli (Pt).
Rivers	Manas, Aie
Date & Time of Issue	13.06.2015; 18:35
Validity	24-48 hrs

PARTIAL SUCCESS

তেজপুৰ, কোক্ৰাঝাৰ, বঙাইগাঁও, বৰপেটাত বান

FLOOD REPORTED

Validation of issued flood alerts from multisource information

RISE IN WATER LEVEL (ABOVE DL)

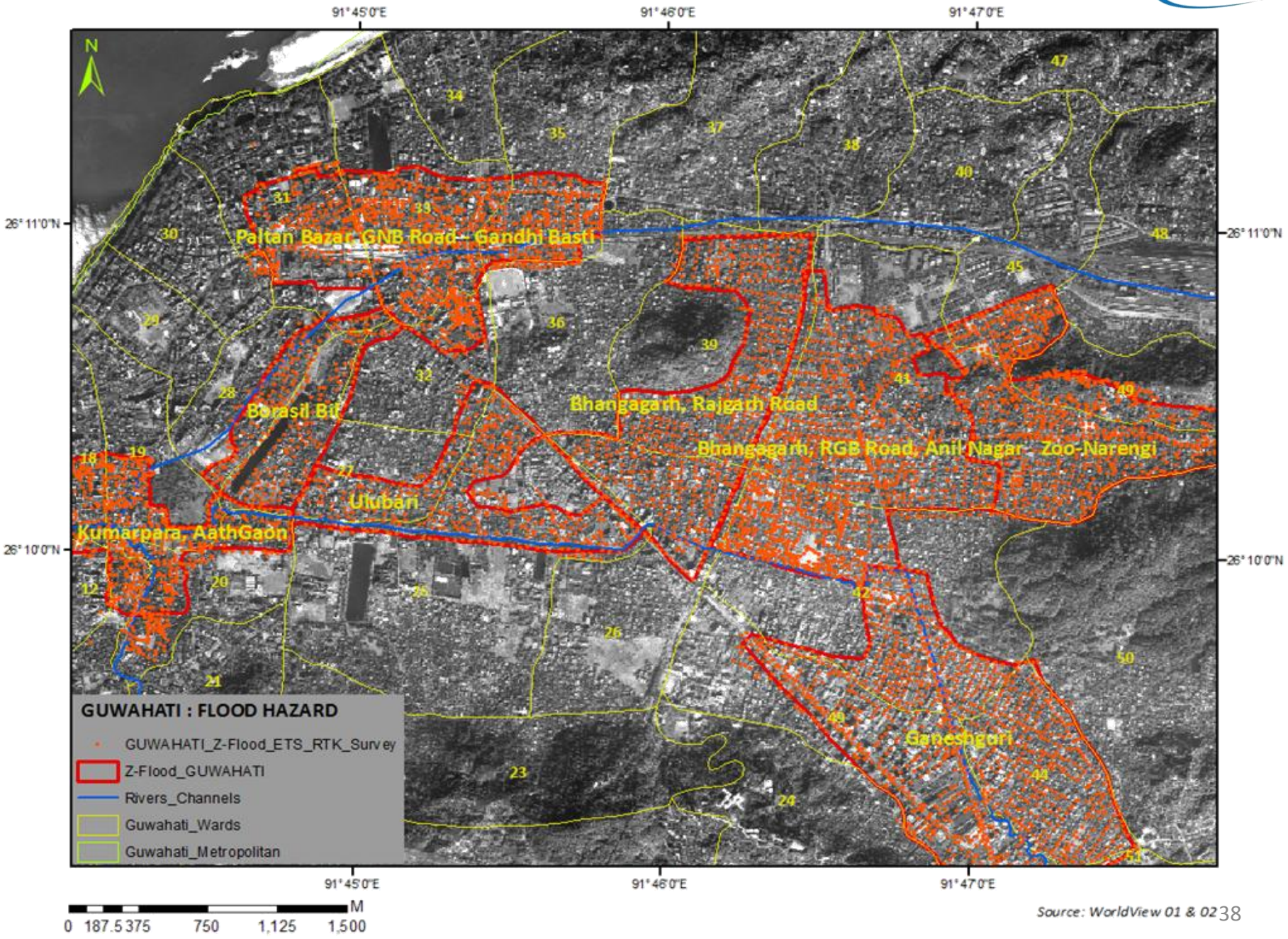
Daily water level			g under Bongaigaon	Ph. No.	03678-241341	Rising
Rivers/ Date		AIE RIVER	AIE MANAS		Below WL	Falling
WARNING LEVEL		43.67	37.84			
Danger Level	36.27	44.67	38.84		Above WL	Steady
DATE	Water Level (MSL)	Water Level (MSL)	Water Level (MSL)		Above DL	
G/D SITE						
June 12, 2015	35.91	44.67	38.31			
June 13, 2015	35.97	44.77	38.31			
June 14, 2015	35.77	44.65	38.47			
June 15, 2015	35.44	44.82	38.41			

Field Data Transmission using Mobile Technology (FIDATRA)

