Hydro-Met Disaster Risk Reduction: Preparedness and Response

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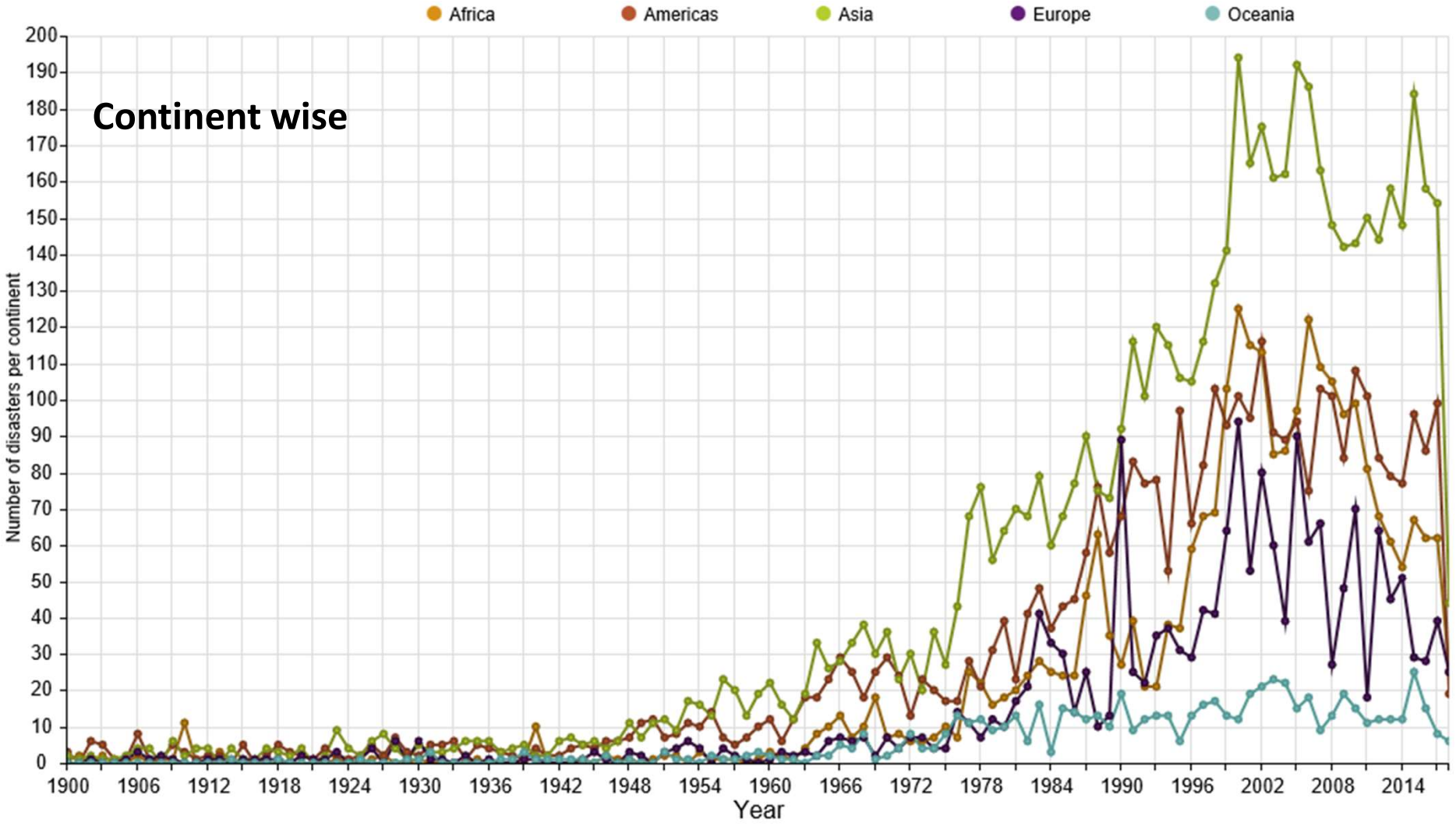
Disaster

Disaster, as defined by DM Act, 2005

"A catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or manmade causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area."

