UNIQUE CHALLENGES OF RIVER FLOOD, URBAN FLOODS AND FLASH FLOODS

RITESH KHATTAR

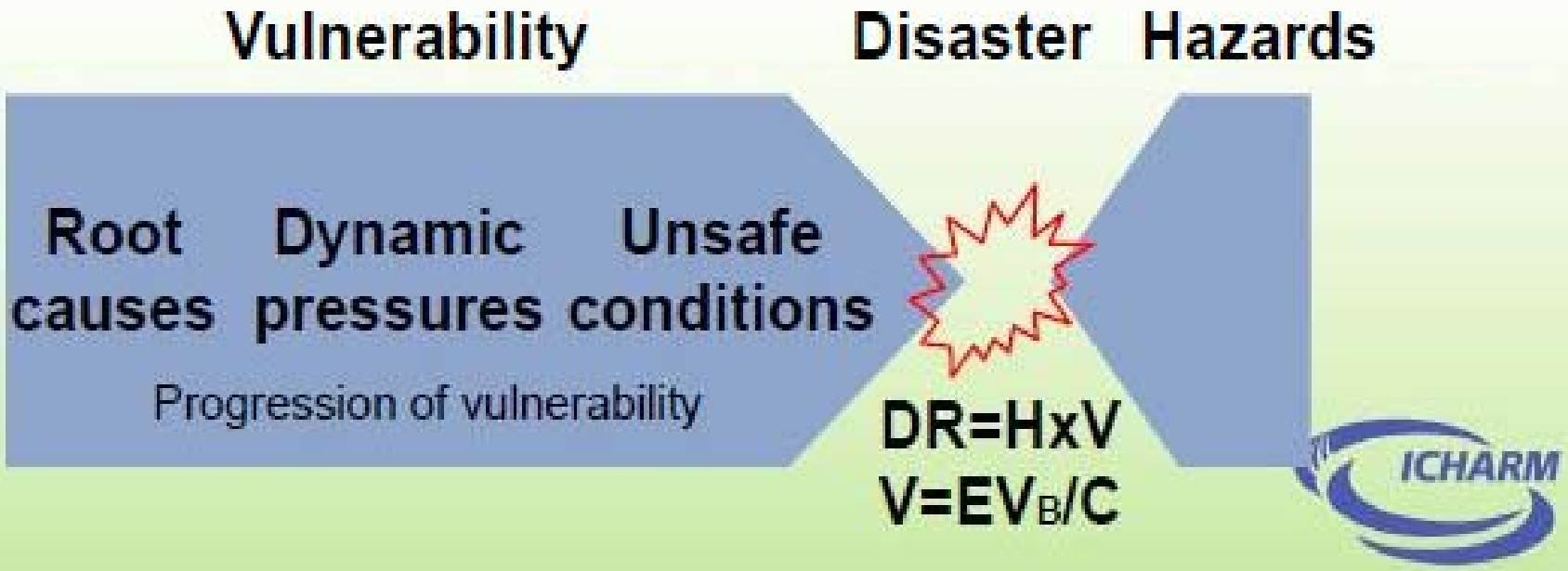
DIRECTOR

FLOOD CONTROL APPLICATIONS DTE-II

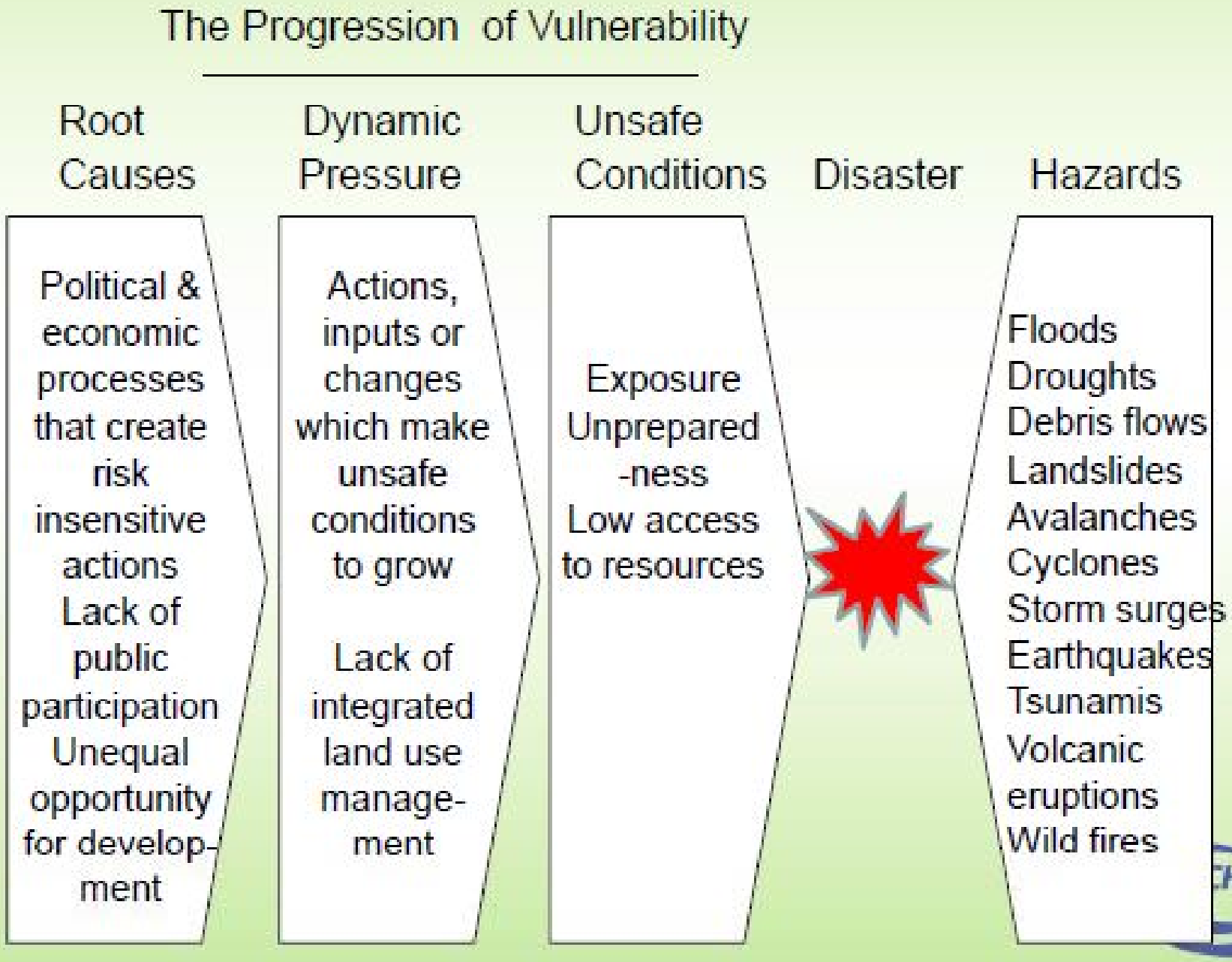
When does disaster occur?

- **Disaster occurs when societal vulnerability meets with hazards.** Consequences depend on how a society is organized in progression of vulnerability.
- **Pressure and release (PAR) model:** The only way to reduce risk is reduction of vulnerability pressure.

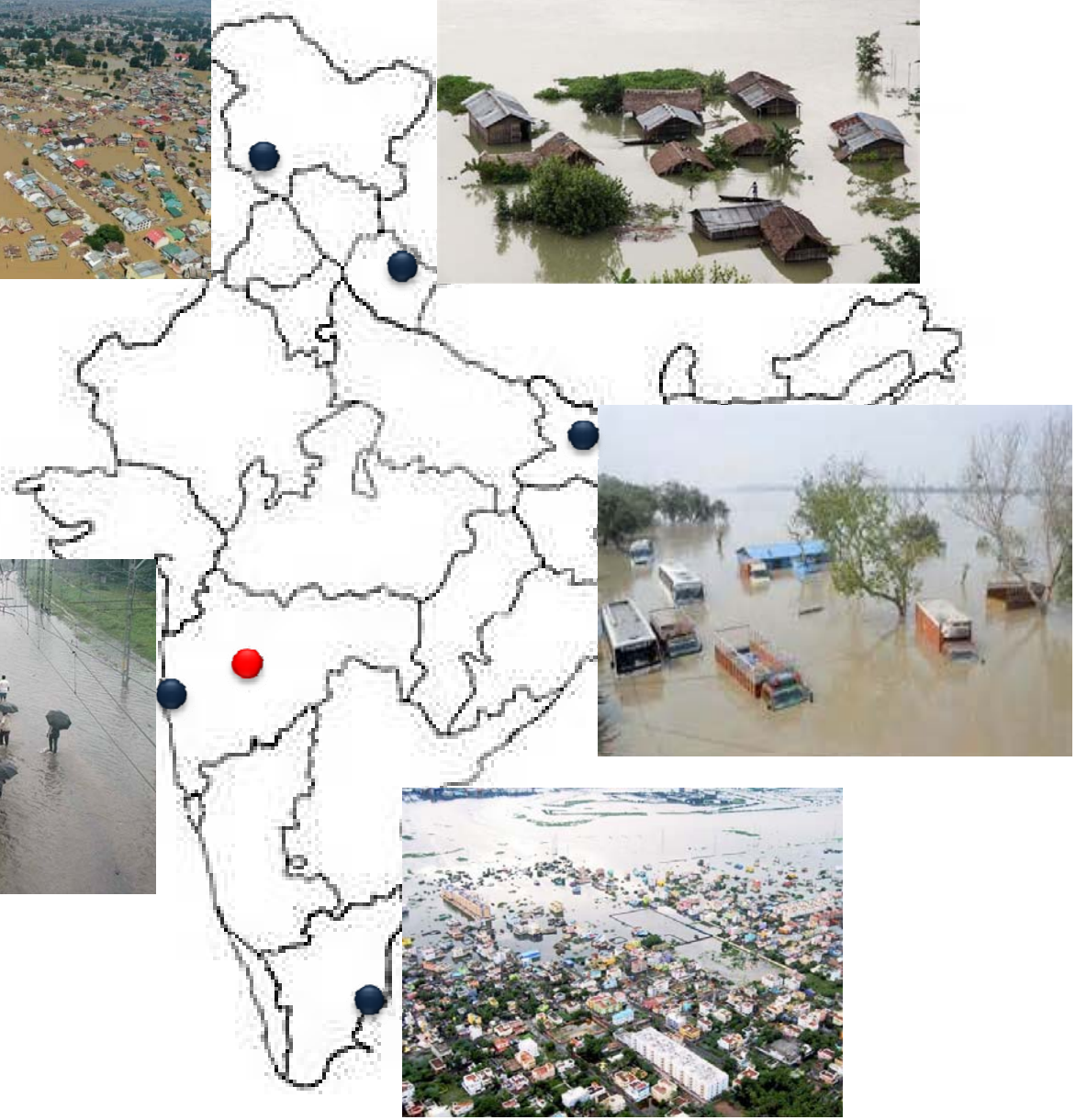
By Ben Wisner, Piers Blaikie, Terry Cannon and Ian Davis, **At Risk**, Second Edition -natural hazards, people's vulnerability and disasters- (Routledge, London & NY, 2004)



Pressure Model



Recent Flood Disasters



Increased occurrences of flood

Recent Memories of Flood Uttarakhand, June, 2013

Figure 1: (a) Huge boulders moved by Chorabari glacial lake outburst flooding in Kedarnath (courtesy – Google images); (b) High sediment deposition due to the GLOF event in kedarnath destroying the entire city (courtesy - Google images)