Salient Feature

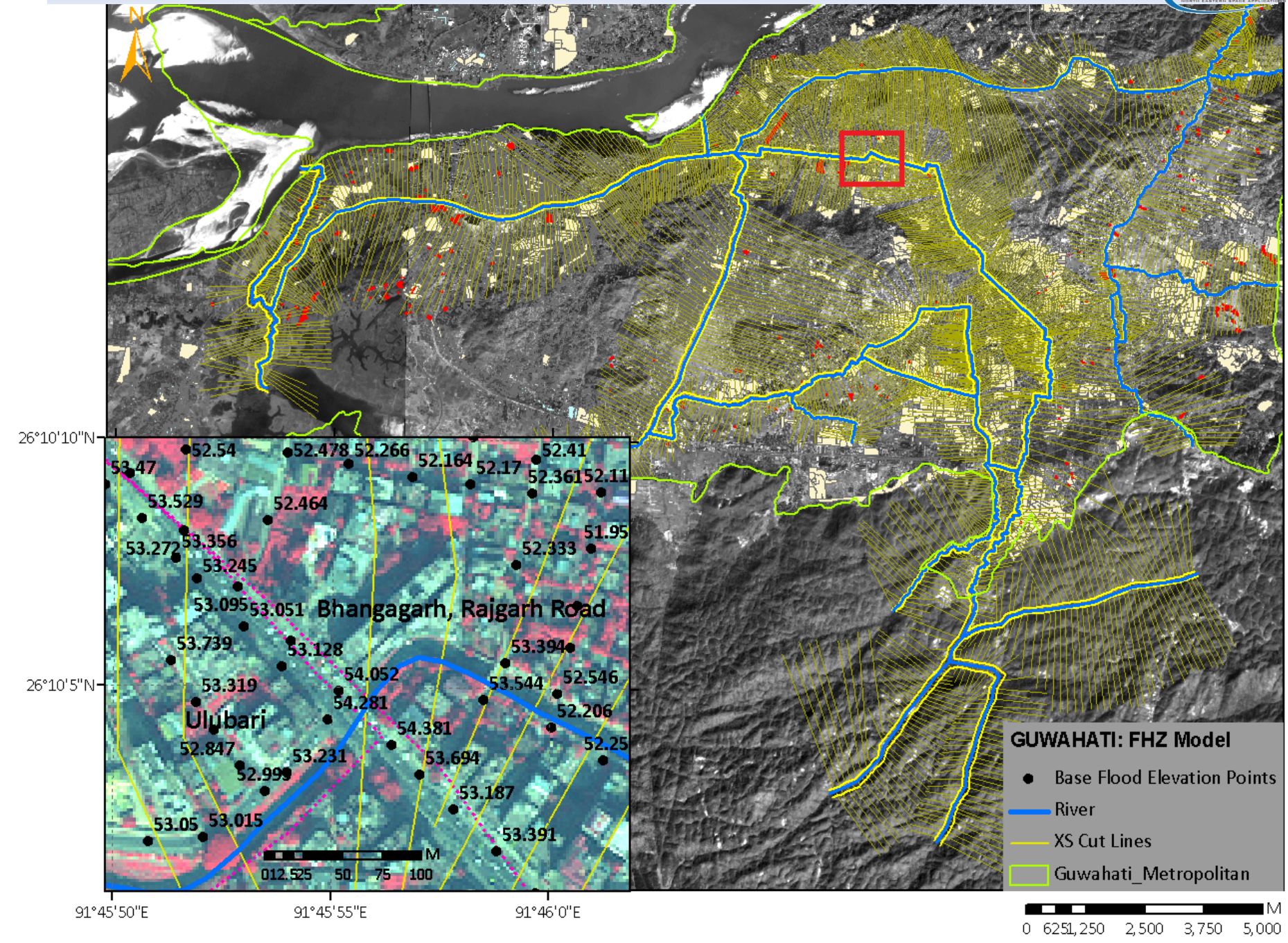
- Apps developed in Android platform
- Any phone with with Android O/S, GPS and Camera can be used
- Communication through GPRS
- Following data may be send
  - Positional data (Lat, Long and Alt.)
  - Photo
  - Video
  - Text
- Graphical representation of data using map/table in the server end
- Also can be used for sending ground truth data from field for any project