- DISASTERS OCCUR WHEN - A Community's risk mitigation measures fails
- Disasters are the consequence of inappropriately managed risk.
- Serious disruption, occurring over a relatively short time
- Consequences: Loss of life, economy and environment

Total number of Natural Disasters



Source: EM-DAT: The Emergency Events Database - Université catholique de Louvain (UCL) - CRED, D. Guha-Sapir - www.emdat.be, Brussels, Belgium

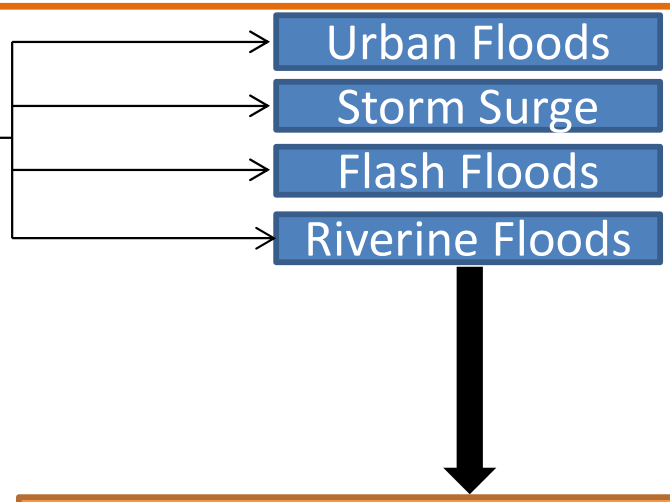
90 % of events, 70 % of causalities and 75 % of economic losses are related to hydro-meteorological Disaster

Nationally Notified Disasters

- Hydro-meteorological
  - Floods
  - Drought
  - Cold Wave/Frost
  - Cyclone
  - Hail Storm
  - Cloudburst
- Geological
  - Earthquake
  - Tsunami
  - Landslides
  - Avalanche
- Others
  - Pest Attack
  - Fire
  - COVID 19

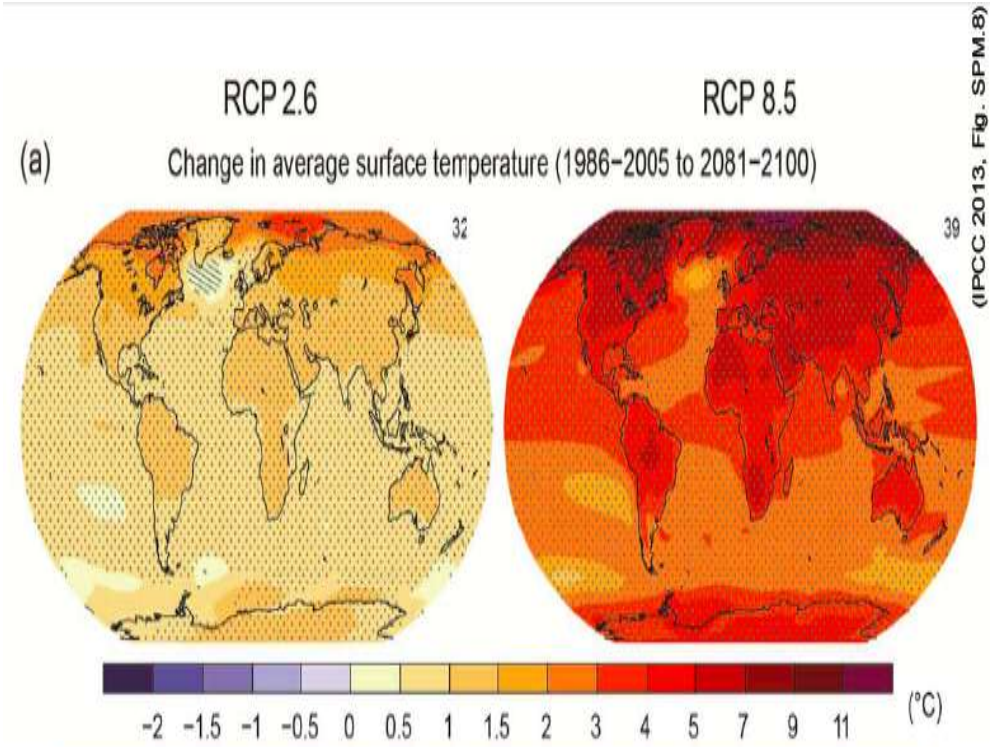
Sate Specific Disasters

- Coastal and River Erosion
- Chemical, Industrial and Nuclear
- Soil piping
- Strong Wind
- Lightning
- Heat Wave
- Accidents