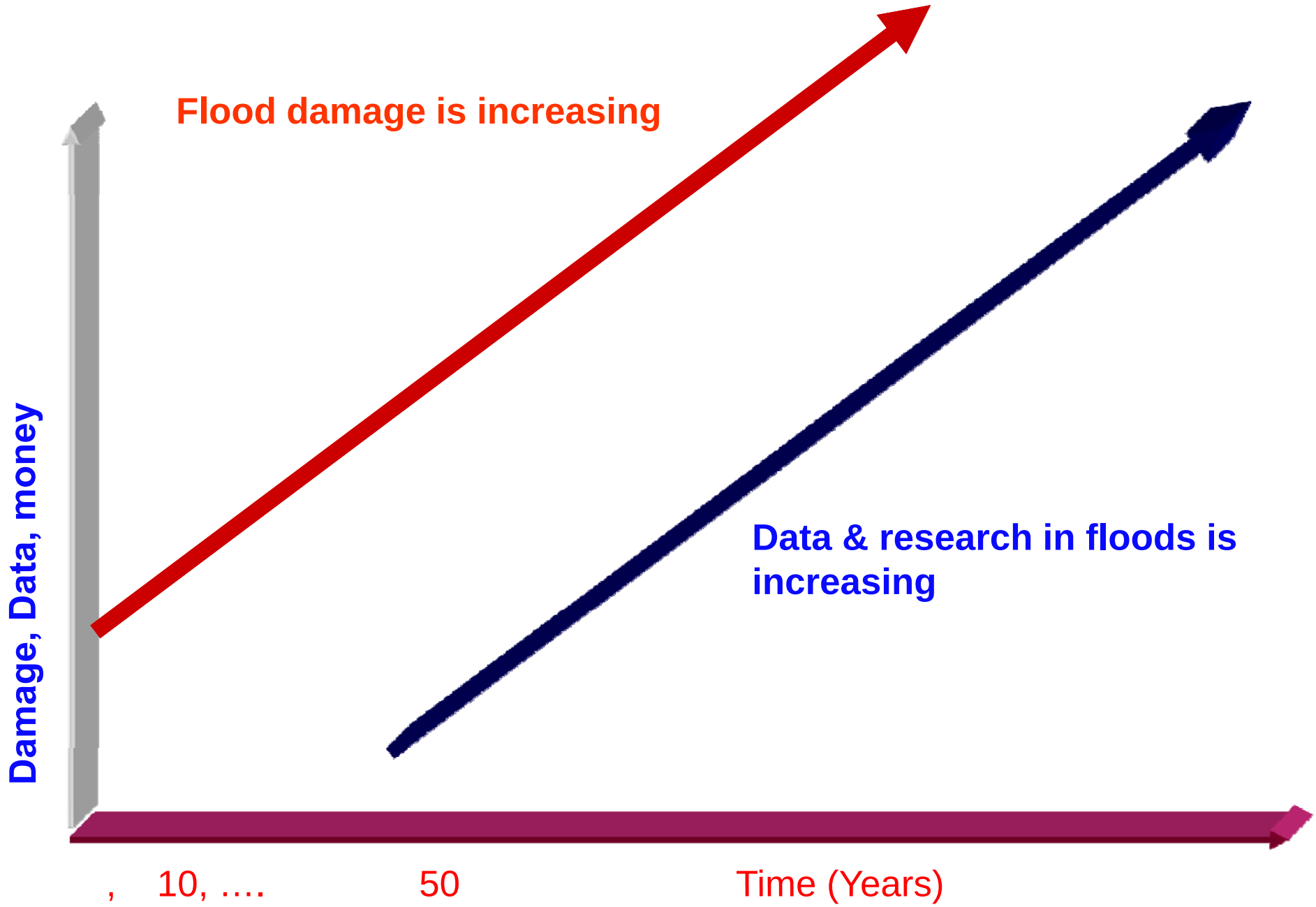
Recent Memories of Flood
Uttarakhand, June, 2013

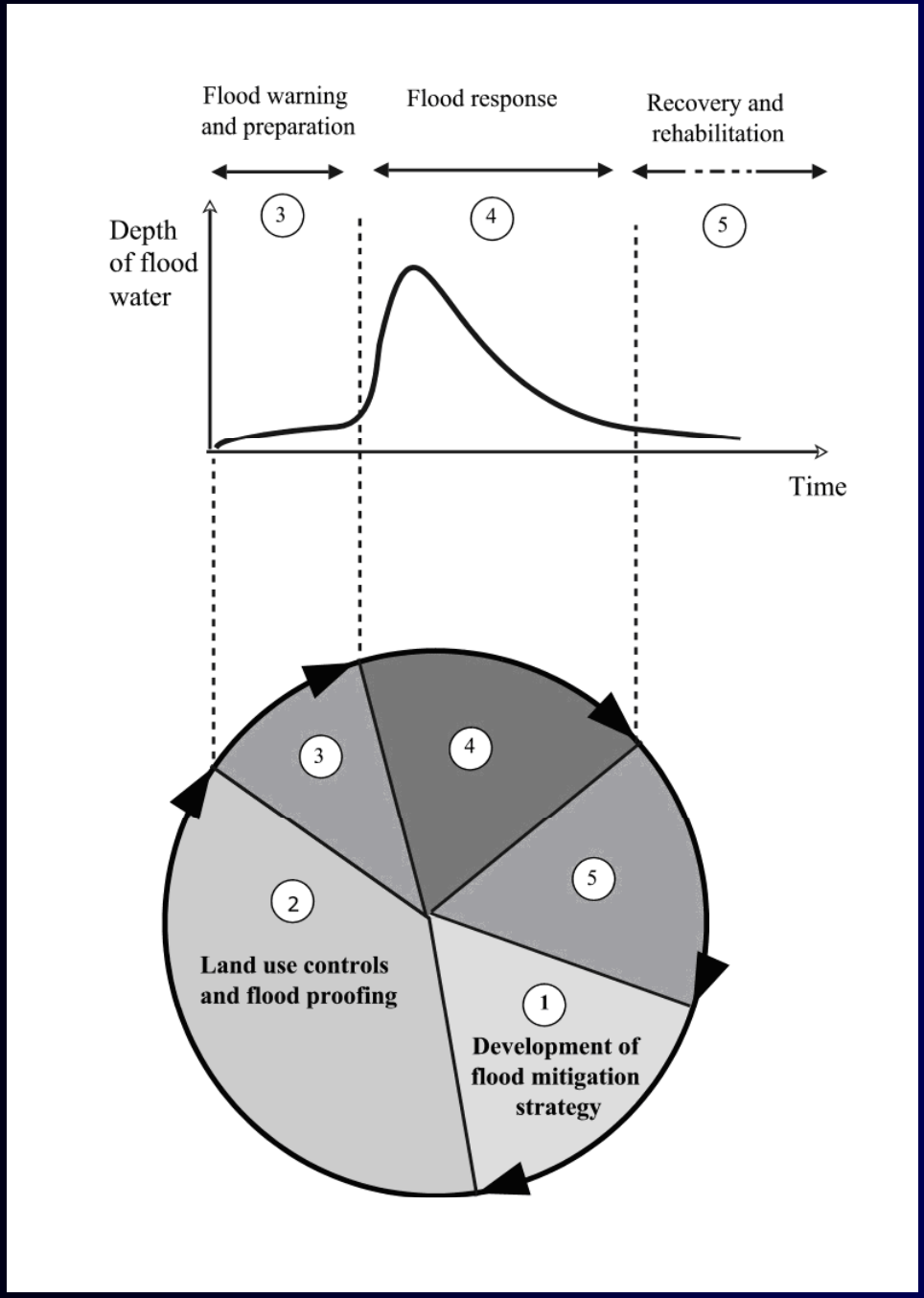
Before

After

Recent Memories of Flood Srinagar, Sept. 2014

Recent Memories of Flood
Chennai, Nov 2015


Flood damage is increasing
Data & research in floods is increasing
Damage, Data, money
, 10, ….
50
Time (Years)



The Flood Management Cycle

General Flood Management Measures practiced in India

Floods are natural phenomena

Complete immunity from flood is not possible, however, their impacts can be minimized by application of appropriate structural and non-structural measures.

- **Engineering / Structural Measures**
- **Administrative / Non-structural Measures**

Structural Measures

- **Dams and Reservoirs**
- **Embankments, Flood Walls, Sea Walls**
- **Natural Detention Basins**
- **Channel Improvement**
- **Drainage Improvement**
- **Diversion of Flood Water**
- **Watershed**

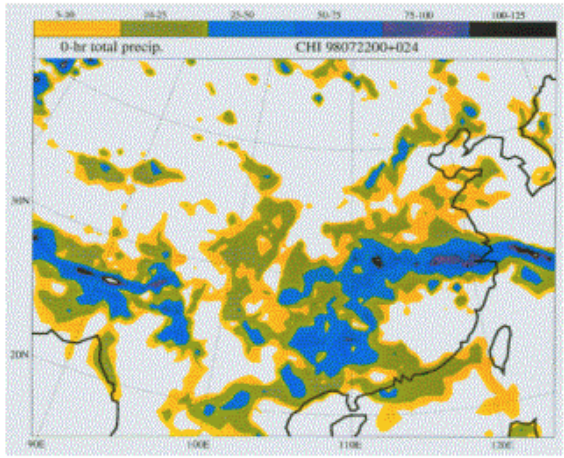
Non Structural Measures

- Flood Forecasting and Warning
- Flood Plain Zoning
- Flood Proofing
- Disaster Preparedness and Response Planning
- Disaster Relief

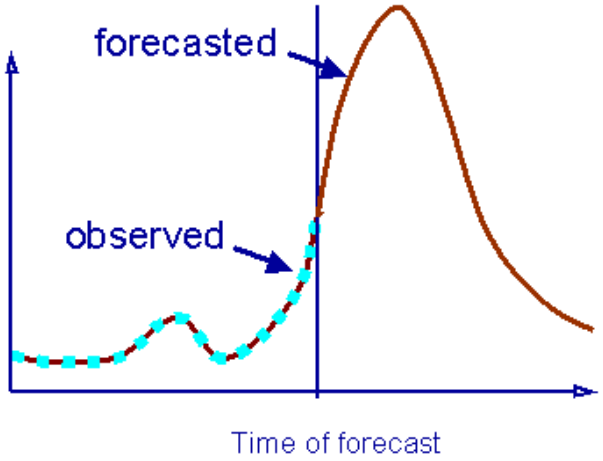
Remote automatic weather station in Switzerland

Meteoro-logical forecasts

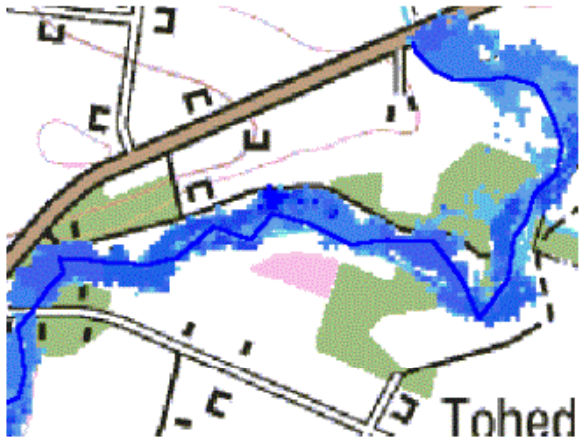
Local radar



Flood Modelling



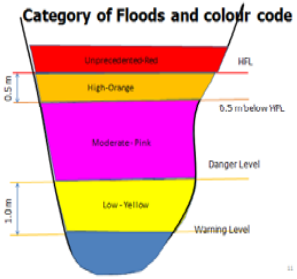
Forecasted hydrographs

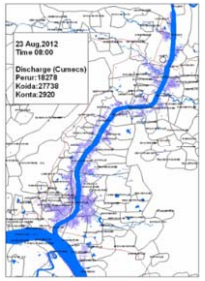


Flood maps

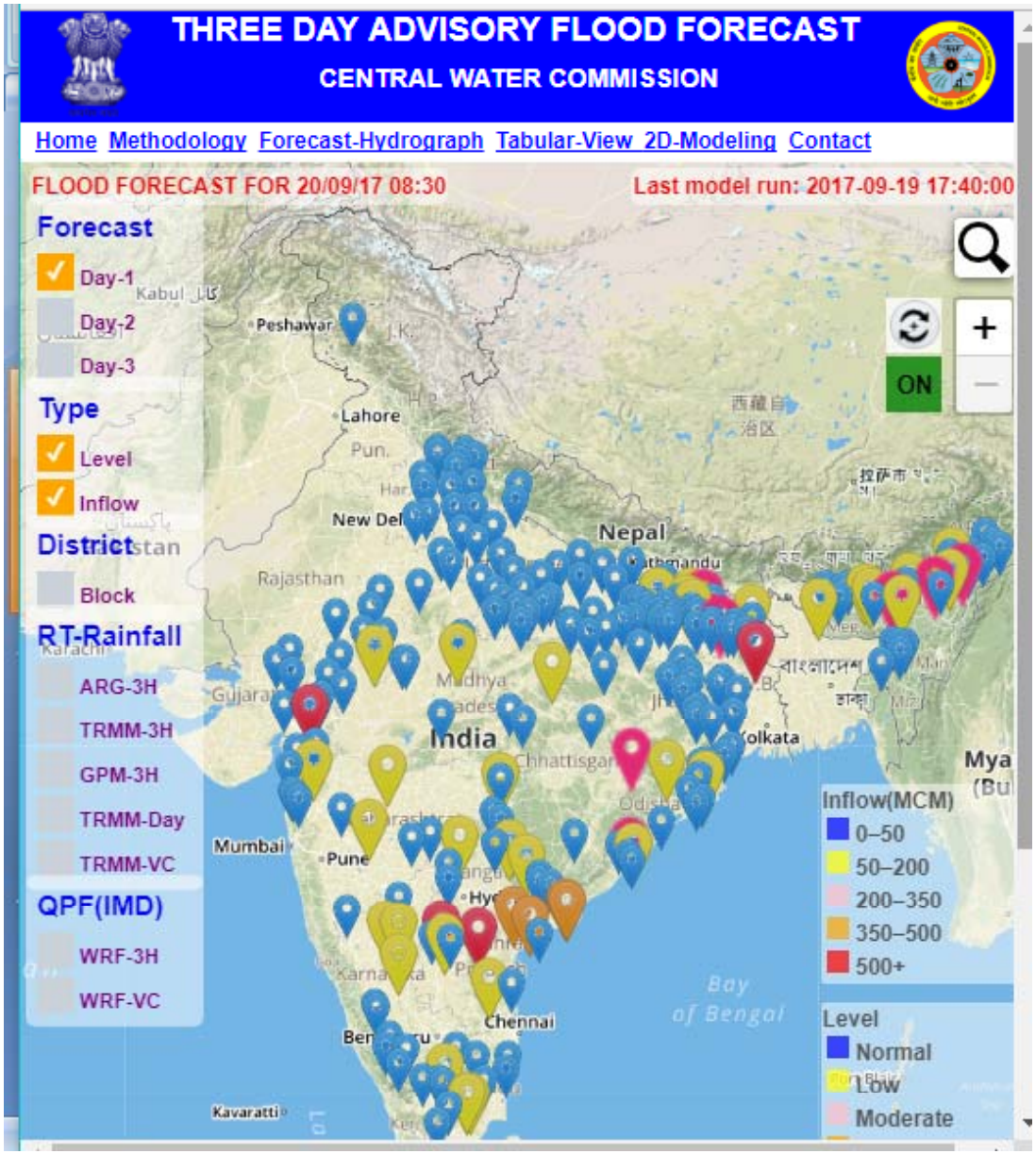
Flood Forecasting Services

- Central Water Commission (CWC), MoWR, RD & GR is the line department for Flood Forecasting
  - Estimation of river water level or inflow into reservoirs in advance to alert concerned
  - River Water Level Forecast for towns/habitations
  - Reservoir Inflow forecast for Reservoir operation
  - Inundation Forecast for areas likely to be inundated
  - GLOF/Landslide advisory