GUWAHATI Metropolitan – Ground Survey using RTK/ETS/DGPS

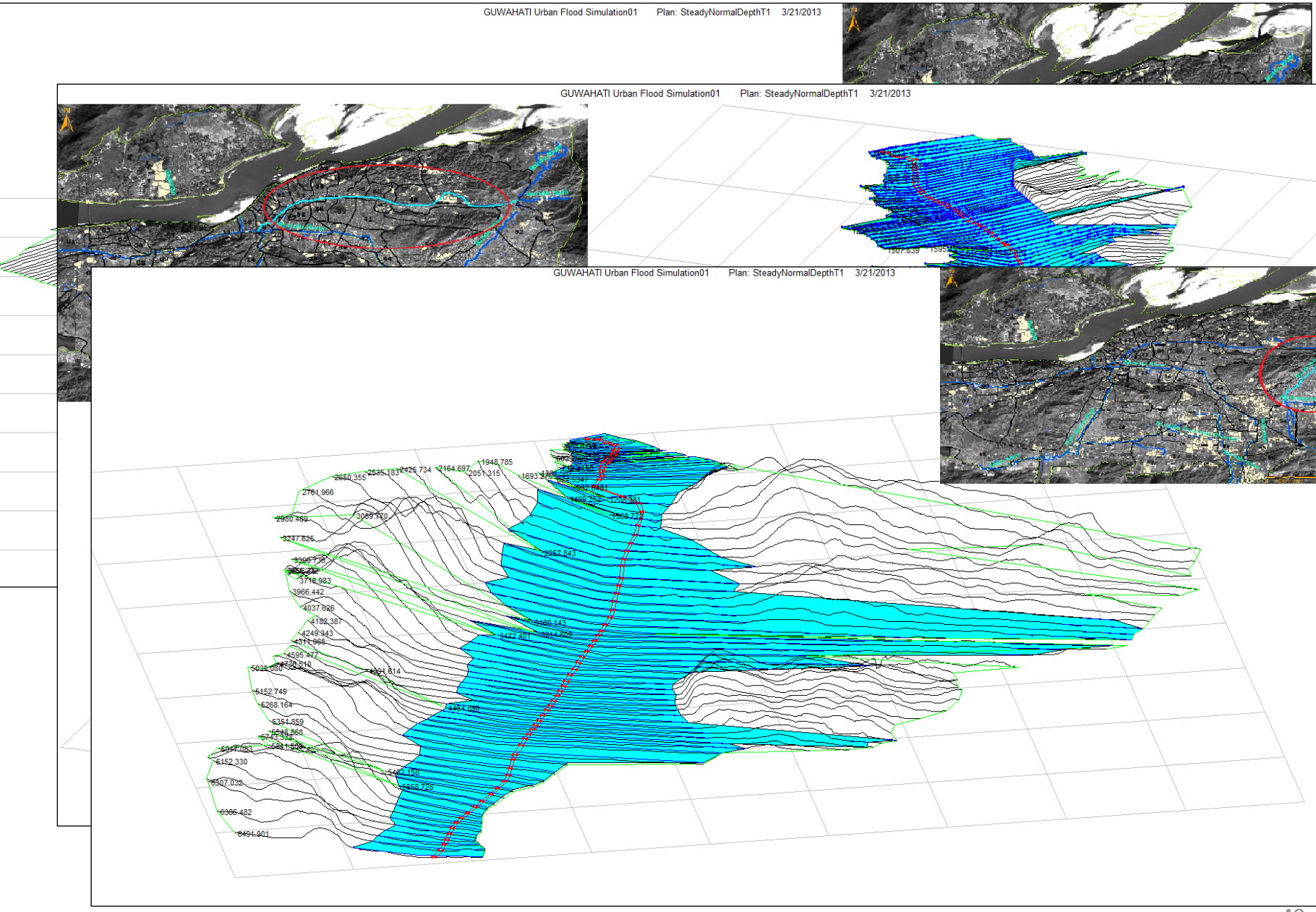


Source: WorldView 01 & 02

GUWAHATI Urban Catchment – Hydraulic Flood Modeling

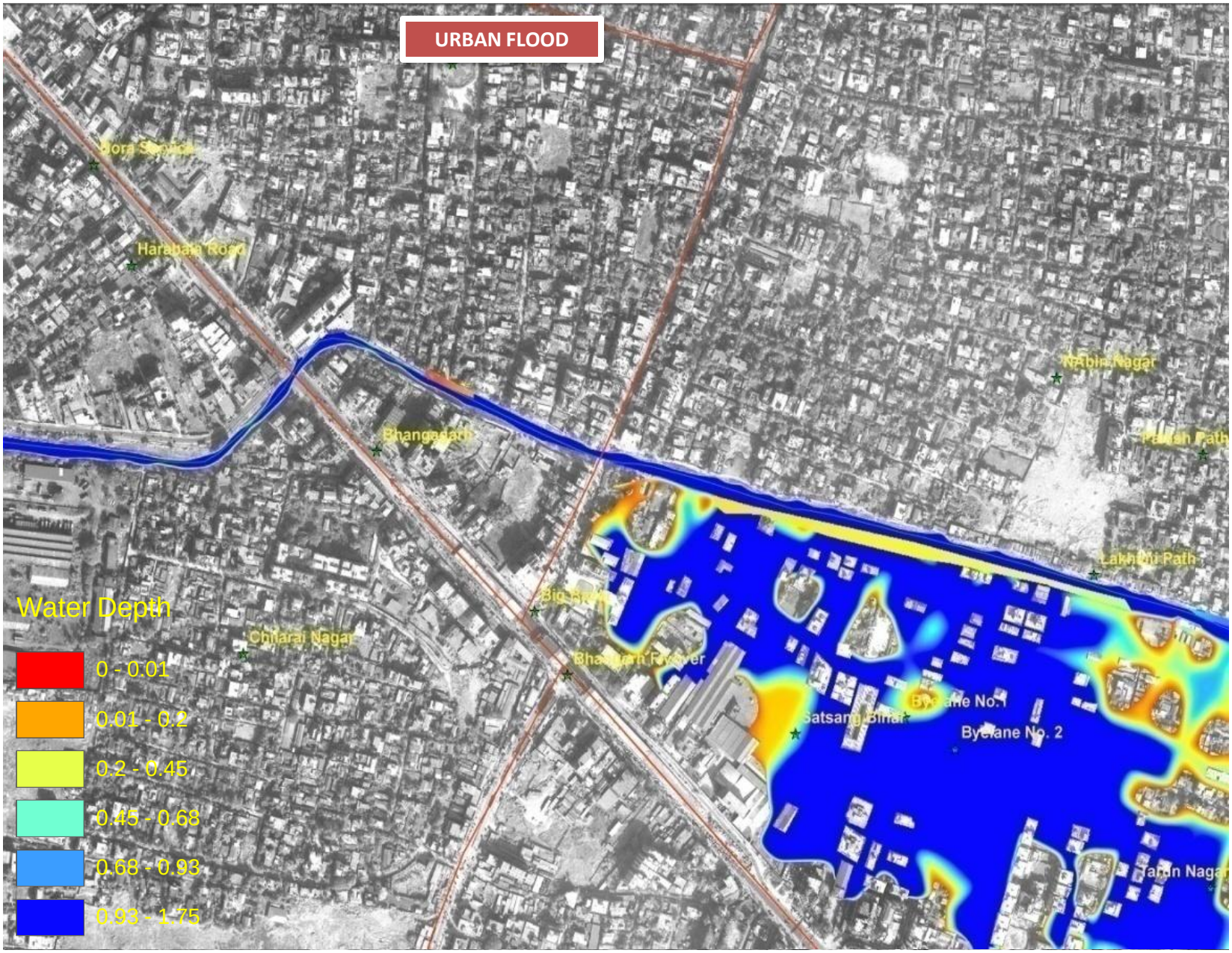


GUWAHATI Urban Catchment – Hydraulic Flood Simulation

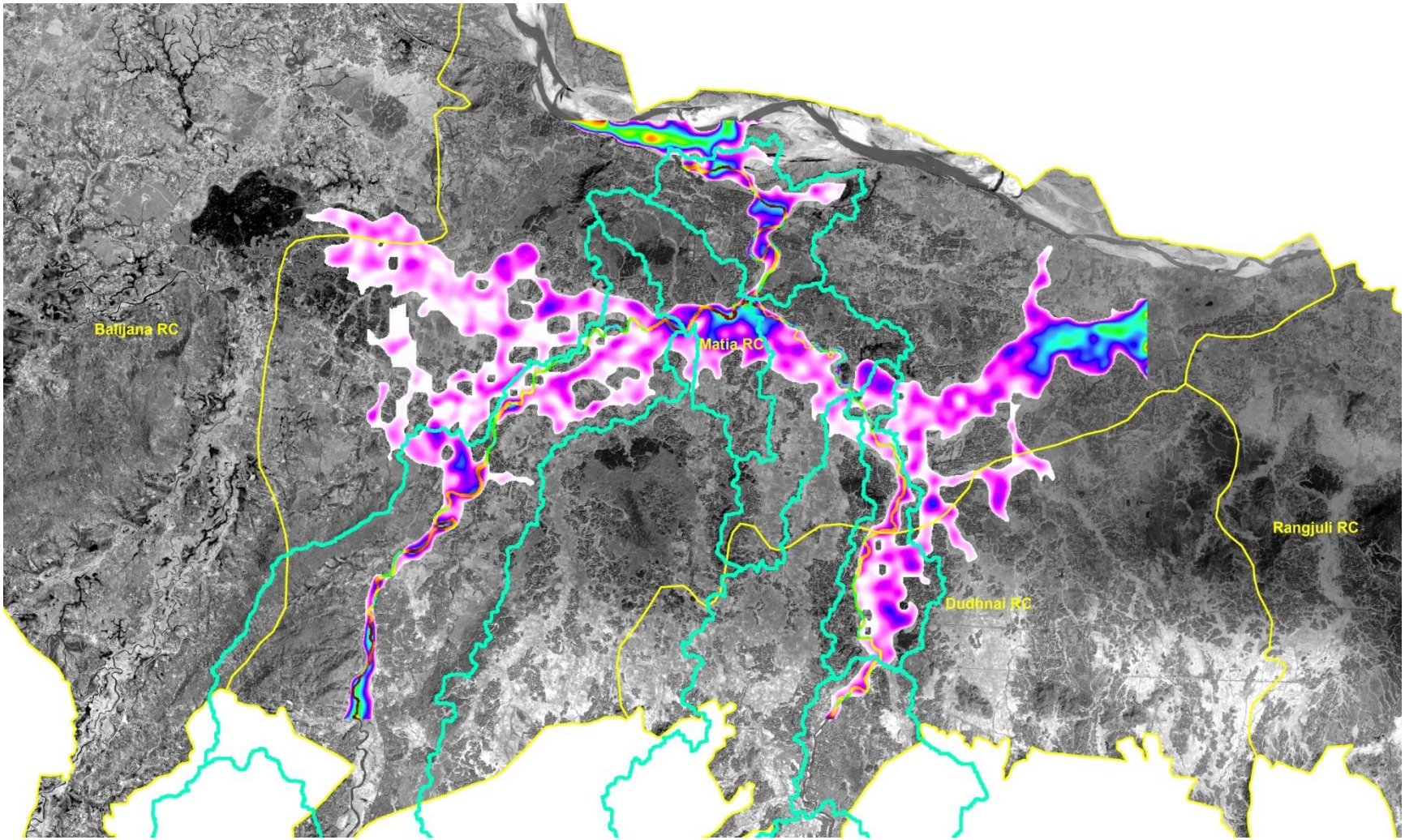


Flood Simulation using MIKE FLOOD 1D-2D Coupled Hydraulic Model

(Two case studies in Ranganadi river (450 cumecs) in Lakhimpur District and Bharalu River(210 cumecs) in Guwahati city, Assam)