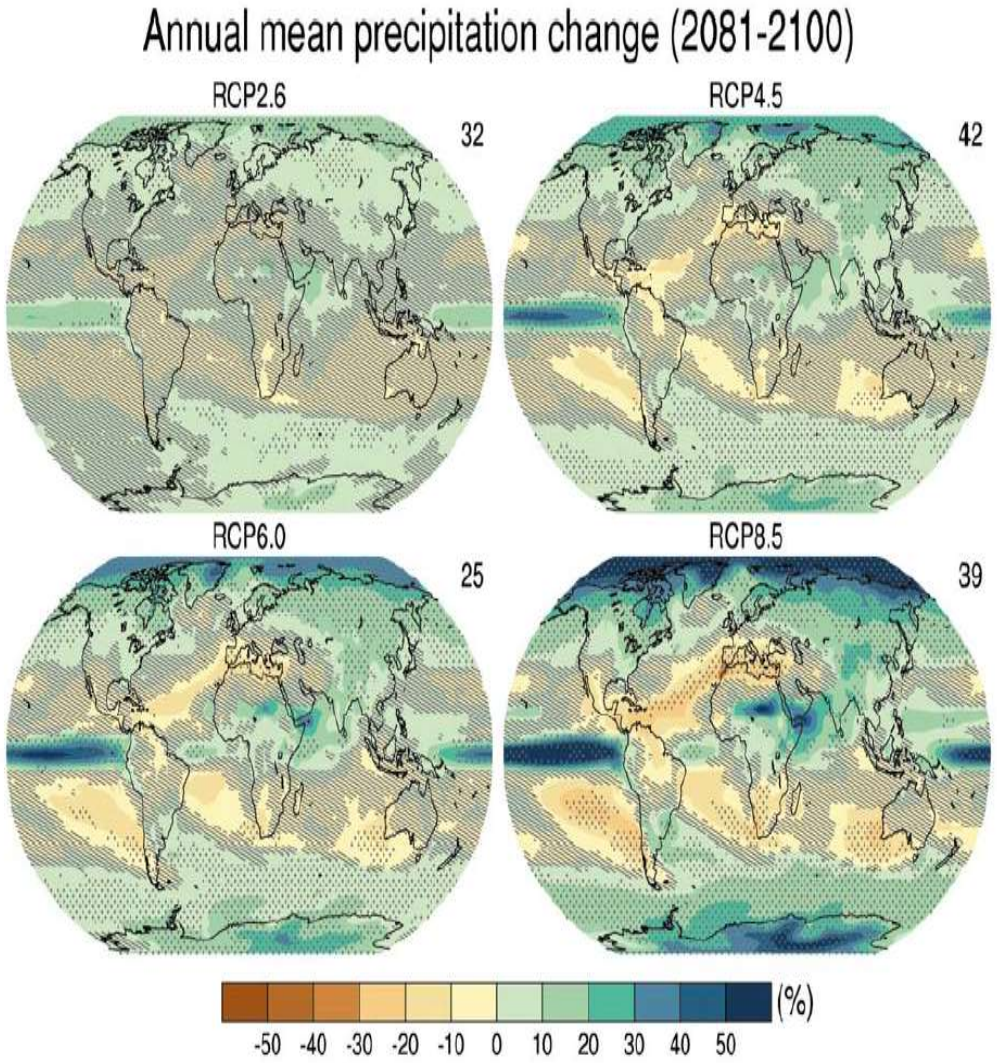


- On an average every year, 75 lakh hectares of land is affected
- Economic Damage Rs. 4.69 trillion
- The frequency of major floods is more than once in five years
- Flood related damages show an increasing trend

Climatology



Increase of global mean surface temperatures for 2081–2100 relative to 1986–2005 is projected to likely be in the ranges derived from the concentration driven CMIP5 model simulations, that is, 0.3°C to 1.7°C (RCP2.6), 1.1°C to 2.6°C (RCP4.5), 1.4°C to 3.1°C (RCP6.0), 2.6°C to 4.8°C (RCP8.5).