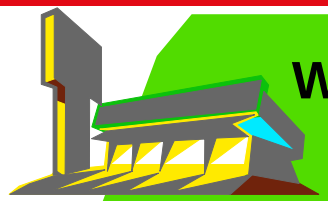


Present Status of FF Activities using 1D Model



- Integrated with IMD Rainfall Forecast
- Forecast time increased to 72 hours
- Covering all major flood prone area of country
- Automatic Generation of Forecast (24 X 7) with update frequency of 3 hrs
- GIS Based Forecast Dissemination portal is ready &running

FLOOD PLAIN ZONING

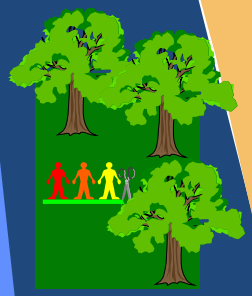


WATER SUPPLY

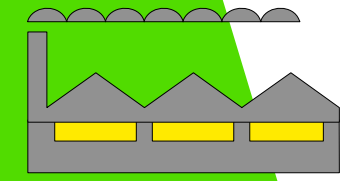
III II I III II I

HOSPITAL

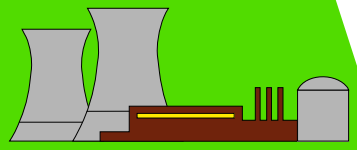
GOVT. OFFICE



PARK

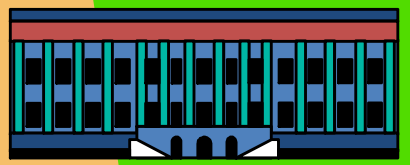


FACTORY



POWER HOUSE

RESIDENTIAL AREA



UNIVERSITY

NORMAL CHANNEL

FREQUENT FLOOD(III)

FLOOD ONCE IN 25 YEARS (II)

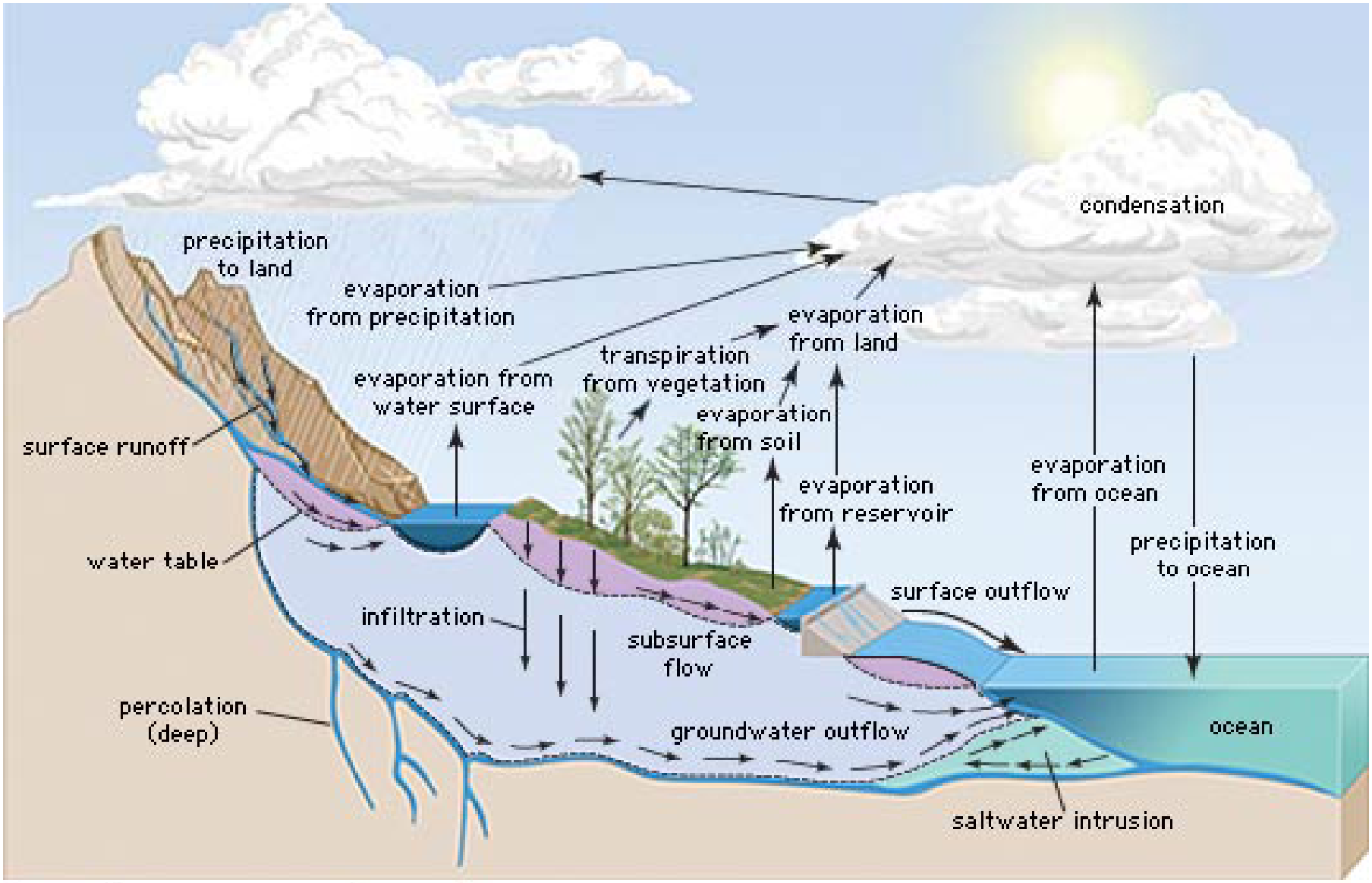
FLOOD ONCE IN 100 YEARS (I)

FLOOD PROOFING

Raising of villages above flood level

1. Previously adopted in Uttar Pradesh, West Bengal and Assam
2. Currently in North Bihar under Central Sector
3. Extended to U.P., Orissa, Andhra Pradesh, West Bengal and Assam in 10th Plan

Hydrological Cycle



Urban Flood- a challenge

- **Increasing trend of urban flooding is a universal phenomenon**
- **Poses a great challenge to city administration and urban planners**
- **Problems range from relatively localized incidents to major incidents,**
  - **Resulting in cities being inundated from a few hours to several days.**
  - **Impact can also be widespread, including temporary relocation of people, damage to civic amenities, deterioration of water quality and risk of epidemics.**

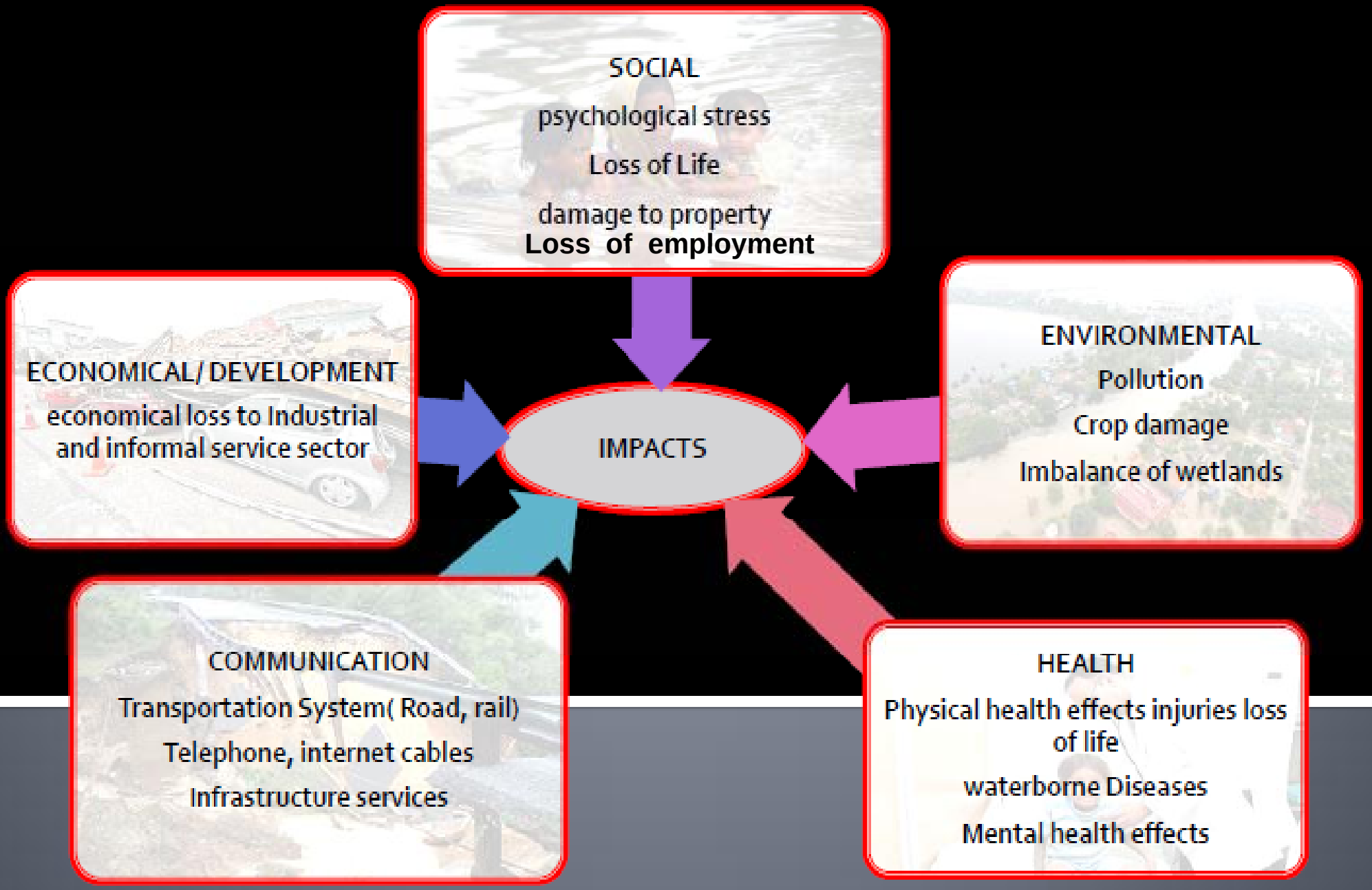
Urban Flooding-Factors for increasing risk

- **Predominantly manmade coupled with natural factors**
- **Unplanned development and encroachments of rivers and watercourses**
  - **the runoff has increased in proportion to urbanization of the watersheds**
  - **poor solid waste management blocking urban drains**
  - **delayed draining out flood water due to reduced carrying capacity of rivers and water courses**
- **New and intensified phase of urbanization during 2001-2011 coupled with spatial expansion of urban extents**
  - **Area under urban settlements (7933 towns) in India has increased from 77370.50 sq. km in 2001 to 102220.16 sq. km in 2011.**
  - **32 % increase**

Actions Desired

- **Multidisciplinary approach**
- **Each city should have their Flood mitigation plans within the overall land use policy and master planning with due importance to**
  - **Flood plain**
  - **River basin**
  - **Surface water**
  - **Urban drains**
- **A prompt, well-coordinated and effective response system**
  - **minimizes casualties and loss of property**
  - **facilitates early recovery**

Impacts of urban flooding



Challenges and Way Forward

- **Real Time Flood Warning System should be developed for effective dissemination of information.**
- **Close coordination with each agency is key factor for minimizing damage due to floods in case of flood disasters.**
- **International cooperation is essentially required for management of flood in international river basins.**

Challenges and Way Forward

- **Acquisition of close contour and high resolution topographical data**
  - **Digital Elevation Model(DEM)**
- **Integration of all relevant data**
  - **Topographical, Hydrological, Meteorological, radar, Sea surge, Reservoir release, Water Utilizations, etc**
- **Reliable Inundation forecast modeling**
  - **2D Modeling**
- **Reservoir Operation in timely fashion**

Challenges and Way Forward

- **A well-designed Catchment Area Treatment (CAT) Plan is essential to reduce soil erosion**
- **Land use planning based on Flood plain Zoning**
- **Flash Flood Advisory**
- **Urban planning to be done in more scientific manner**
- **Proper Storm water management**

THANK YOU

Elements of End-to-end Floods Monitoring and Warning Mechanism for South Asia

RITESH KHATTAR

DIRECTOR

FLOOD CONTROL APPLICATIONS DTE-II

Why we need flood forecast ?