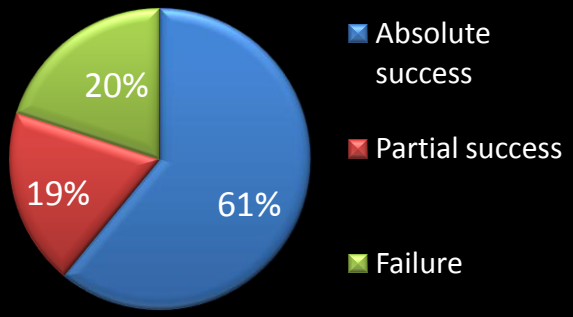
Detailed Alert Issue using Hydraulic Models (Pilot)



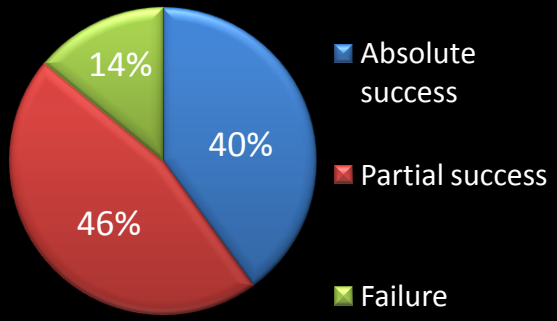
RC Level Inundation check

SUCCESS & RECOGNITIONS

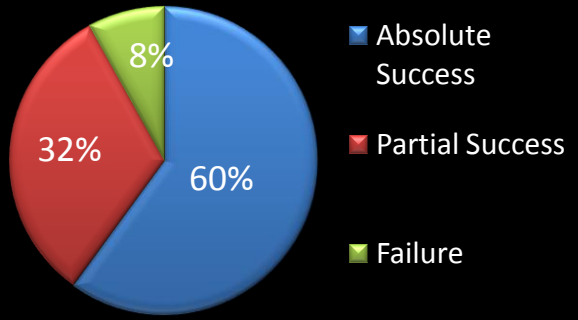
Alerts issued: 2012



Alerts: issued 2013



Alerts Issued: 2014



Note: Partial success is the rise in river level without reported inundation

FLEWS Technical training provided to Disaster Managers from all NER States under state level capacity building initiatives

AWARDS & RECOGNITIONS:

- ❑ **Winner of e-North East Award, 2013 in the category of e-Governance and Citizen Services Delivery.**
- ❑ **Declaration as "a good governance practice & funding for professional documentation" by the Department of Administrative Reforms under Ministry of Public Grievances & Pensions, Govt. of India in the year 2012.**
- ❑ **Short listed as a finalist for Prime Minister's award for innovations in 2012**
- ❑ **Several parliament questions have been answered till date on the feasibility of FLEWS implementation in other parts of the country.**

- ❖ **All flood prone districts of Assam covered in 3 years of operational existence**
- ❖ **Average percentage of annual alert success is 75% with lead time ranging from 12-36 hours**
- ❖ **Different Hazard zones created from hydrologic and hydraulic assessment**
- ❖ **Various Review meetings reflects user comments on reduction of loss of life**

ADVANTAGES OVER CONVENTIONAL METHODS OF FLOOD FORECASTING

Hydro-met Flood Alerts	Conventional Flood Alerts
Based on basin scale hydro-met rainfall and stream flow forecasting	Based on in-situ river level observations in real-time. Basically a now-casting
Improved flood forecast lead time due to use of forecasted rainfall from WRF model	Flood forecast lead time is less as based on real time river level data
River wise flood plain is considered while issue of alert for all major rivers of Assam	Forecasting station based alert only in few major rivers
Un-gauged rivers can be addressed	Only limited gauged rivers are addressed
Hydrological routing is done with effect of time lag	No routing is done
Flood alert is issued with district and revenue circle information	Flood alert is issued for a particular river station with no information on area of influence
Annual embankment breach monitoring is done as an additional service	No such monitoring of embankments

Embankment breach monitoring

MAJOR COMPONENTS OF EMBANKMENT BREACH WATCH

1. Monitoring of embankments using high resolution Cartosat-I data before upcoming flood season

2. Post flood embankment breaches identification and mapping in district level.

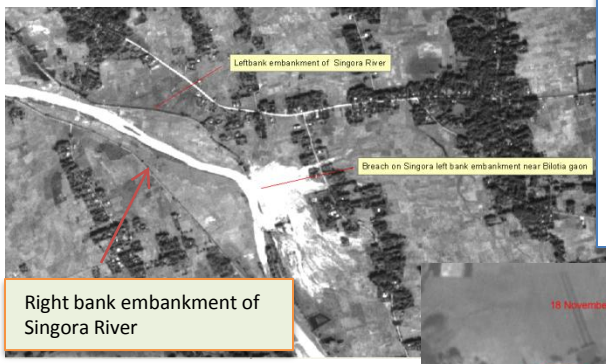
3. Report breach locations/points in flood prone river systems for mitigation works.

DATA USED

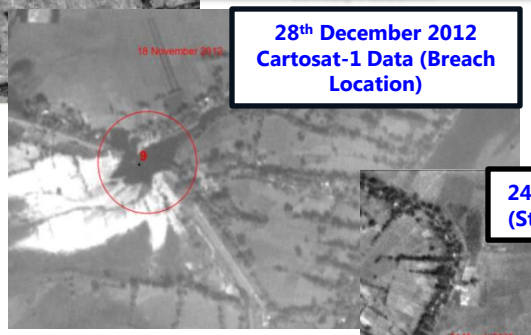
(i) Temporal Cartosat –1 / RISAT – 1 satellite data Aft Scene of various acquisition dates of 2.5 m spatial resolution

(ii) River Index Map of Assam (source: WRD Assam)

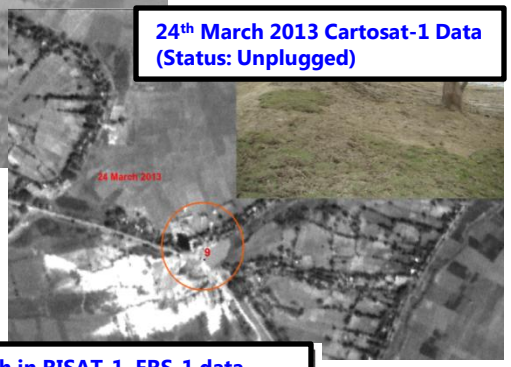
(iii) Information of river embankment breach locations as supplied time-to-time by WRD, Assam.