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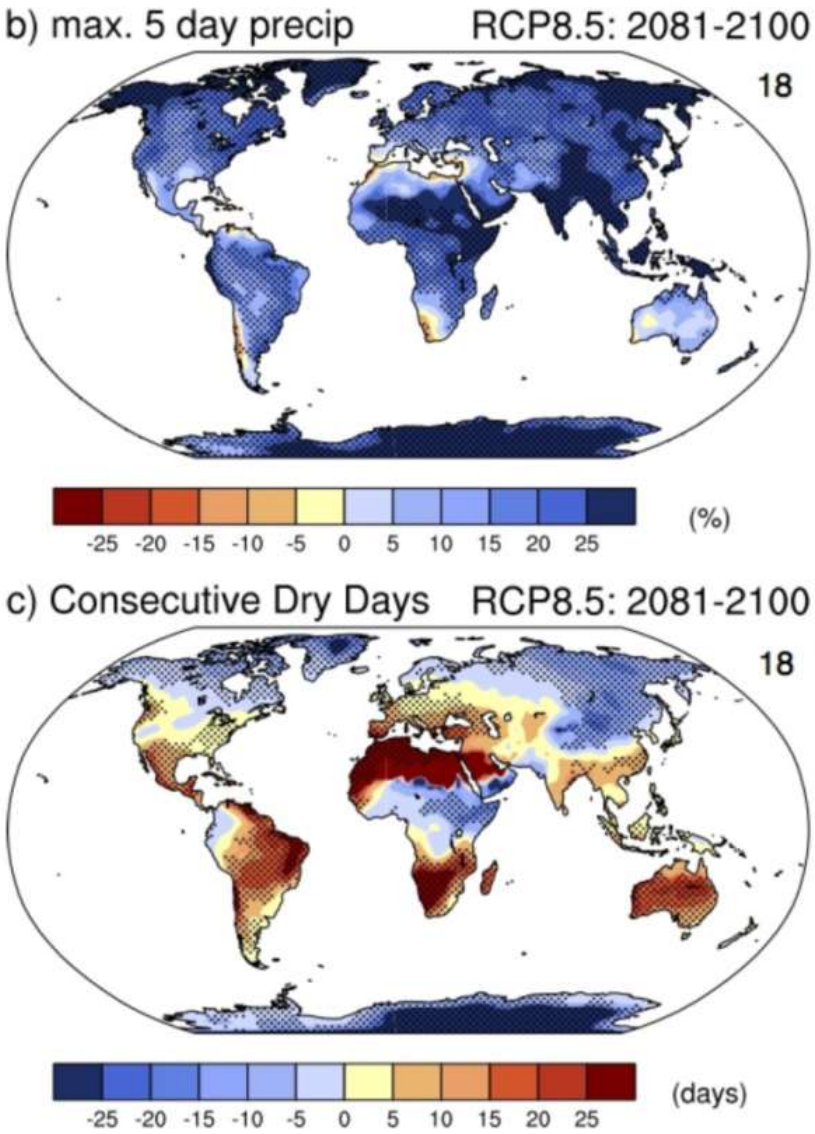