With forecasting/dissemination

Without forecasting

Evacuation Progress

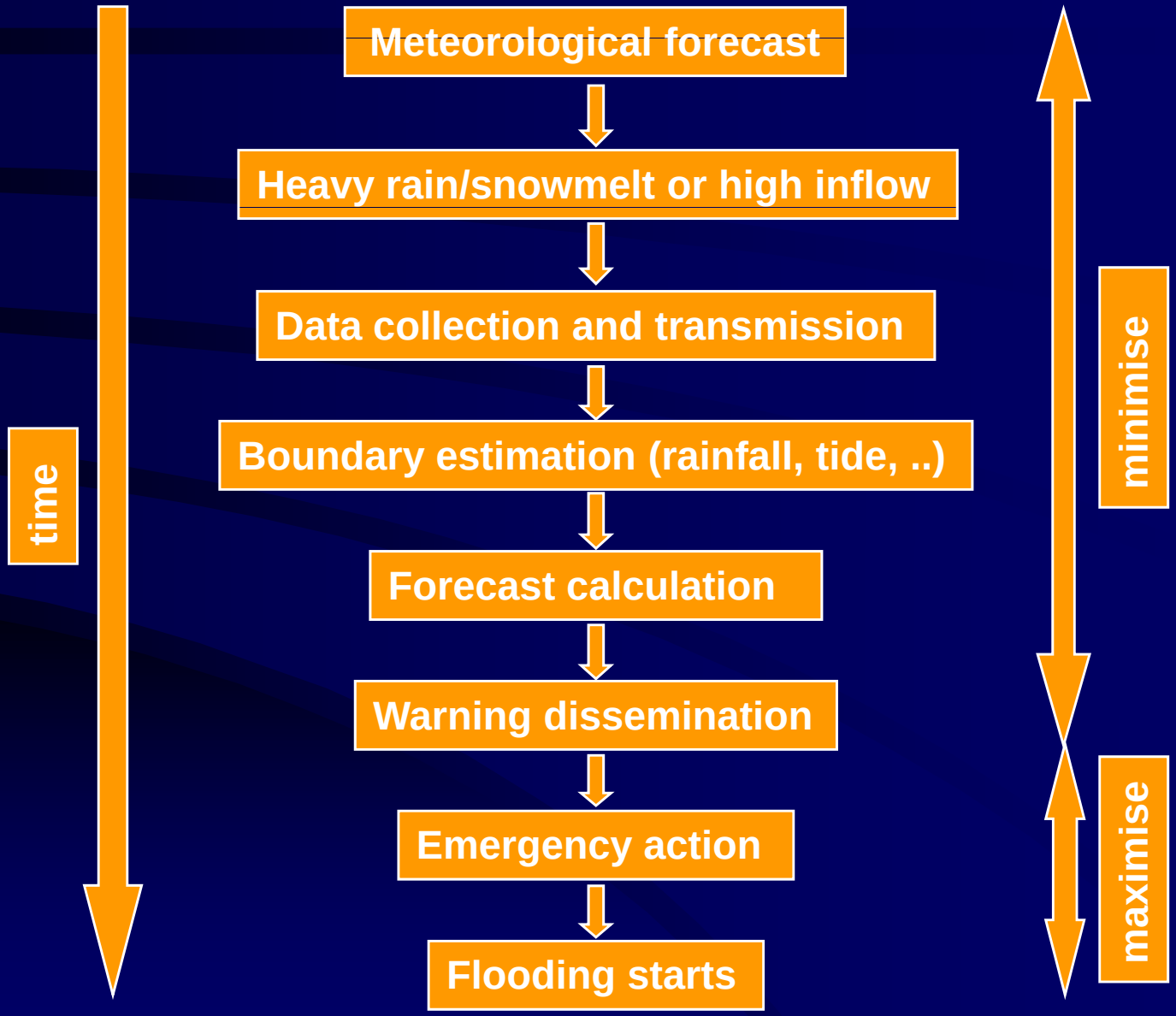
0, 1, …. 6 hours

Time

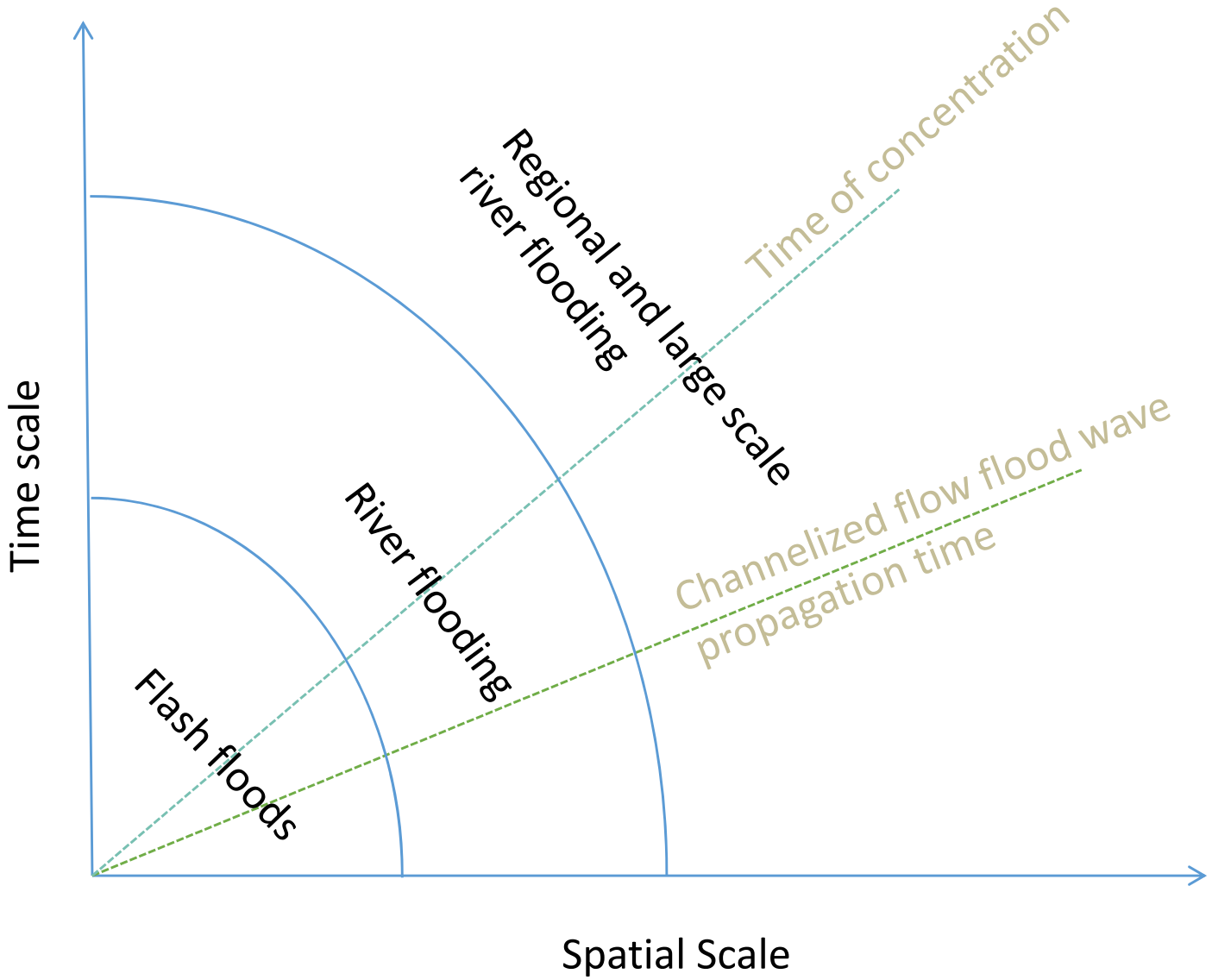
Integrated Flood Management

Land-use Planning	**Keeping people away from floodwaters**
Structural Measures	**Keeping floodwaters away from people**
Flood Preparedness	**Getting people ready for floods before they come**
Emergency Management	**Helping affected people cope with floods**

Flood forecasting and warning

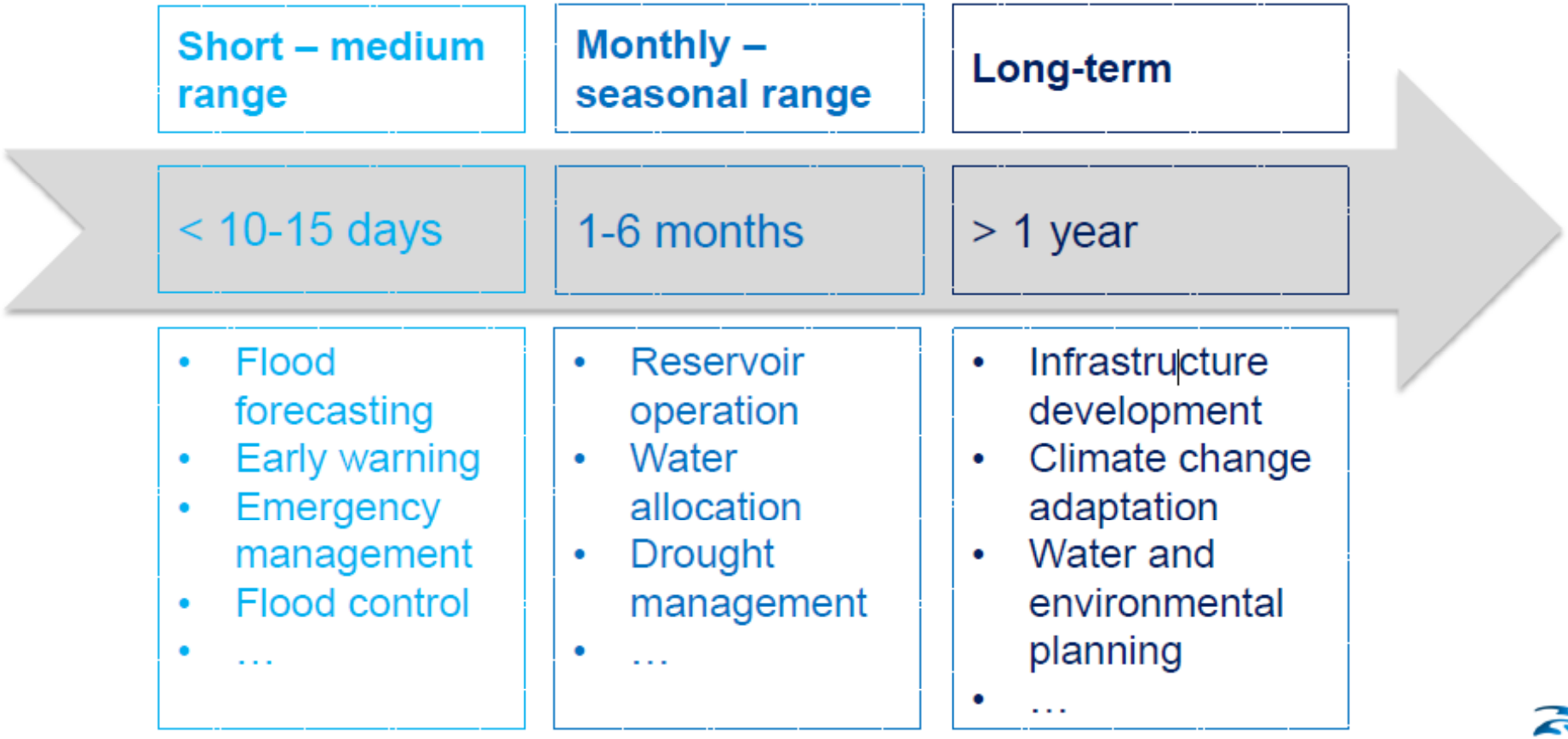


Flood forecasting data, models, tools, etc.



