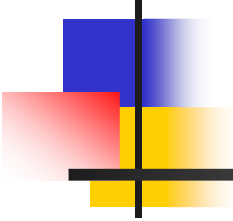


# Urban floods and Climate change



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ED - IRADe  
Date: 9-6-2010

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Adaptation





# Cities and Climate Change

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- **Climate change impacts felt locally—in cities, towns, and other human settlements.**
- **Due to rapid urbanization, cities are more at risk given the existing environmental, economic and social problems.**
- **Cities with large concentration of population, property and crucial economic assets and infrastructure are in highly vulnerable**



# INCREASED URBANIZATION

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Flooding has become a problem in recent years because:

1. Developments encroach
  - Floodplains,
  - Obstructing floodways and Waterways
  - Causing loss of natural flood storage.
2. Continued development and redevelopment to higher density land uses by high land costs in cities.

Conti.....



### 3. Increased impervious areas such as

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- Roads,
- Roofs and
- Paving,

Due to increasing development densities  
means more run-off

In Urban Flood any part of city can badly get affected  
and more significantly low lying areas

- Urban floods are due to stagnation
- Sometimes urban flood occurs due to inflow from river  
/ sea in urban drains during high stage / high tides

# Climate Induced Vulnerability of Cities in India

- High and multidimensional risks
  - Mean minimum and maximum temperature by 2-4°C
  - 7-20% in mean annual precipitation
  - Frequency of heavy rainfall
  - Sea level by 0.8 meters by the end of this century
- 5 to 25% in semiarid and drought prone central India
- Winter rainfall in north India
- Number of rainy days

Conti.....



The urban heat island effect has resulted in an increase in rainfall over urban areas

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Climate change is resulting in

- Changed weather patterns and
- Increased intensities of rainfall in lesser number of rainfall events during the monsoons

Thus, many of our cities located

On the coast,

On riverbanks,

On downstream of major dams and

Even otherwise need to have special provision for mitigation of urban flood disasters,

Our urban centers should quickly recover from flooding incidences through adequate flood disaster mitigation measures



Flooding in urban areas can be caused by  
flash floods, or coastal floods, or river floods,  
heavy rains

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## Urban floods is a specific phenomenon

The annual disasters from urban flooding are now  
**much greater** than the annual economic losses due to  
other disasters.

In 2001, there were **285 million people** residing in **35  
metro cities** (having a population of 1 million plus).

This is estimated to exceed **600 million** by **2021** in over  
a **100 metro cities**.



# Significant Urban floods in India in recent years

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- **2005** Severe urban floods were reported from 10 cities and Mumbai was worst affected.
- **2006** Number of affected cities rose to 22. Surat was worst affected. Vishakhapattanam airport was inundated for more than 10 days.
- **2007** Number of affected cities rose to 35. Kolkata was worst affected.
- **2008** Jamshedpur, Mumbai, Hyderabad were worst affected



# URBAN FLOODING



Flooding in the cities and the towns is a recent phenomenon caused by :

1. Increasing incidence of heavy rainfall in a short period of time,
2. Inadequate capacity of drains and
3. Lack of maintenance of the drainage infrastructure.

In Urban Flood any part of city can badly get affected and more significantly low lying areas.

Sometimes urban flood occurs due to inflow from river / sea in urban drains during high stage / high tides.

# URBAN FLOOD: Impacts

Urbanisation **increases flood risk** by up to three times

Floods are now affecting a large number of people living in urban India

(peak flows result in flooding very quickly due to faster flow times (in a matter of minutes),