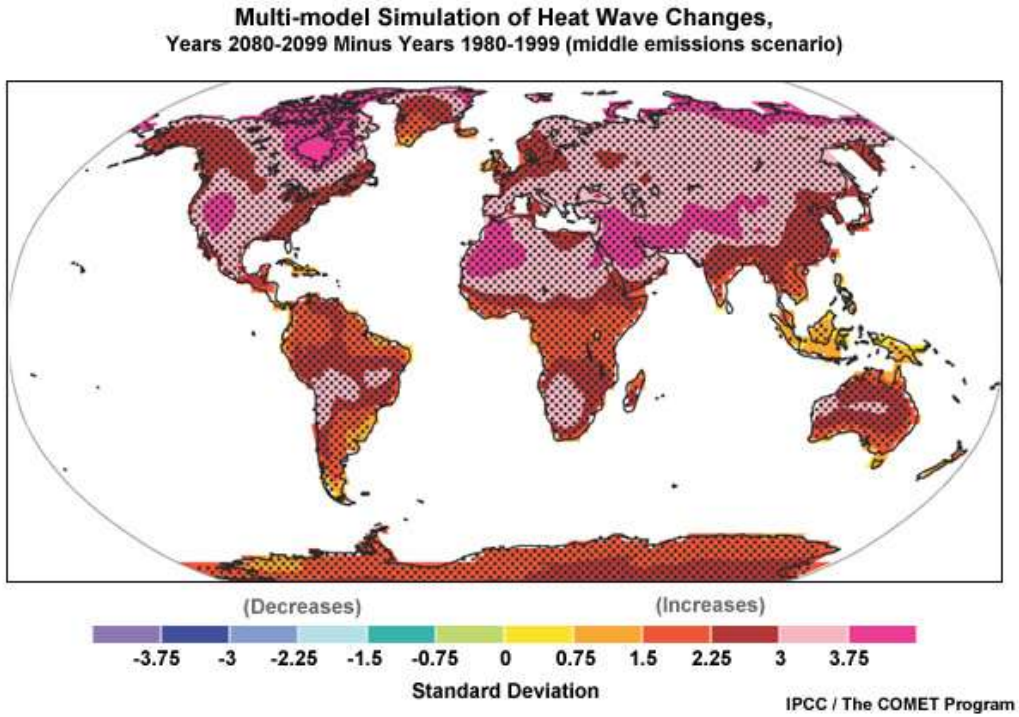
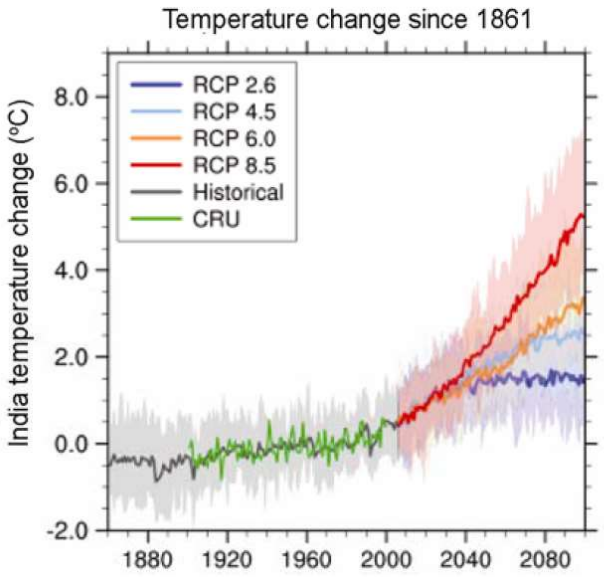
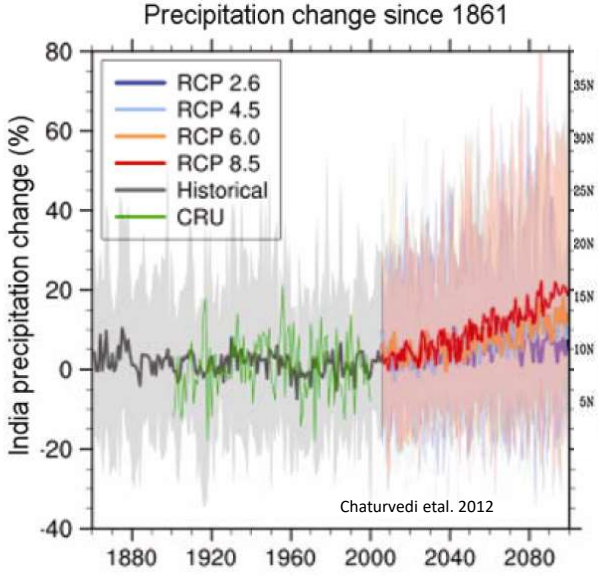