Hydrological Forecasting

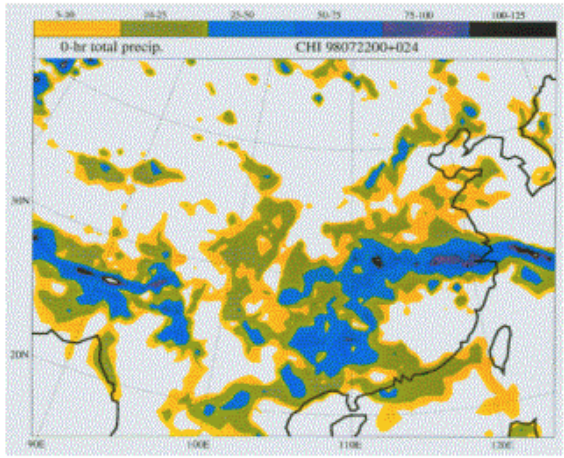
Hydrological forecasting to support water management at different time scales



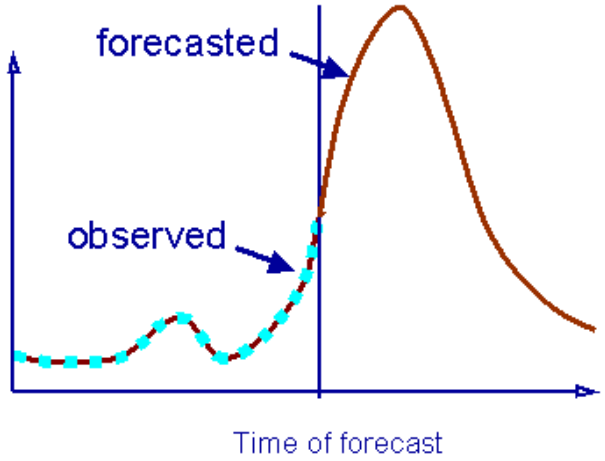
Remote automatic weather station in Switzerland