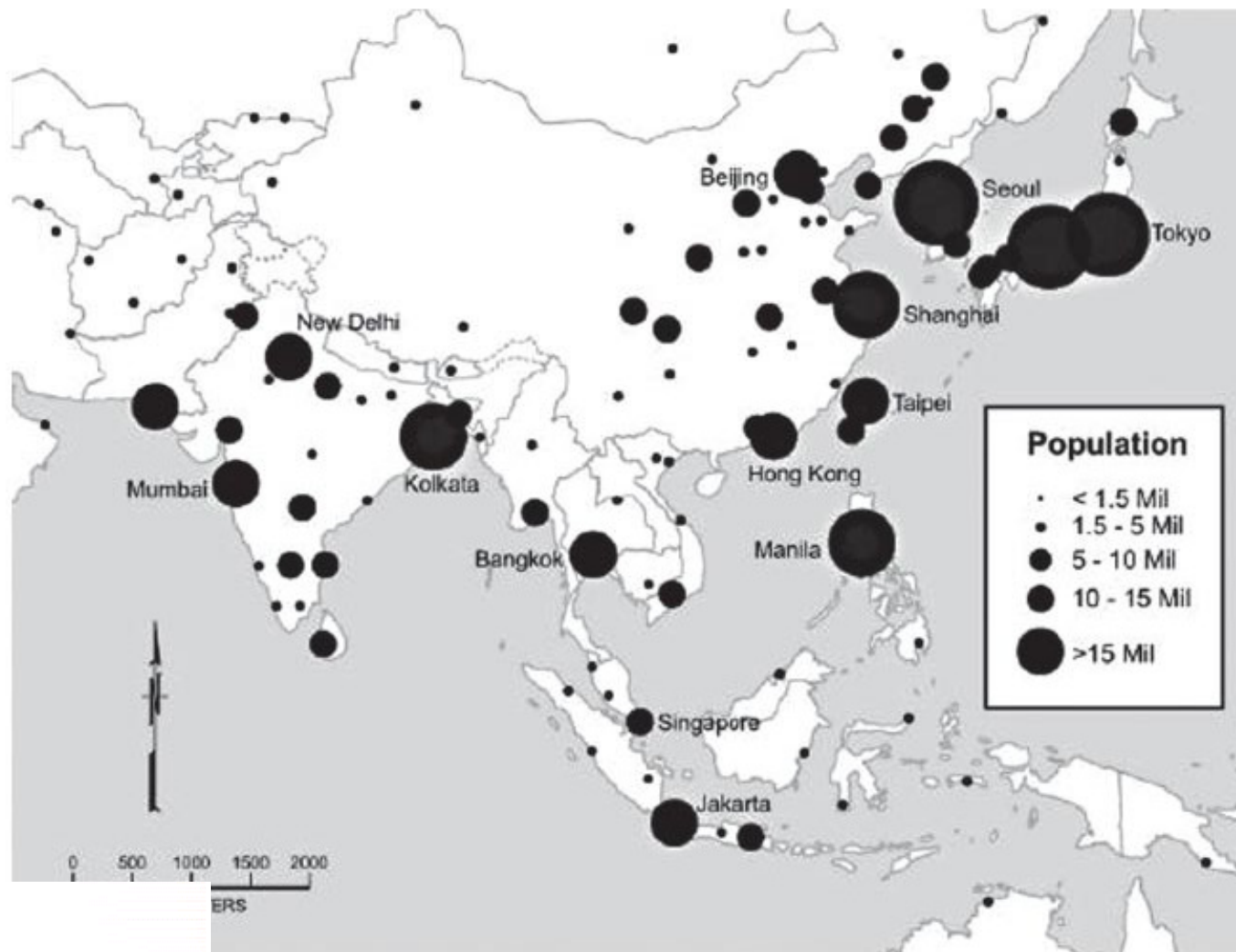
Major cities have witnessed

- **Loss of life and property,**
- **Disruptions to transport and power and**
- Incidences of epidemics during the monsoons,
- Severe economic and infrastructure loss to industry and commerce

Most notable amongst them being Mumbai in 2005, Surat in 2006 and Kolkata in 2007