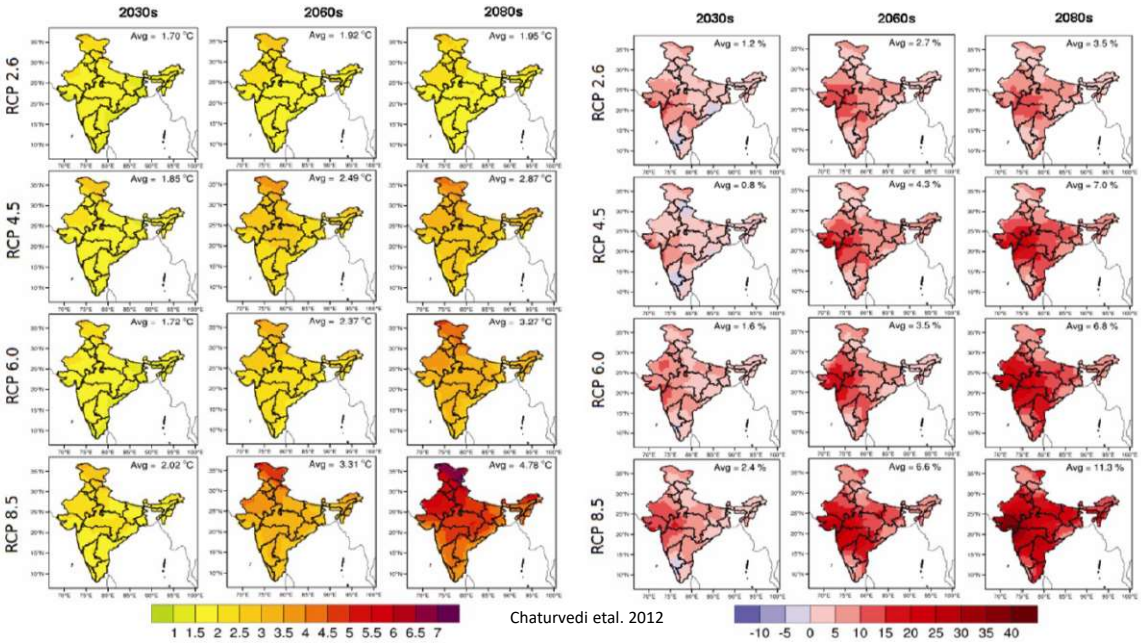


India context





Chaturvedi etal. 2012



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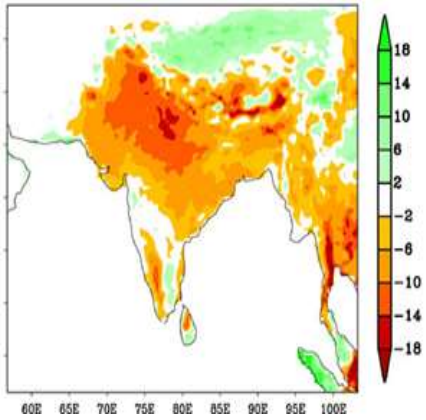
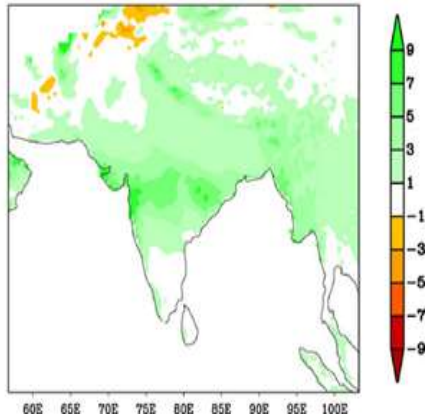


Projected future change in number of rainy days (rainfall >2.5 mm) during monsoon season (JJAS).



Projected change in the intensity (mm/day) of rainfall on a rainy day.

Krishna Kumar et al..

Significant evidences and analysis on increasing extremes in future on India wide / homogeneous scale

Projected Change in Climate over India

- **A warmer India:** on avg. 27 more hot days (>45^{o}) each year and around 1.3 more consecutive hot days (heat waves) events each year for next 30 years.
- **Higher Annual rainfall with more heavy rainfall days**: minus 10% to 30% with around 4 – 18 more days of very high rainfall in near future.
- **More Dry Days:** Rainfall is projected to concentrate over lesser number of days.
- **Increased Lightnings are expected**
- **Regional sea level changes** have been estimated at close to 2.0 mm/yr over North Indian Ocean and 4 mm/yr over the Bay of Bengal region.
  - **Tide gauge trends**: All coastal cities shows increasing historical trends with Kolkata showing the maximum.
- **15-20% increase in storm surges** with 100 year return levels projected for East coast.
- **Intensity of cyclones** have seen an increase historically as well as projected to increase in future.
- **Rapid Warming of Arabian Sea:** high SSTs are showing itself wrt to higher cyclonic activity over this region.

Floods


Floods – the biggest, severest natural disaster we face year after year

Magnitude of the Impact

- The last 65 years (1952-2018), there was not a single year when flood didn't impact the country with significant losses to lives and property.

- Floods killed 109,412 people in the span. Over 258 million hectares of crops were damaged and 8,11,87,187 houses were raged. The total economic losses due to crop, house and other property damages came to Rs 4.69 trillion.