Meteoro-logical forecasts

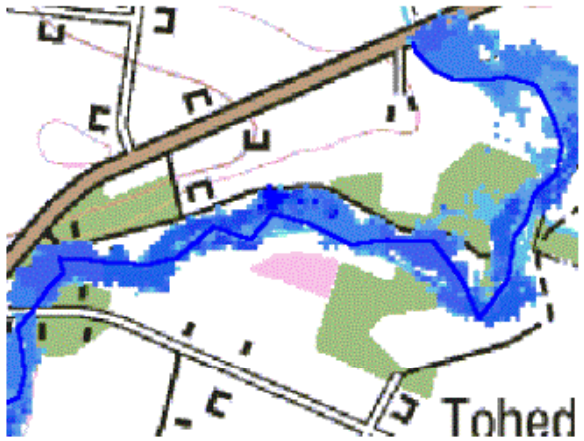
Local radar



Flood Modelling

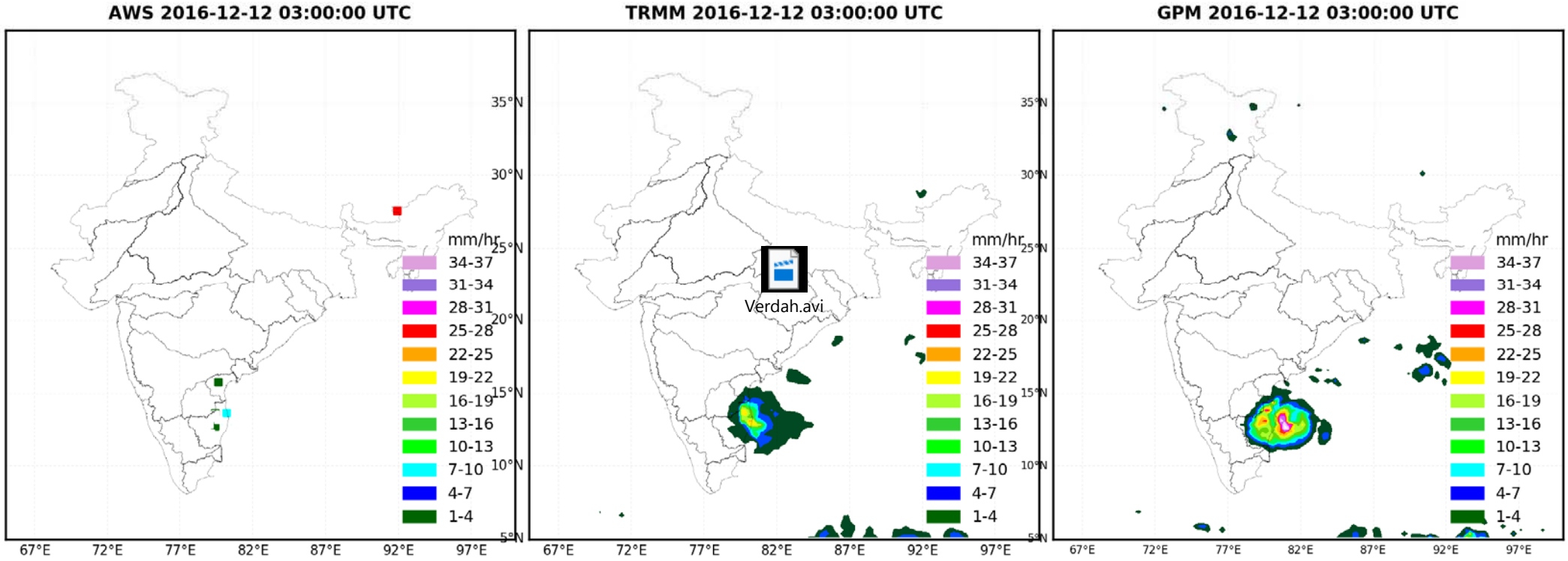


Forecasted hydrographs

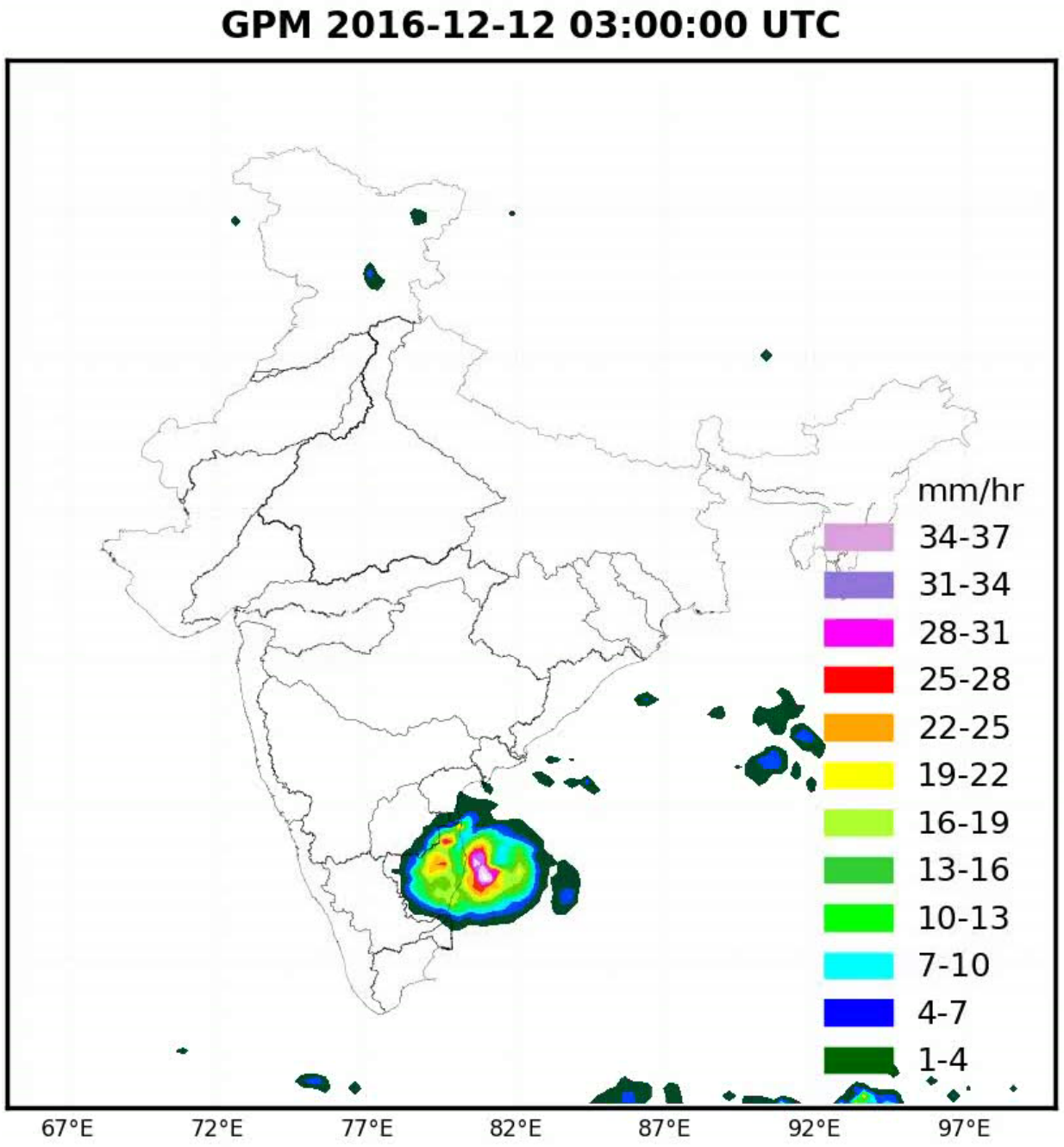


Flood maps

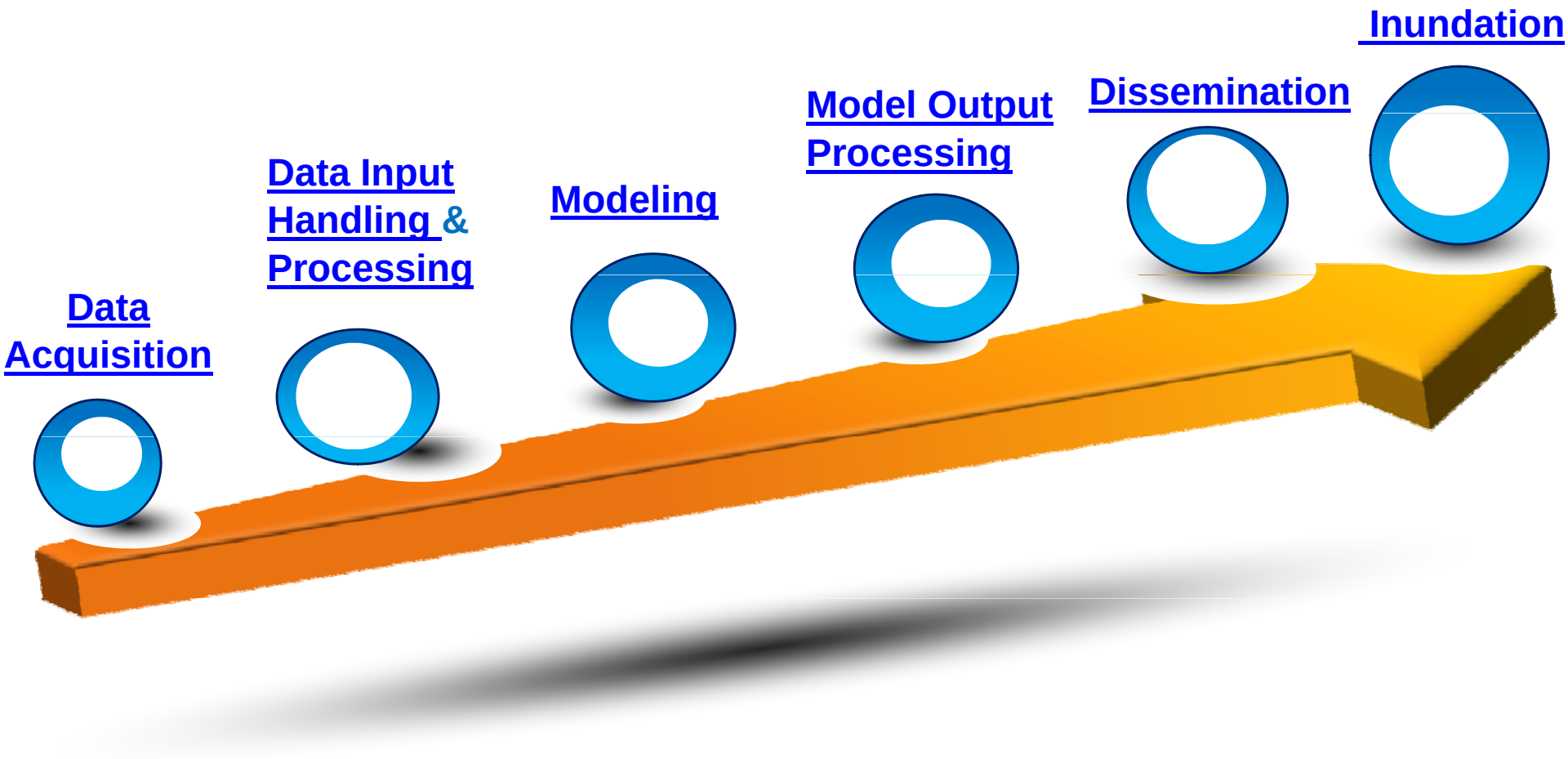
Rainfall Space Distribution



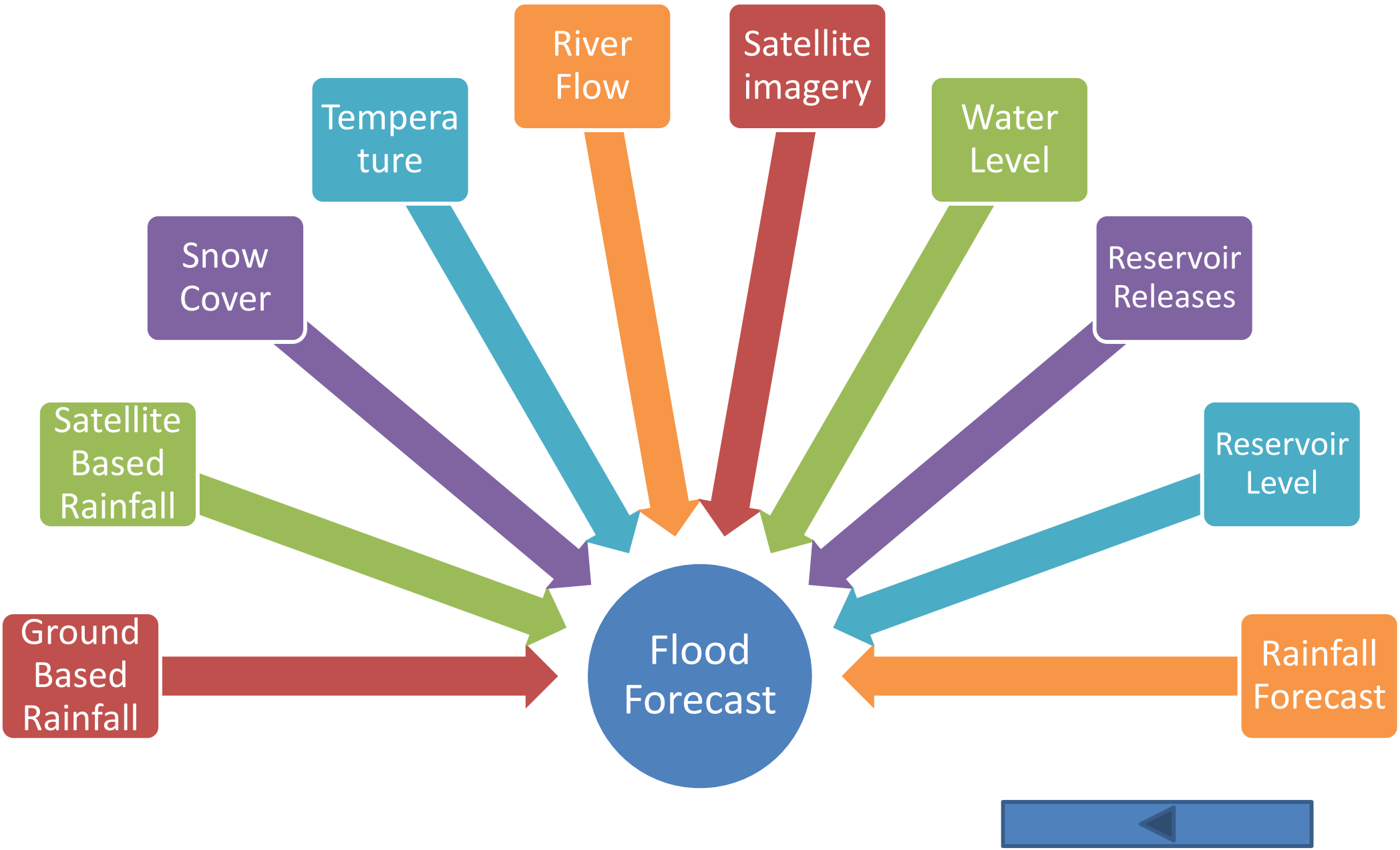
Rainfall Consistency



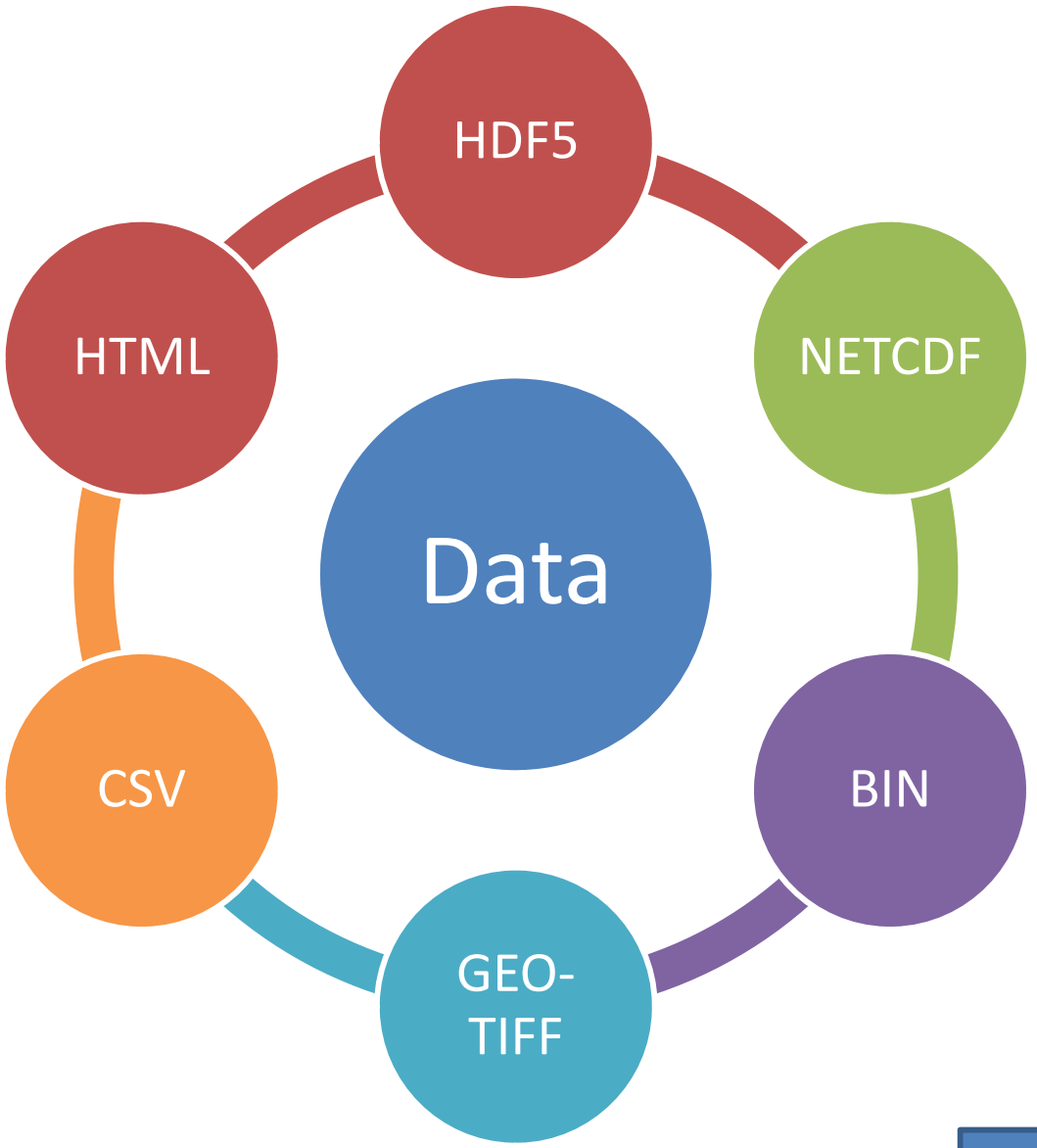
Stages of FF


Data Acquisition
Data Input Handling & Processing
Modeling
Model Output Processing
Dissemination
Inundation