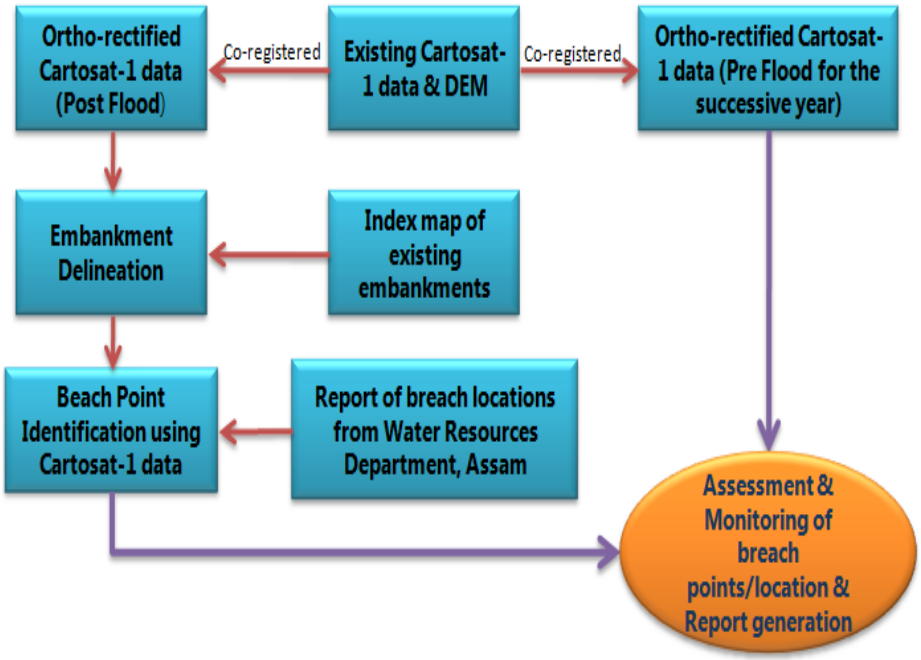
Right bank embankment of Singora River



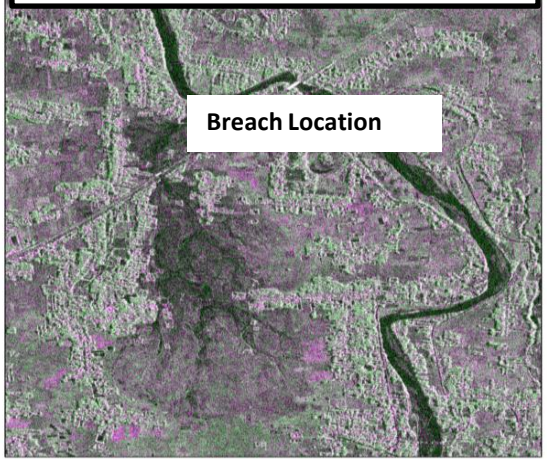
28th December 2012 Cartosat-1 Data (Breach Location)



24th March 2013 Cartosat-1 Data (Status: Unplugged)

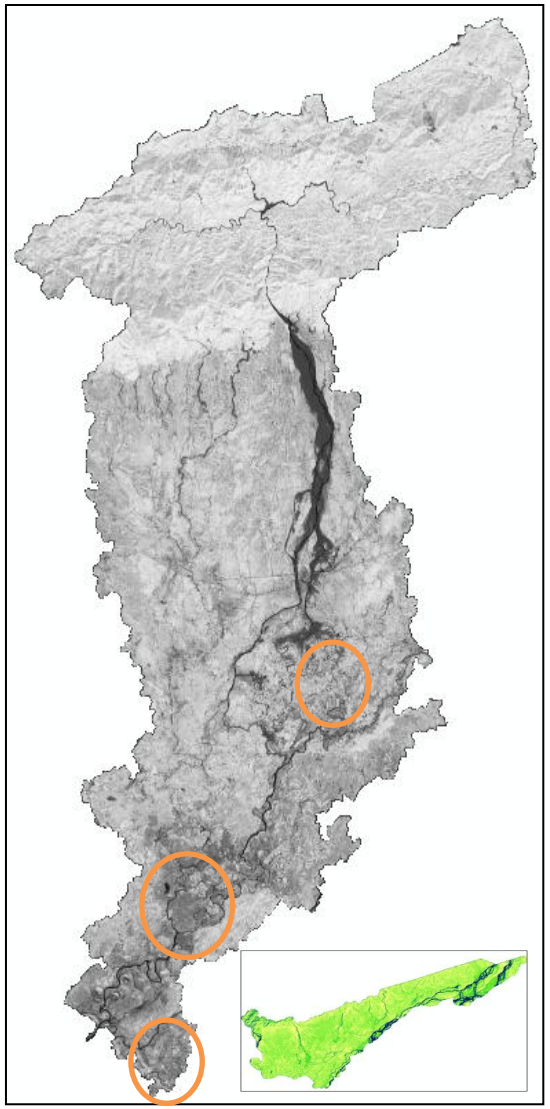


Embankment Breach in RISAT-1, FRS-1 data, HH+HV+HH



Breach Location

Active floodplain depicted by NDVI and NDMI as the indices based Flood Hazard Zonation