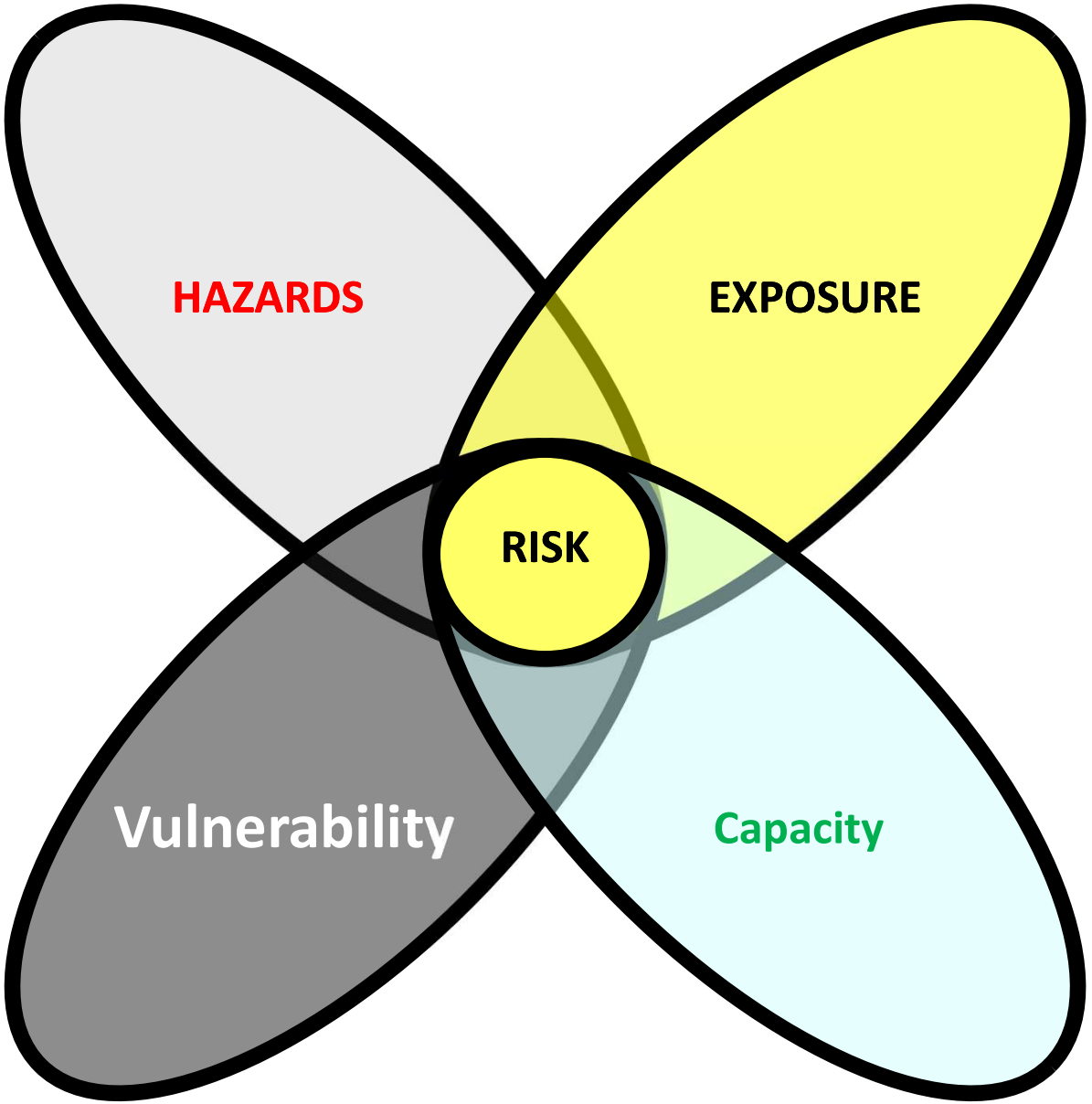
- India suffered a loss of Rs 95,736 crore in 2018 floods, 2.6 times more than the financial loss due to floods in 2017

- Coastal flooding risk in India had increased significantly. Estimated 36 million people in India are under risk, which is six times more than the earlier estimates

STATUS: UNPREPARED

- More than 200 nations and 7 billion people are investing over 6 trillion dollars each year in urban development and billions in education.
- Each year, approximately 700-900 events cause economic losses in Billions with large tolls in mortality and morbidity
- Traditionally our response to the disaster have been limited to post disaster recovery and relief
- Paradigm shift from Post disaster response to Preparedness and prevention through risk assessment and risk reduction