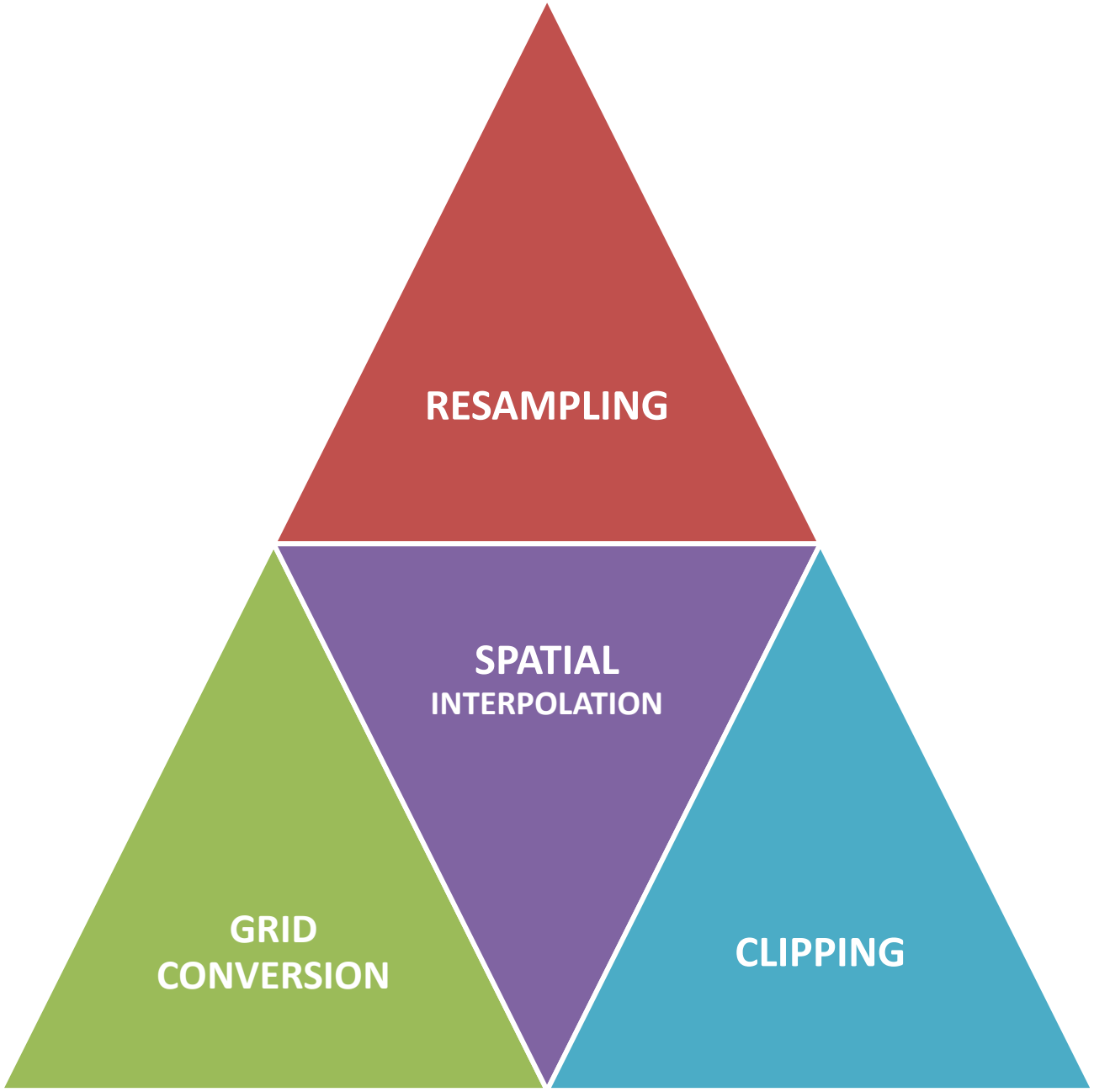
Data Acquisition



Data Handling/Readability



Data Input Processing



MODEL

Observed Rainfall

Observed flow

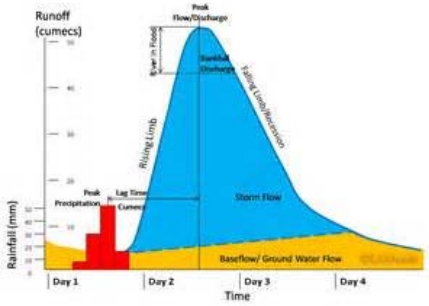
Rainfall forecast

Hydrological Model

Rainfall-Runoff

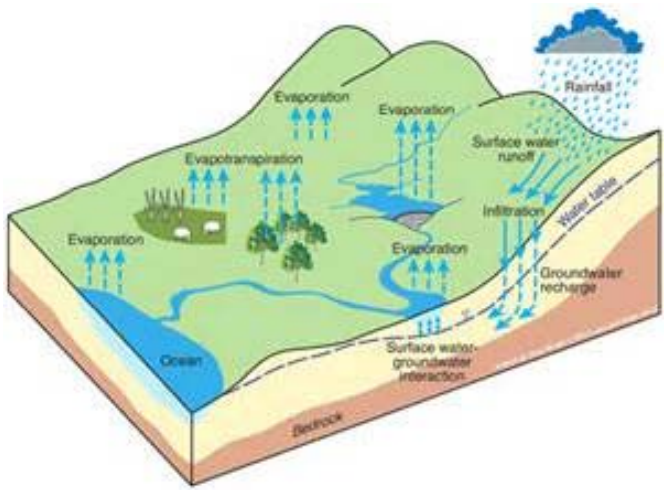
+

River Routing

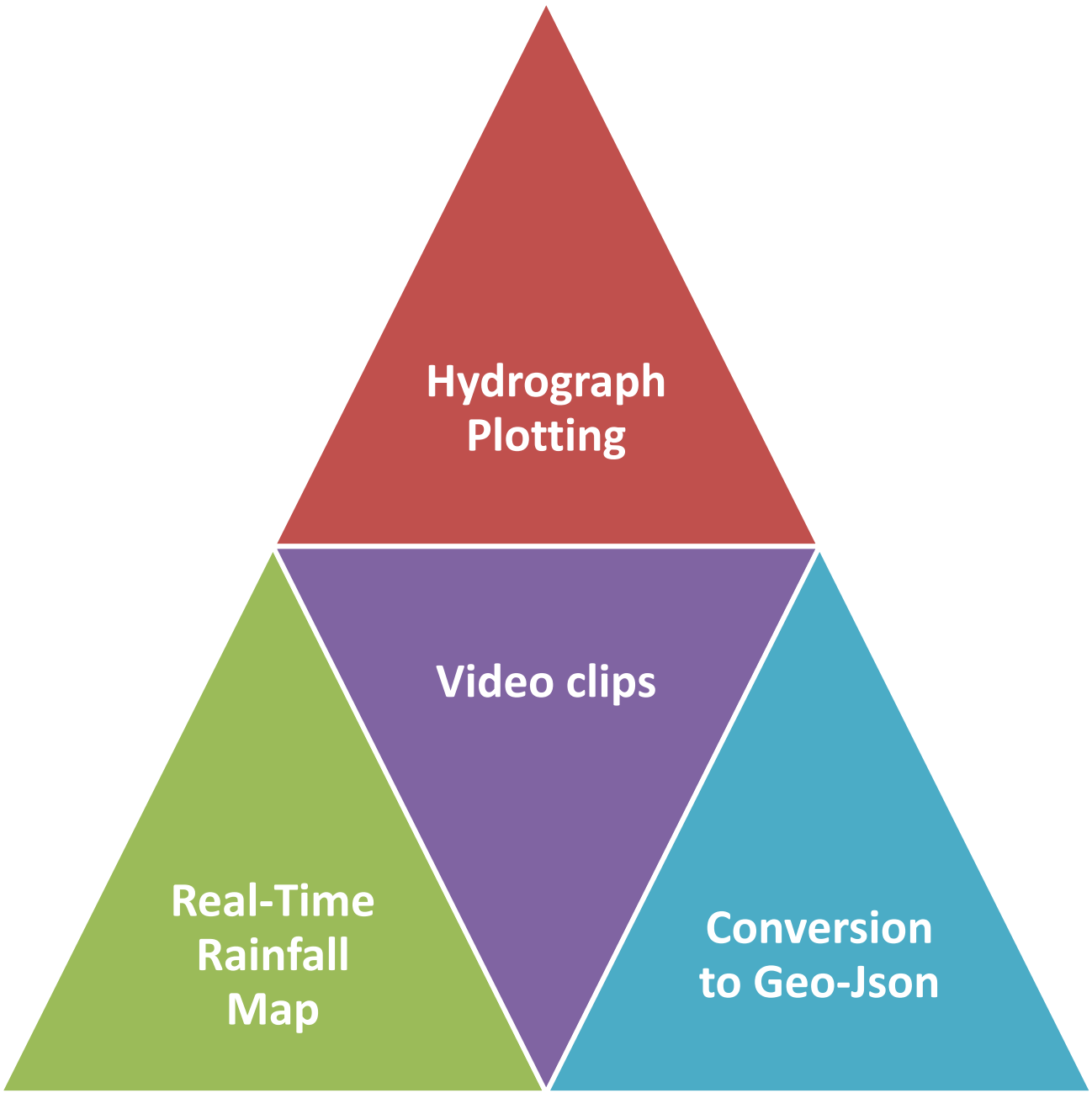


Time series forecasts

Warnings

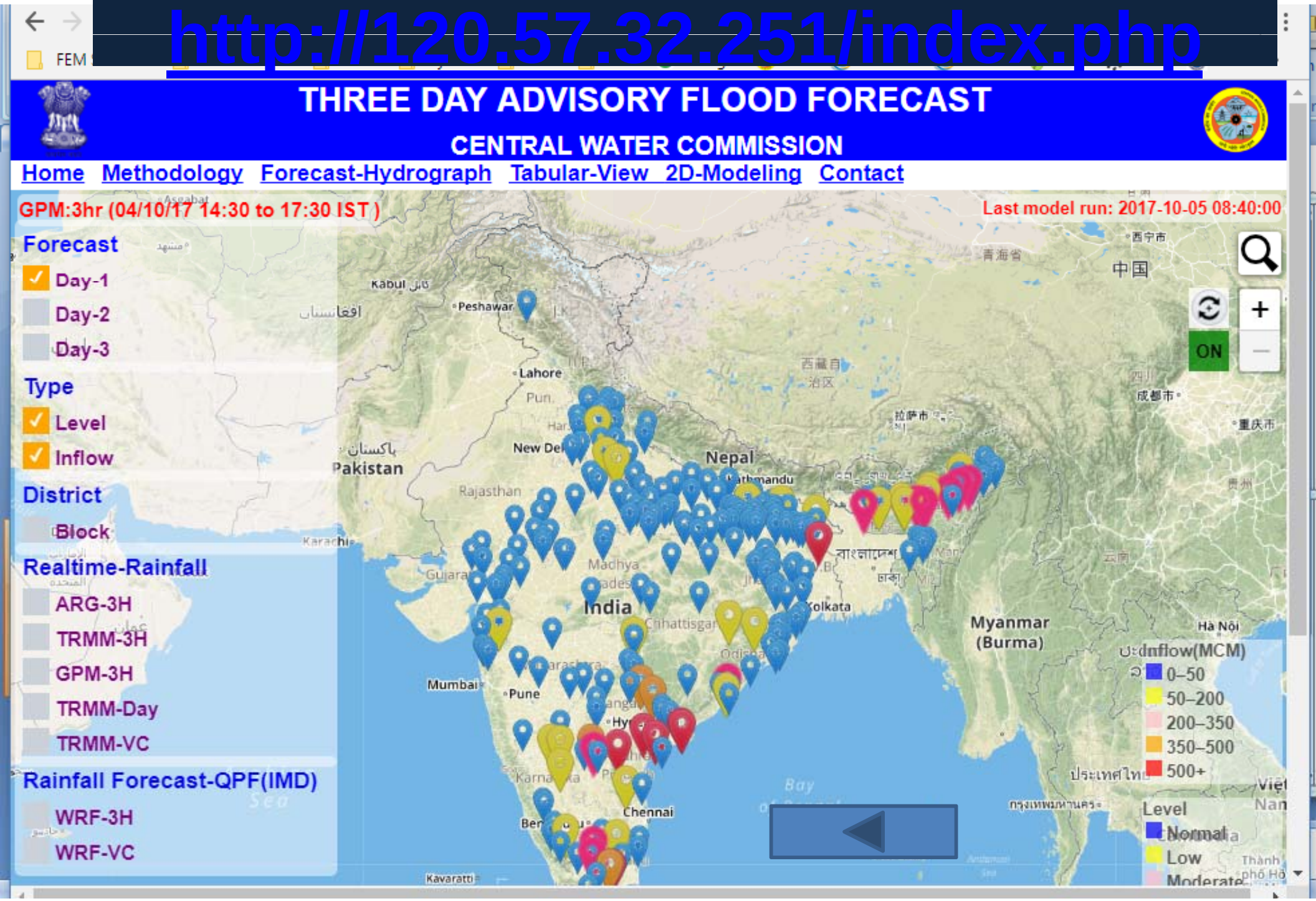


Model Output Processing

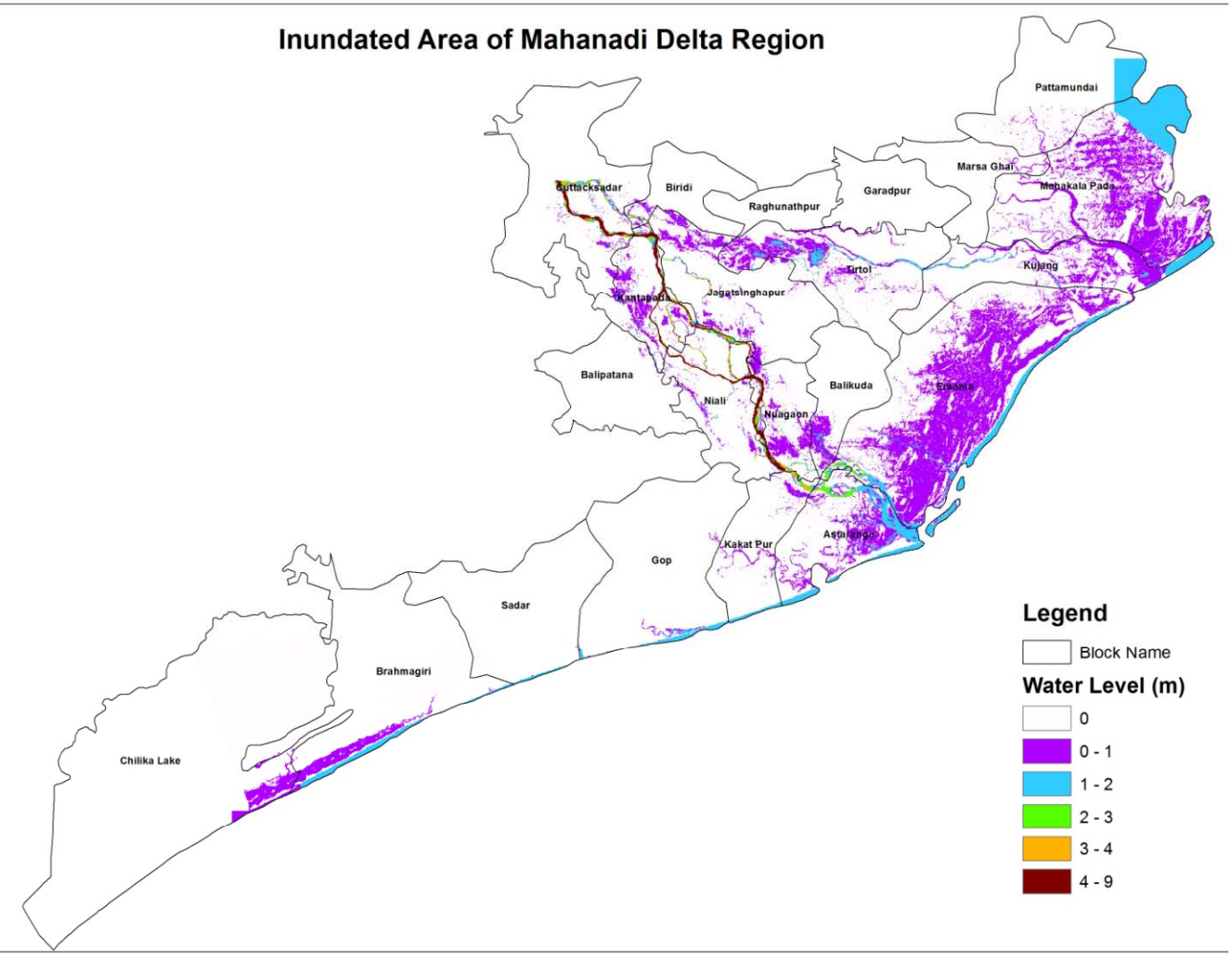


Web Dissemination

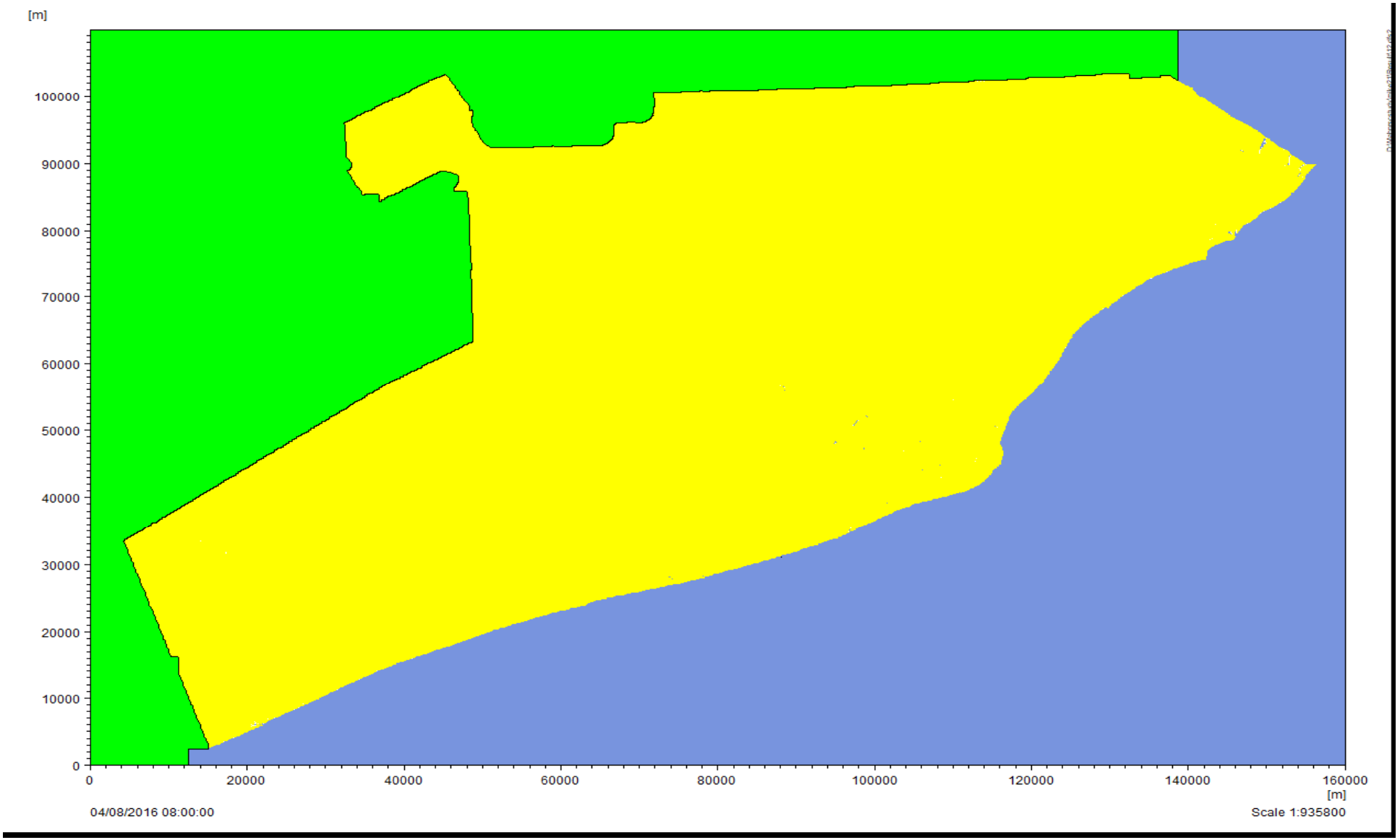
http://120.57.32.251/index.php



Present Status of FF Activities using 2D Model



- Mahanadi Delta region studied so far
- Dem data purchased from NRSC(4.65 crore)
- Resolution (horizontal 1m and .5 m vertical)
- Area covered 7749 Sq Km
- 2016 Flood event simulated with model resolution of 90 m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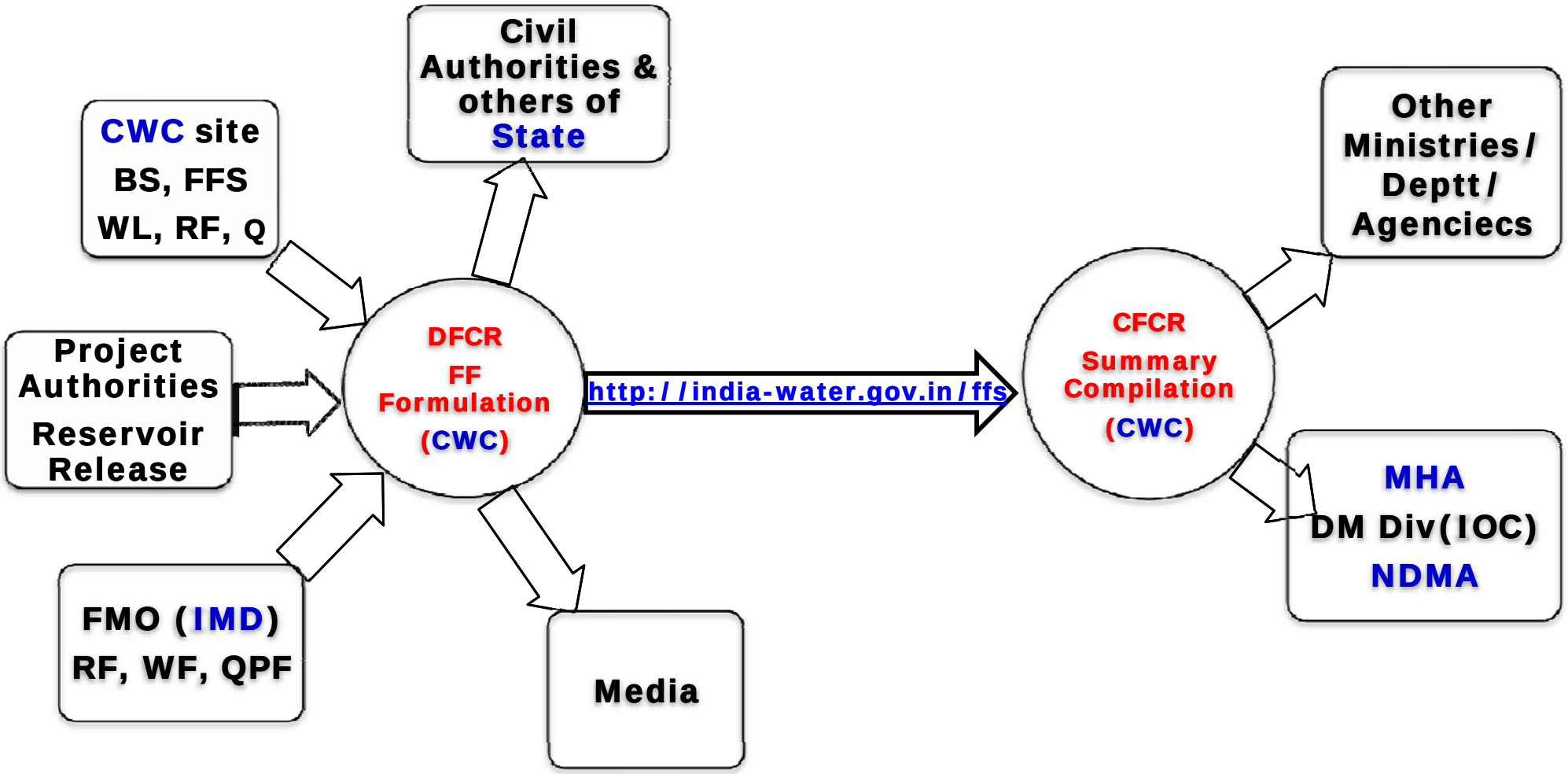
THANK YOU

Causes of Floods

- **Long duration heavy rainfall**
- **Inadequate channel capacities**
- **Landslides / river blockages**
- **Drainage congestion**
- **Haphazard Development**
- **Poor Reservoir Regulation**

Flood Forecasting Set Up



Impacts of Floods

- **Loss of Human Life, Livestock, Property , Infrastructure, Agriculture, Environment etc.**
- **Annual Average damages is more than Rs. 1800 cr.**
- **Disrupt Normal Life**
- **In some river valleys, floods have been turned to economic advantage as millions of people grow their rice, wheat, millet and corn on flood plains.**

Introduction

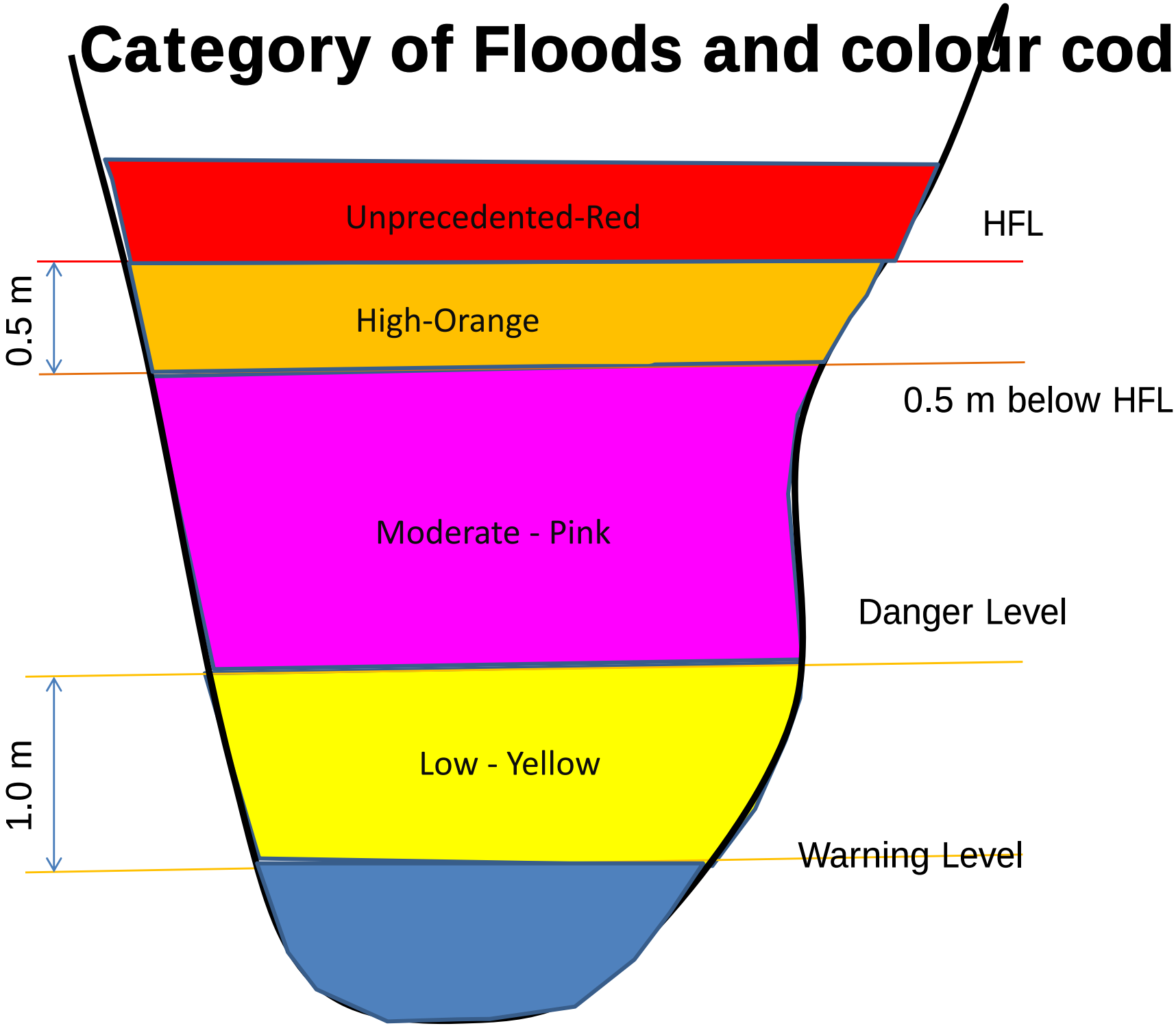
- Floods have been recurrent phenomenon in many parts of India, causing loss of lives & public property and bringing untold misery to the people, especially those in the rural areas
- Indian continent has peculiar climatic conditions since it has floods in some parts whereas drought in other parts.

Flood Monitoring Period

Sl. No.	Basin	Modified Period
1.	Brahmaputra Basin	1st May to 31st Oct
2.	All other Basins upto Krishna Basin	1st June to 31st Oct