$$NDVI = \frac{NIR-R}{NIR+R}$$

Legend

Value

High : 0.786585

Low : -0.155963

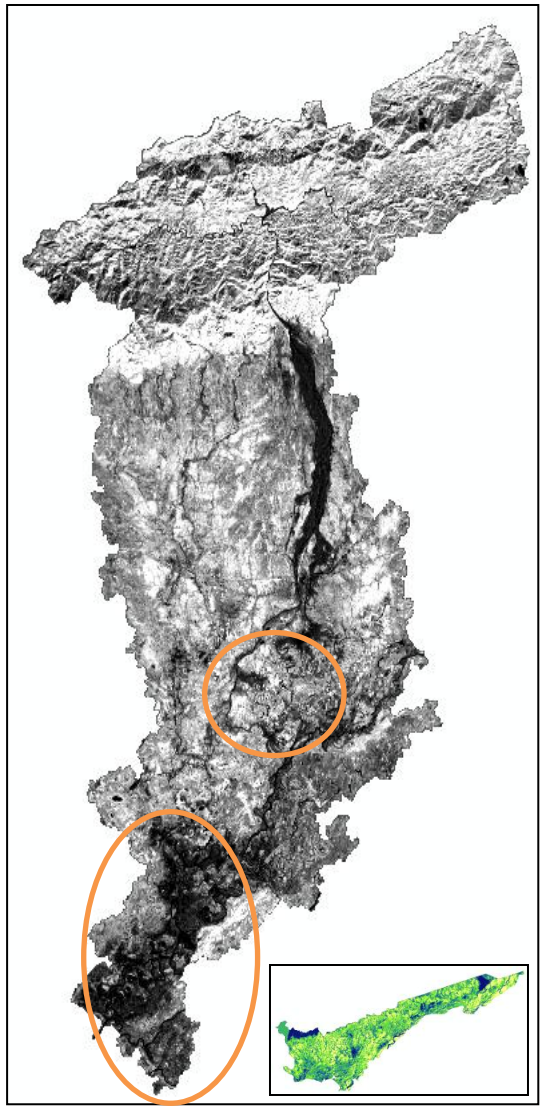
$$NDMI = \frac{IR-SWIR}{IR+SWIR}$$

Legend

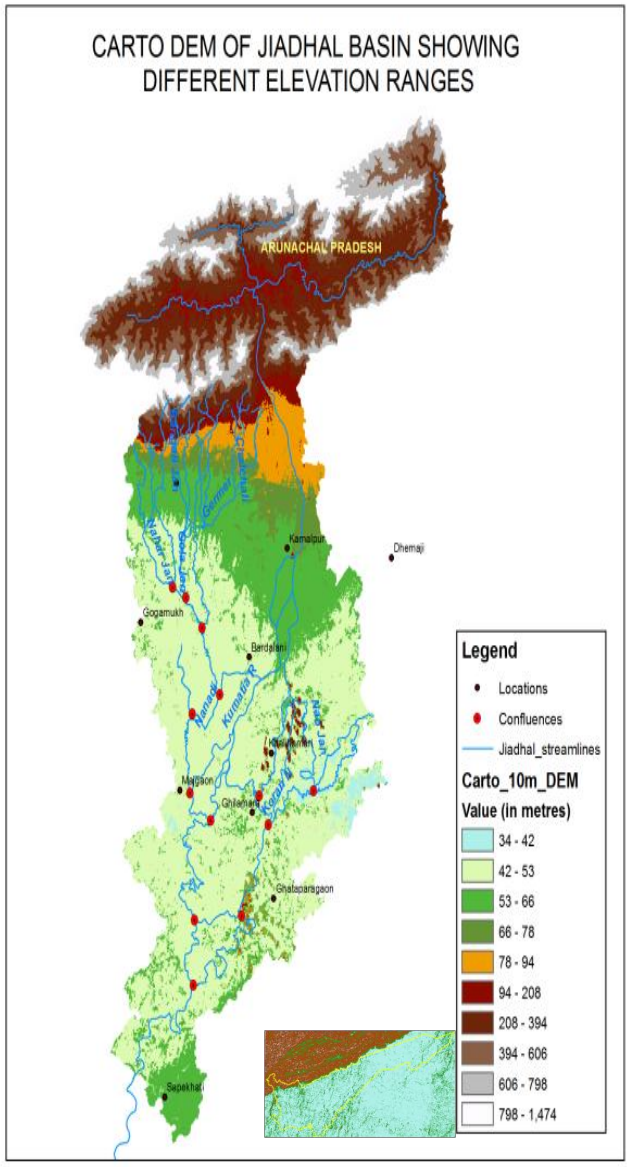
Value

High : 0.405797

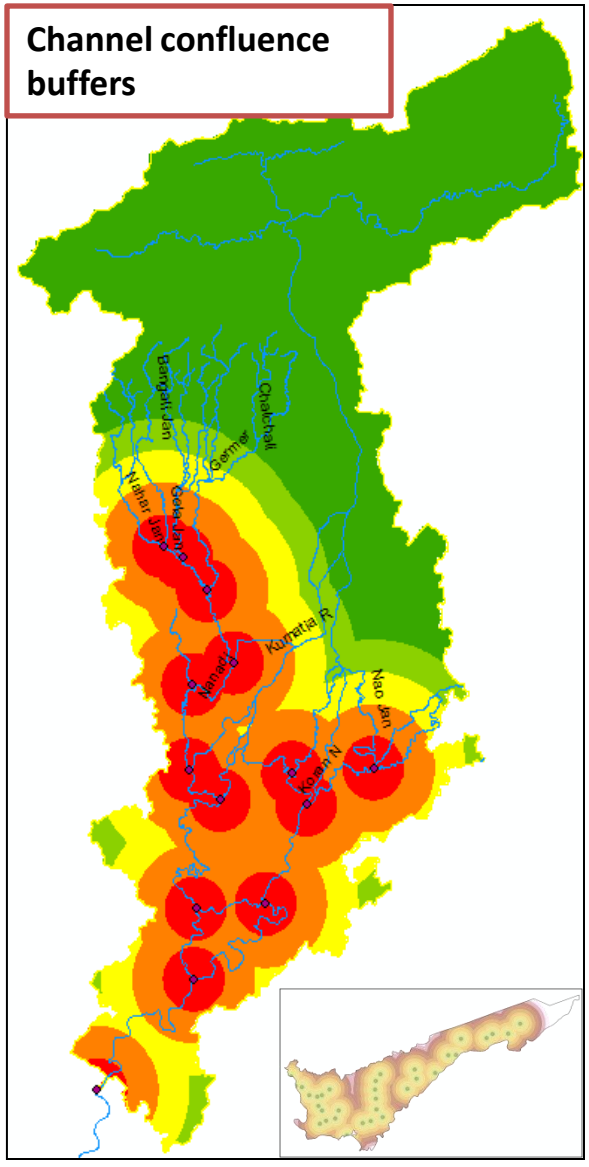
Low : -0.40146