Elements of Disaster Risk



Understanding the risk is fundamental

Disaster Risk Reduction Strategy

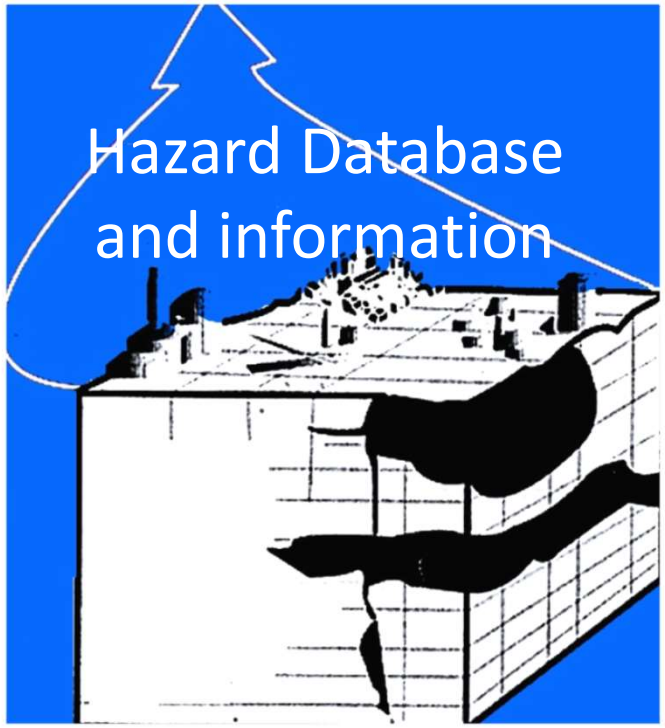
RISK ASSESSMENT

- **HAZARDS**
- **INVENTORY**
- **VULNERABILITY**
- **LOCATION**

RISK

ACCEPTABLE RISK

UNACCEPTABLE RISK



GOAL: DISASTER RESILIENCE

FOUR PILLARS OF RESILIENCE

- **PREVENTION (M&A)**
- **PREPAREDNESS**
- **RESPONSE**
- **RELIEF AND RECOVERY**

Preparedness

- Flood Zonation Mapping
- Vulnerability analysis
- Flood Risk Mapping
- Mitigation and adaptation plans for flood protection
- Climatological, Weather and Inundation Forecasting and Early Warnings for decision Making

Supportive Technology and Tools

- GIS and Remote Sensing
- Hydrological/Hydrodynamic Models
- Climate Models
- ICT Tools, AI&ML

Modelling Software

Hydrological and Hydrodynamic Model	Weather Forecast	MIS and Web
• MIKE by DHI • ADCIRC • Aquaveo SMS • SWMM • HecRAS • HecHMS	• WRF • GFS • ECMWF • Satellite • Real time AWS • Doppler RADAR	• Server • Automation • WebSQL • WebGIS

Model input data Requirement

Topography

- DEM, Contour, UAV, Survey

River Cross section

- River Profile survey

Discharge

- River Discharge observation, water lavel

Rainfall

- Station observation/Gridded, and forecast

Surface, sub surface and soil properties

- LULC, GW information, soil data

Structures

- Any hydrological structure

Meteorological Information

- Temp, ET

Response: Flood Plain Management

- **Structural Measures**

  - Dams, Diversion Chanel, Storage structures, levees, Strom Water Drains, Embankments, Channel Improvement etc.

- **Non Structural Measures**
  - Land use planning
  - Flood Plain Zoning
  - Mainstreaming DRR in developmental work
  - Policy and Regulations
  - Incentives, compensations and Insurance
  - Awareness and Capacity building
  - Emergency Response Plans

TOWARD DISASTER RESILIENT SOCIETY

- IMPROVE PUBLIC AWARENESS
- FORMATION OF CENTERS OF EXCELLENCE
- IMPROVE EMERGENCY MANAGEMENT
- IMPROVE HAZARD CHARACTERIZATION MODELS AND MAPS
- IMPROVE RESILIENCE AND DEVELOP CAPACITY
- REDUCE ALL VULNERABILITIES AND MANAGE RISKS
- IMPROVE ALL ASPECTS OF DATA MANAGEMENT
- IMPROVE ENVIRONMENTAL VULNERABILITY AND RISK ASSESSMENTS

There is No Planet B