# Mega cities in East Asia

FIGURE 1.4 / Mega cities in East Asia

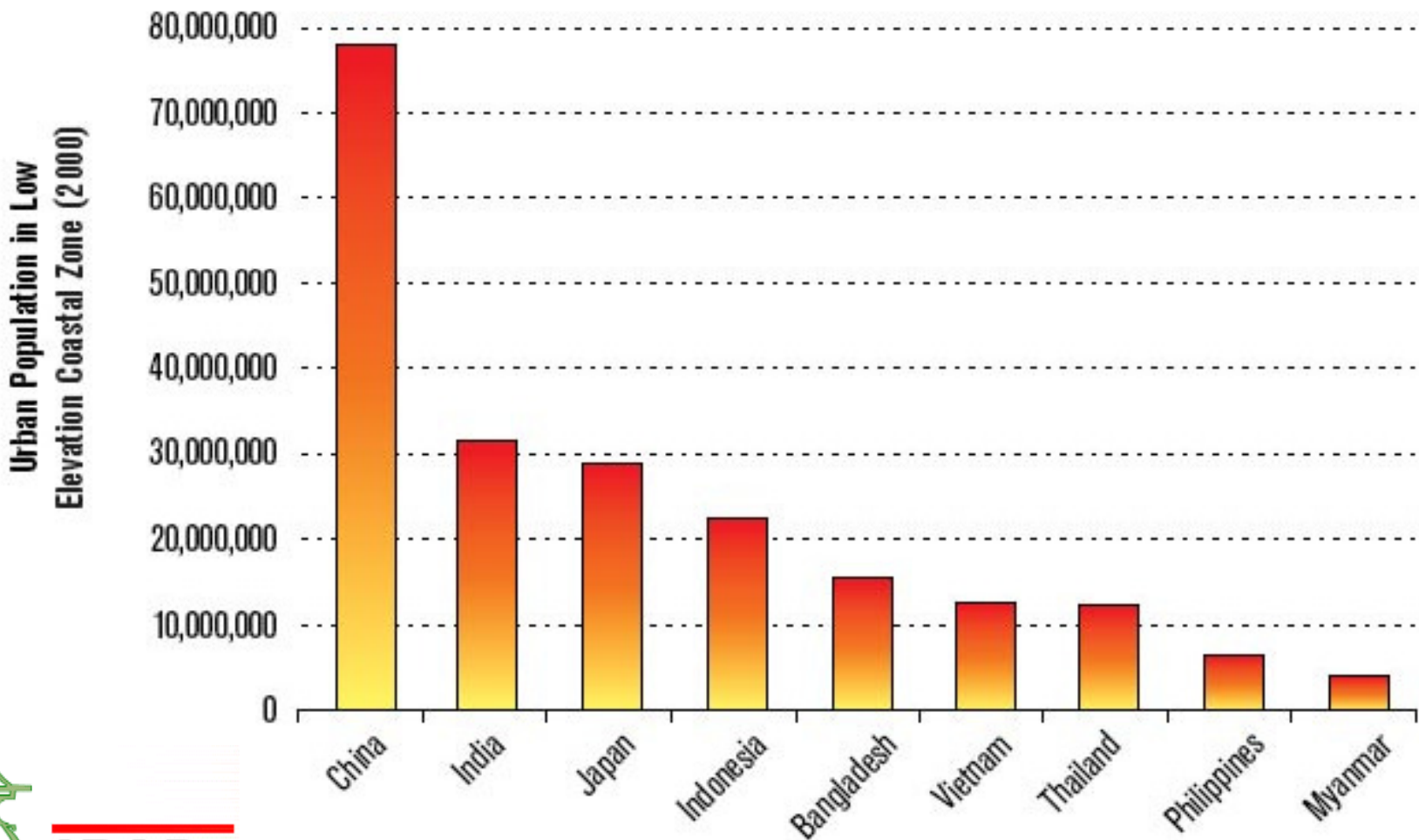


Source: Gill, I., and H. Kharas, *An East Asian Renaissance: Ideas for Economic Growth* (Washington, D.C.: World Bank, 2007).

# Coastal population vulnerable to sea level rise



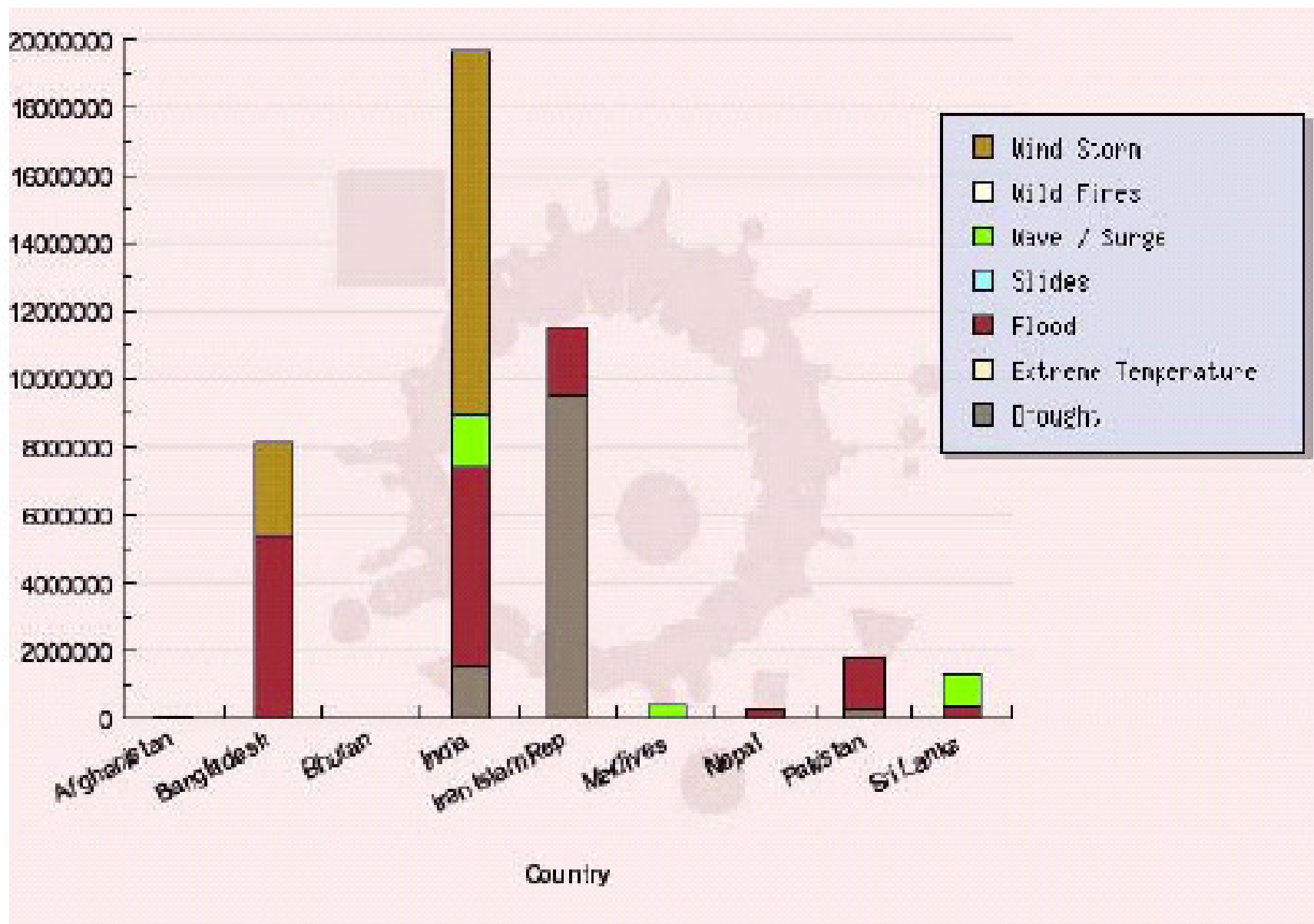
**FIGURE 2.5/** Coastal population of select countries that are highly vulnerable to sea-level rise