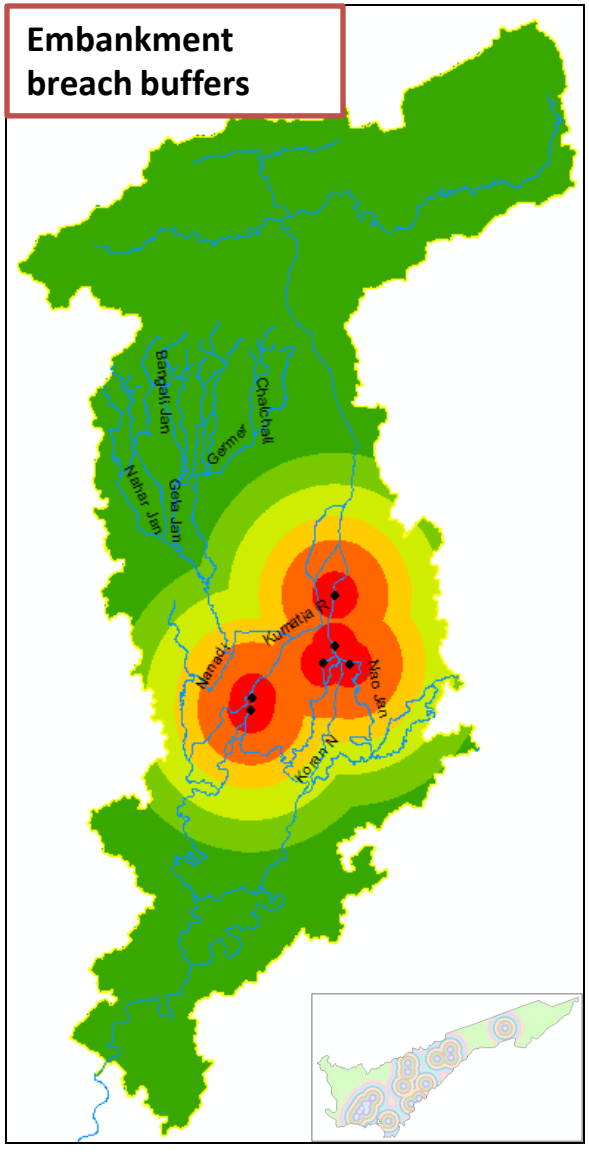
The three field based hazard zonation criteria



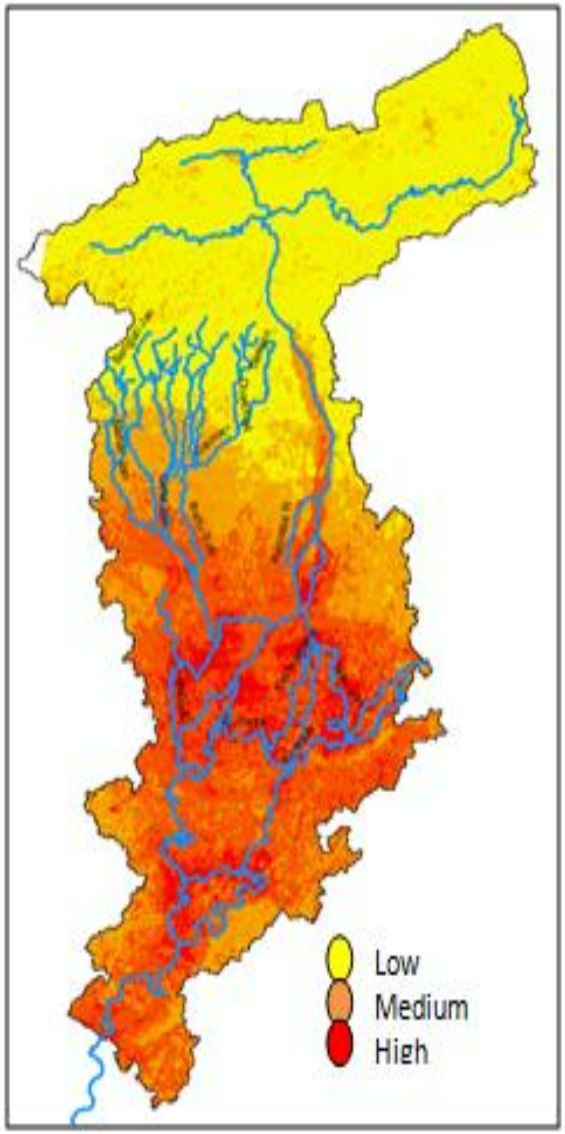
Channel confluence buffers



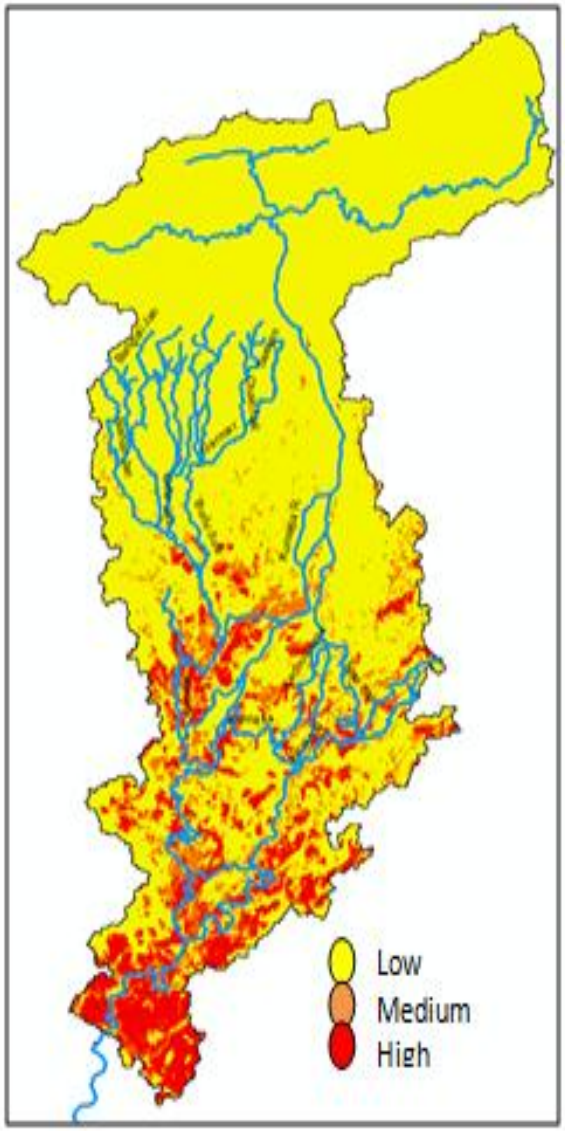
Embankment breach buffers



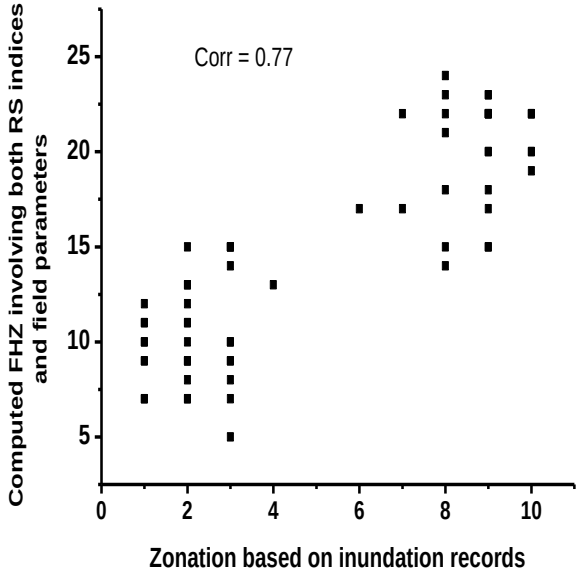
Jiadhal river whole floodplain with all criteria