3.	Basins South of Krishna Basin (Pennar, Cauvery and Southern Rivers)	1st June to 31st Dec

- In case of floods beyond designated period due to unexpected rain/releases from dams or other reasons, FF activity shall be resumed by concerned organisation/division till water level falls below threshold limit & necessary bulletins shall be disseminated.

Category of Floods and colour code



Flood Prone Area (India)

- **Geographical Area of India : 329 Mha**

- **Total Flood Prone Area**
  - **As Assessed by RBA : 40 Mha**
  - **As reported by the States : 49.815 Mha**
    (12th Plan Working Group on Flood Forecasting)

- **Area protected with reasonable : 15.8 Mha degree of protection by various structural measures**

Urban Flood Management Phases

- **Pre-Monsoon Phase:**
  - **Preparedness: Planning for Disaster Reduction**
- **During Monsoon Phase:**
  - **Early Warning**
  - **Effective Response and Management**
  - **Relief planning and execution**
- **Post-Monsoon Phase:**
  - **Restoration and Re-habilitation**

Management Guidelines

- **National Disaster Management Authority (NDMA) has prepared Guidelines for Management of Urban Flooding in September, 2010.**
  - **establishment of Urban Flooding Cells at State Nodal Departments and ULBs.**
  - **Specific responsibility to various agencies**

Preparedness Plans

- **Planning for Disaster Reduction**
  - **Estimation of emergency needs**
  - **Identification of the resources to meet these needs.**
  - **Familiarizing the stakeholders, particularly the communities through training and simulation exercises.**
  - **Identification of Teams for maintaining the drains and roads, mobilization of resources, etc.**
  - **Establishment of inter agency co-ordination mechanism**

Early Warning

- **Timely, qualitative and quantitative warnings based on**
  - **intensity of rainfall**
  - **urban drainage system**
  - **topographical details**
  - **river water level**
  - **releases from through integrated reservoir operation**
  - **tidal condition**
  - **proximity to hills**