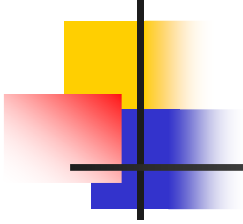
Source: Data Cent Eleva (LEC Estim sedac edu/

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- ...
- Many **cities are** on **risky sites** – near rivers or harbours – while others, established on safer ground, have expanded onto riskier land like steep hillsides or floodplains.
  - Thus many **cities are at risk from climate change** impacts such as sea-level rise, floods and extreme weather.
  - **1.2 billion people** live along coastal **areas with low elevation**.
  - When cities flood, access to **safe drinking water, food and sanitation is difficult**, particularly for the poor. Children can drown, and disease outbreaks are rife.

**Figure 4. Damages due to extreme climate events in Asia**

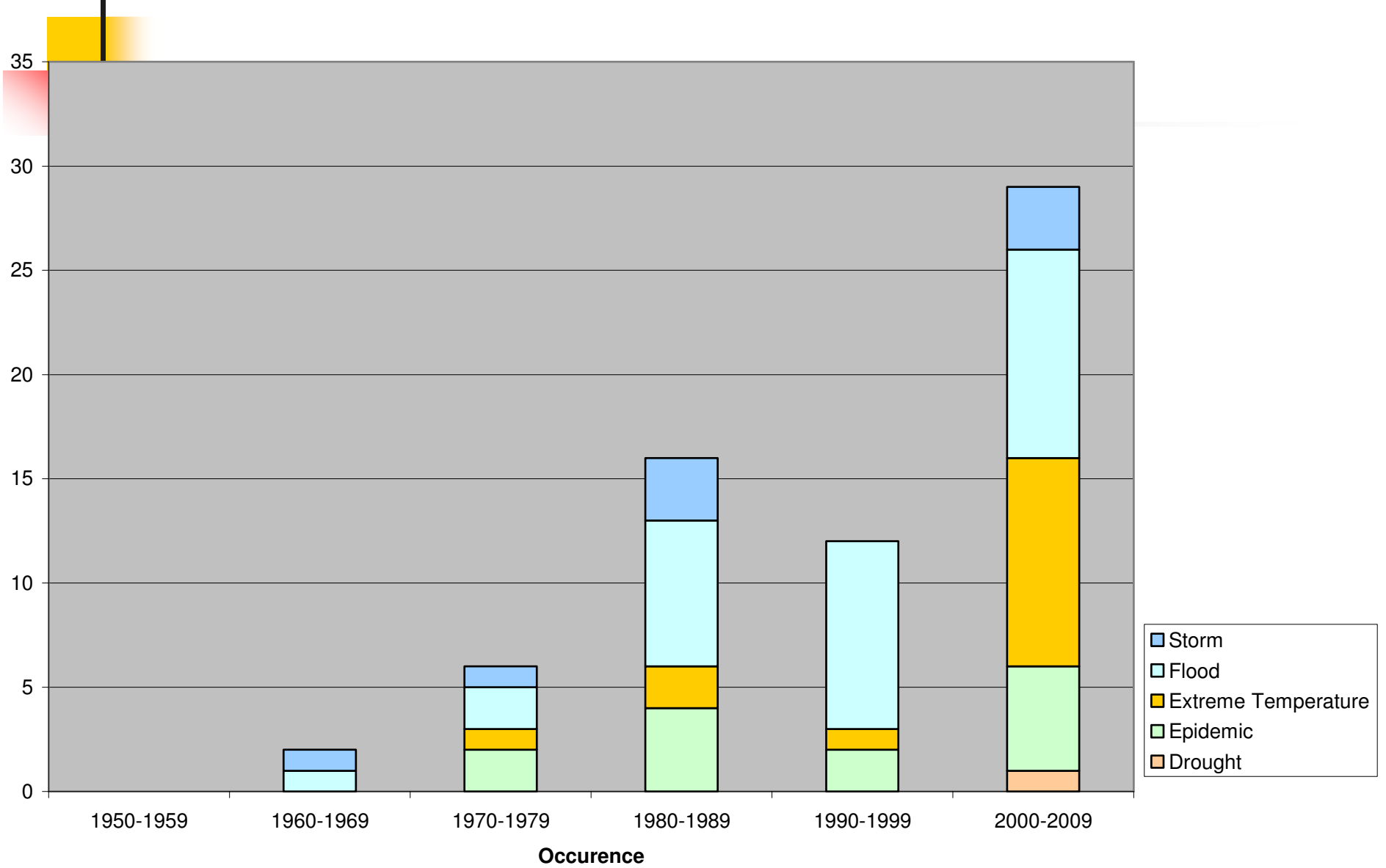


Source. Human Development report 2007

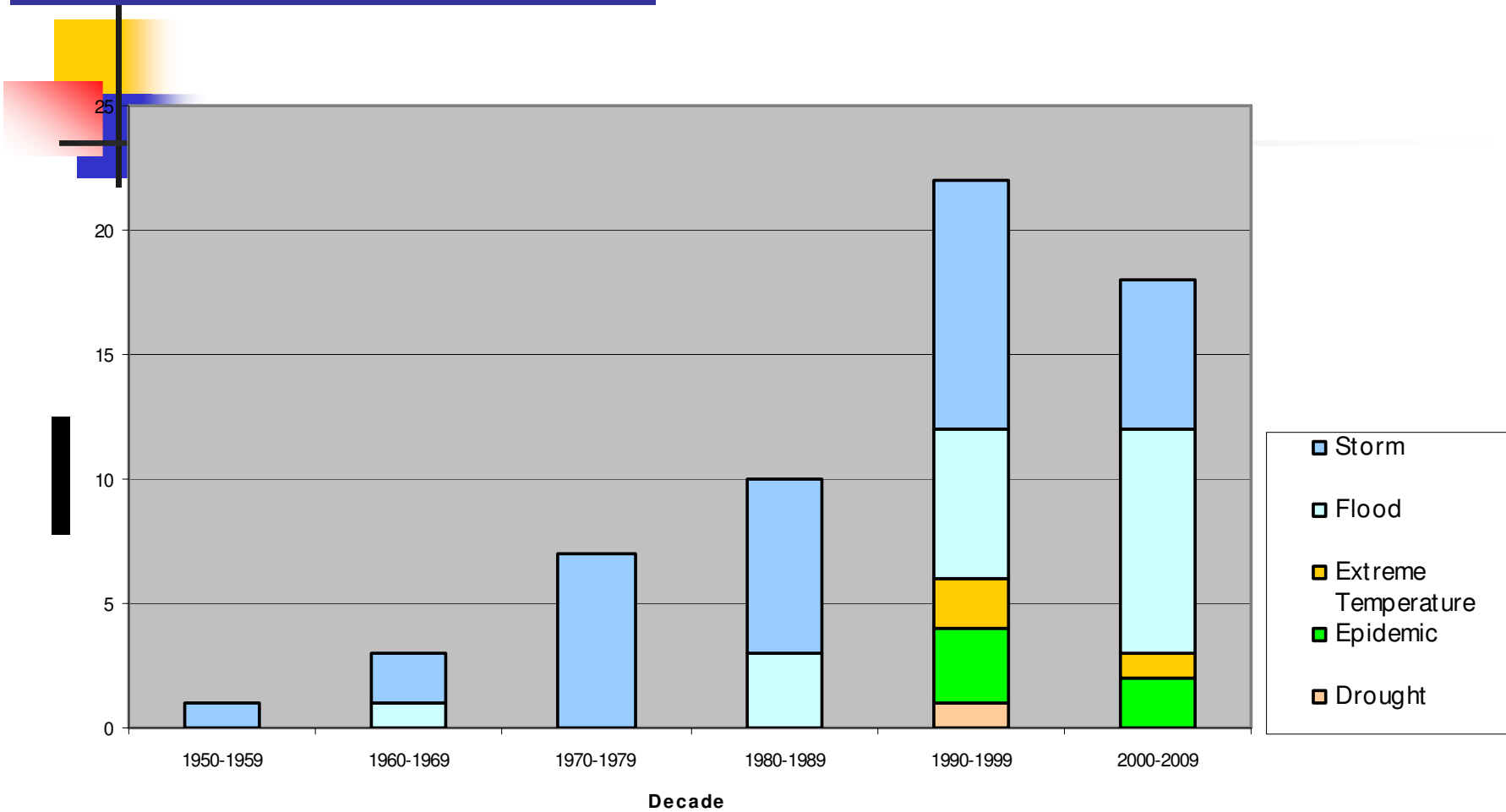


# Top Five States of India (Based on disaster occurrence)

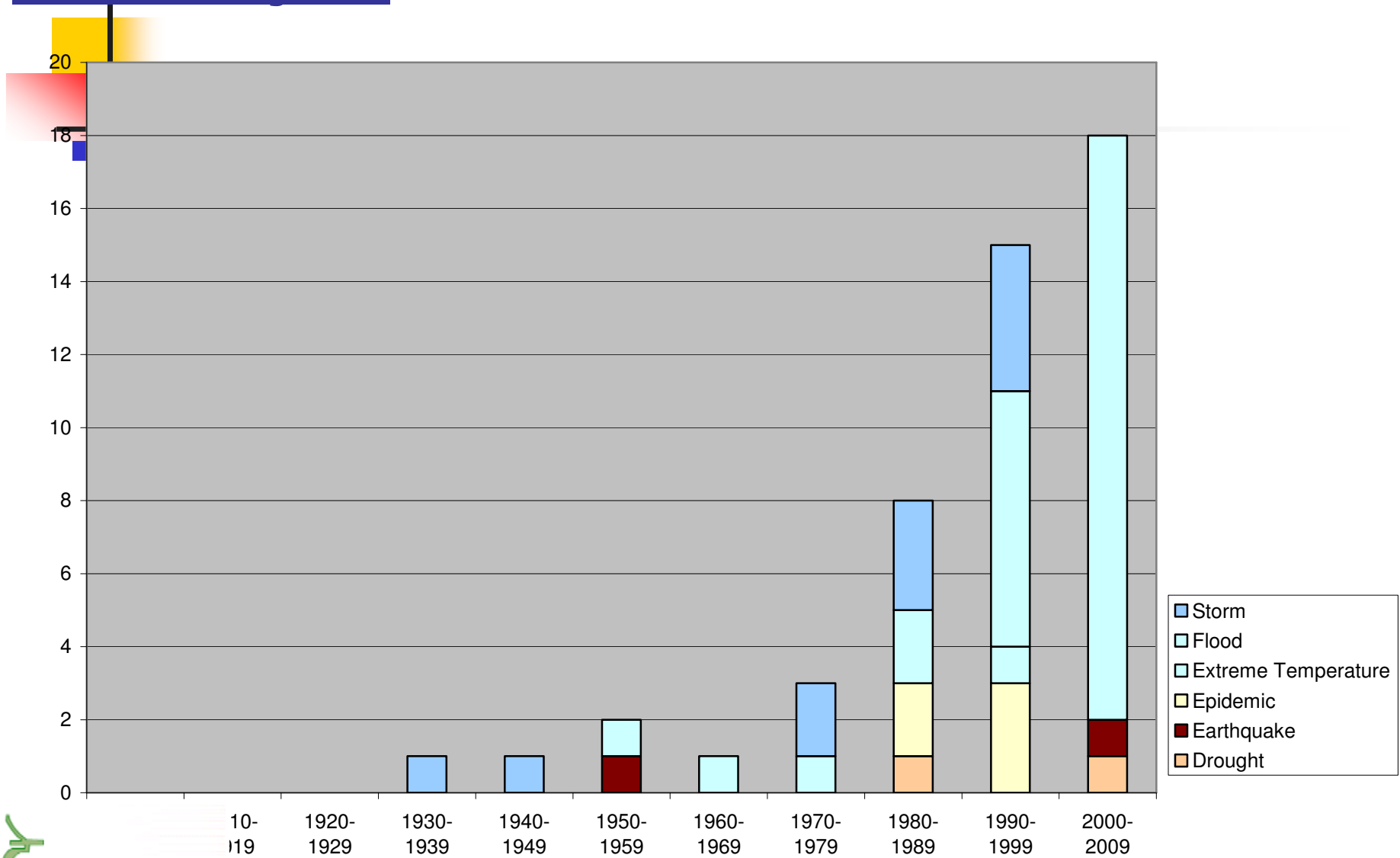
# Profile: Uttar Pradesh



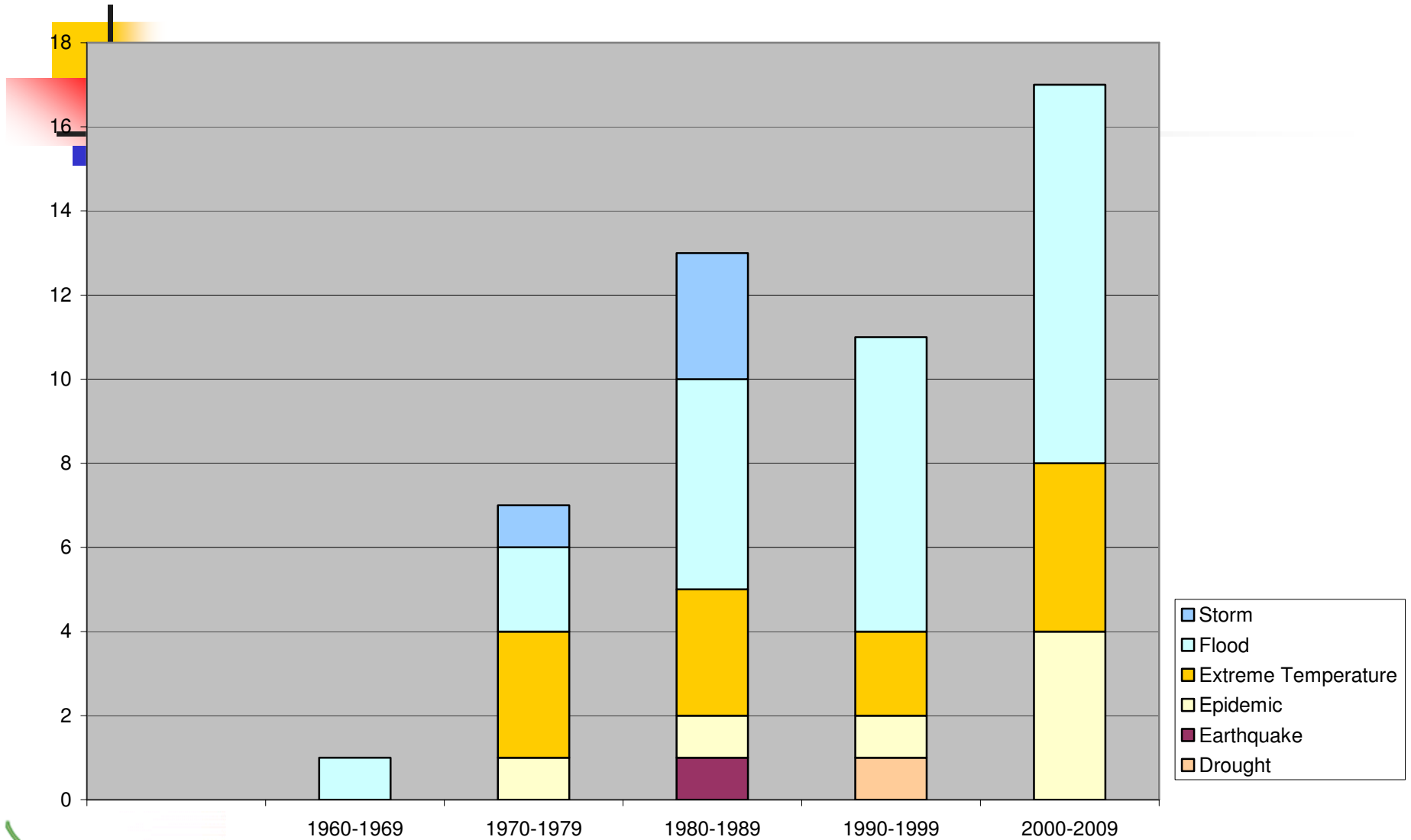
# Profile: Andhra Pradesh



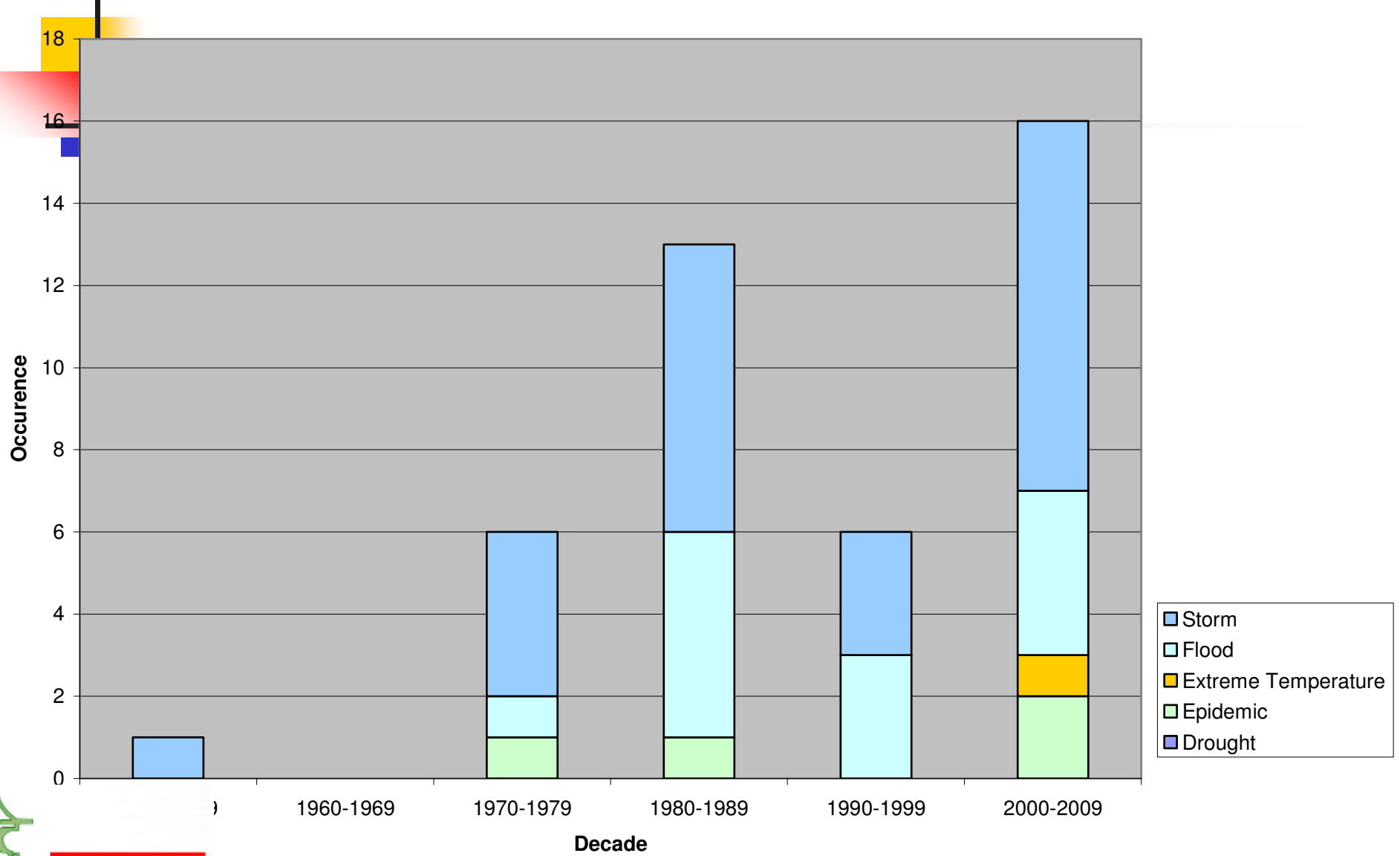
# Profile: Gujarat



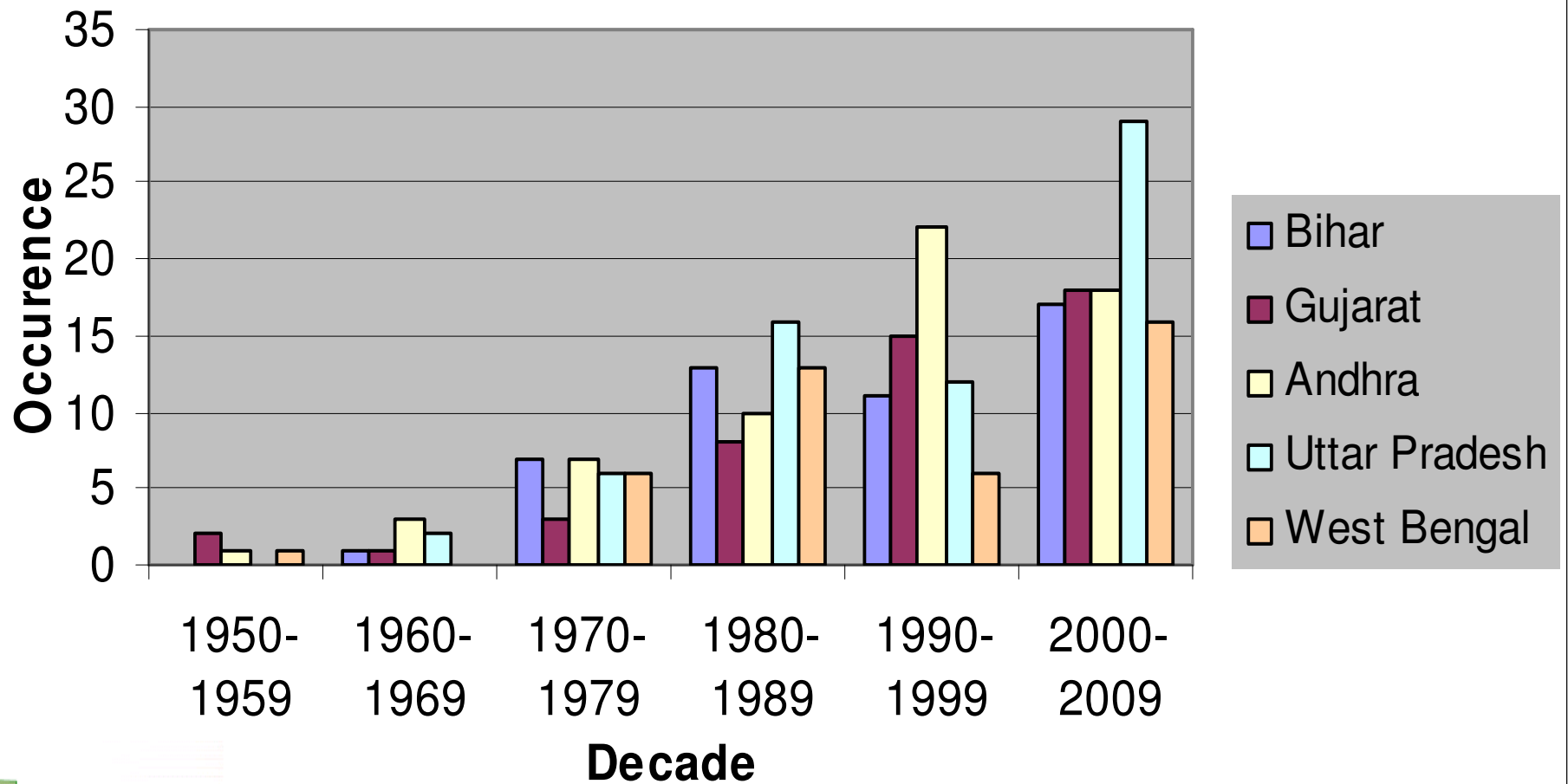