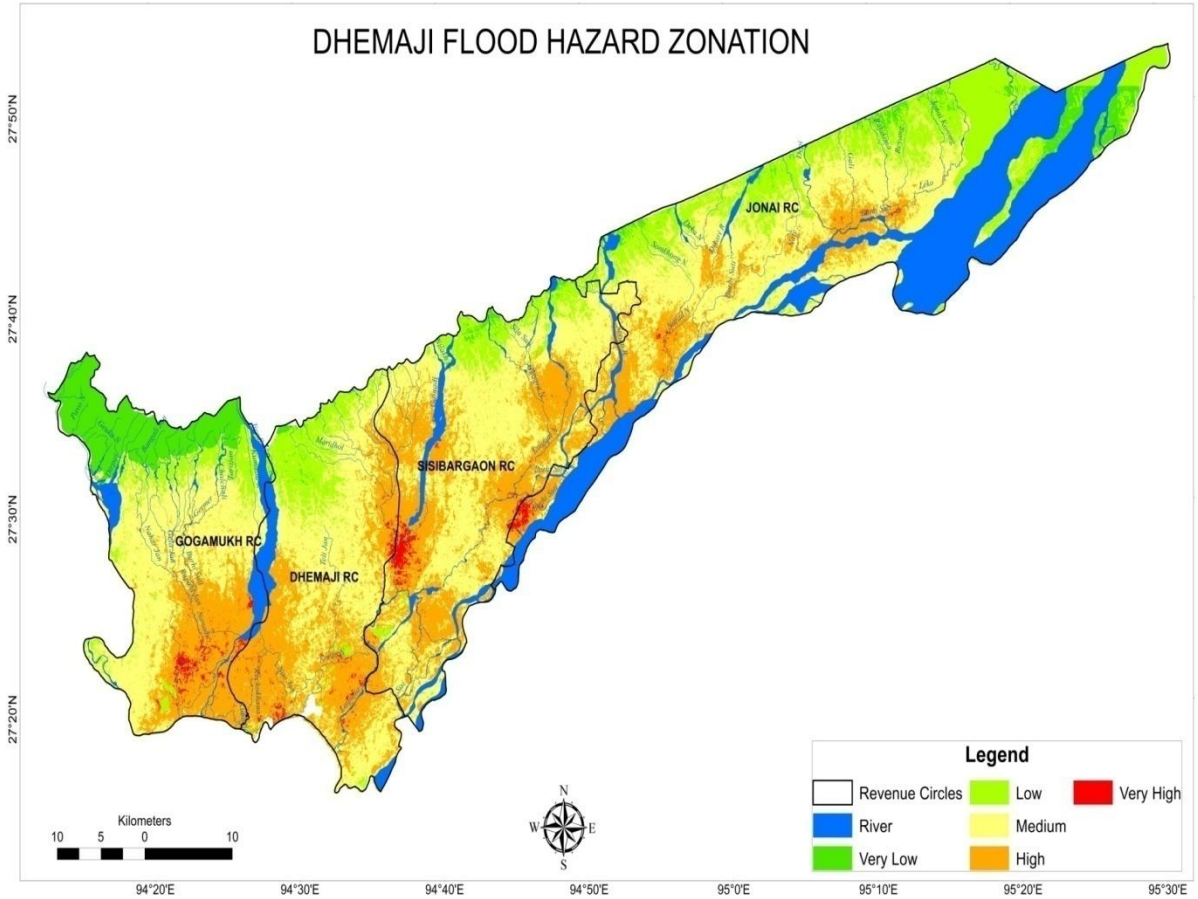


Multi-criteria FHZ



Historical inundation





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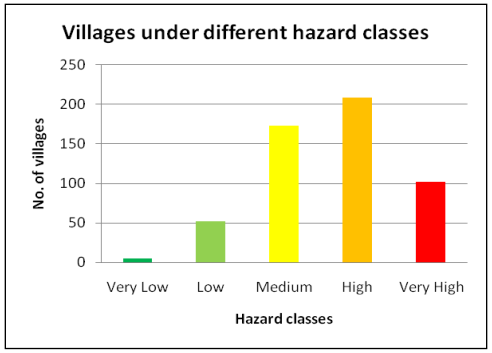
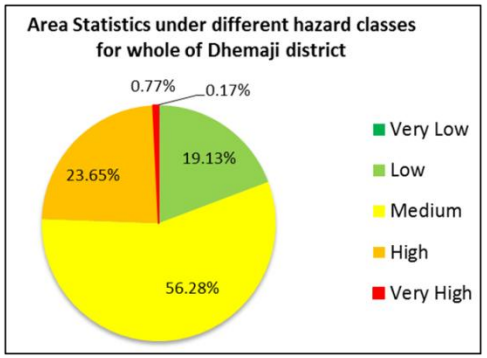
Flood resilience technology in Europe: identifying barriers and co-producing best practice
I. White, A. Connelly, S. Garvin, N. Lawson and P. O'Hare
Accepted manuscript online: 27 FEB 2016 04:05AM EST | DOI: 10.1111/jfr3.12239

Assessing and mapping flood hazard, vulnerability and risk in the Upper Brahmaputra River valley using stakeholders' knowledge and Multi-Criteria Evaluation (MCE)
Nabajit Hazarika, Diganta Barman, Apurba Kumar Das, Arup Kumar Sarma and Suranjana Bhaswati Borah
Accepted manuscript online: 27 FEB 2016 02:32AM EST | DOI: 10.1111/jfr3.12237

Debris Flow Damage Incurred to Buildings: An In-Situ Back Analysis





Major bottlenecks in developing a even better state of art system

Problems	Probable Solutions
Vertical resolution of the topography data of the flood plains and river bathymetry	Fine beam DEM generation by either LIDAR or SAR interferometry in order to achieve contour intervals of 30 to 80 cms + regular cross section survey by the custodian agencies
Calibration and validation of both the hydro and the met model associated with flood forecasting	A robust discharge collection network. The custodian agencies urgently needs to transform their "Gauge only" sites to at least Gauge & Discharge sites///// Similarly automated Met station density to be increased as per WMO guidelines
Inter agency sharing of data	A dynamic hydro-met data infrastructure in high resolution GIS domain to be shared freely among stake holder technical groups with restricted user access protocol through MOUs

Few issues on capacity building and data

What do we want ? ? A one time exercise or a sustainable process of development

Have we selected the right manpower ??

Is training programmes are customized to our need ??

Do we have adequate data to fit into these sophisticated softwares..... What about processing speed during disaster ??

The NESAC, Shillong

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Thank you all

Major areas of activities

- RS & GIS
- Space and Atmospheric Science
- SATCOM
- NER-DRR