# Profile: Bihar



# Profile: West Bengal



## Comparative of 5 states



## Key Observations

- All regions have a higher proportion of climate related disasters, with northern and eastern states with highest occurrence of events since 1950.
- Partially related climate disaster like epidemics also show a rise in occurrences over the decades.
- Floods are the most frequent disaster experienced in all regions with the highest occurrence in the South.
- Storm is the second most frequent disaster in the regions, but has the largest presence in the southern states with 40% of all disaster proportion.
- Extreme temperature has a larger presence in the northern states as compared other regions.
- The Top five states as per the highest registered events in the last decade are: Uttar Pradesh, Andhra Pradesh, Gujarat, Bihar, and West Bengal.
- These results are crucial in identifying the cities in these states that register the highest disaster occurrence.



# Most vulnerable populations and elements in a city

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- Slum dwellers
- Settlements in low-lying areas
- Industrial and informal service sector workers
- Buildings
- Industrial units
- Lifeline public and private infrastructure
- Ecosystems and the natural environment

Source: Aromar Revi



# Vulnerable Groups

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## Slum-dwellers:

- They lack secure tenure, proper shelter, water, sanitation, electricity and other services. Most have no insurance.
- Their access to food and water depend on climatic conditions.
- Climate change will increase their **vulnerability** in terms of health, access to food and income generation.
- They are the least-informed, least-empowered, and least-mobile group in the face of climate hazards.



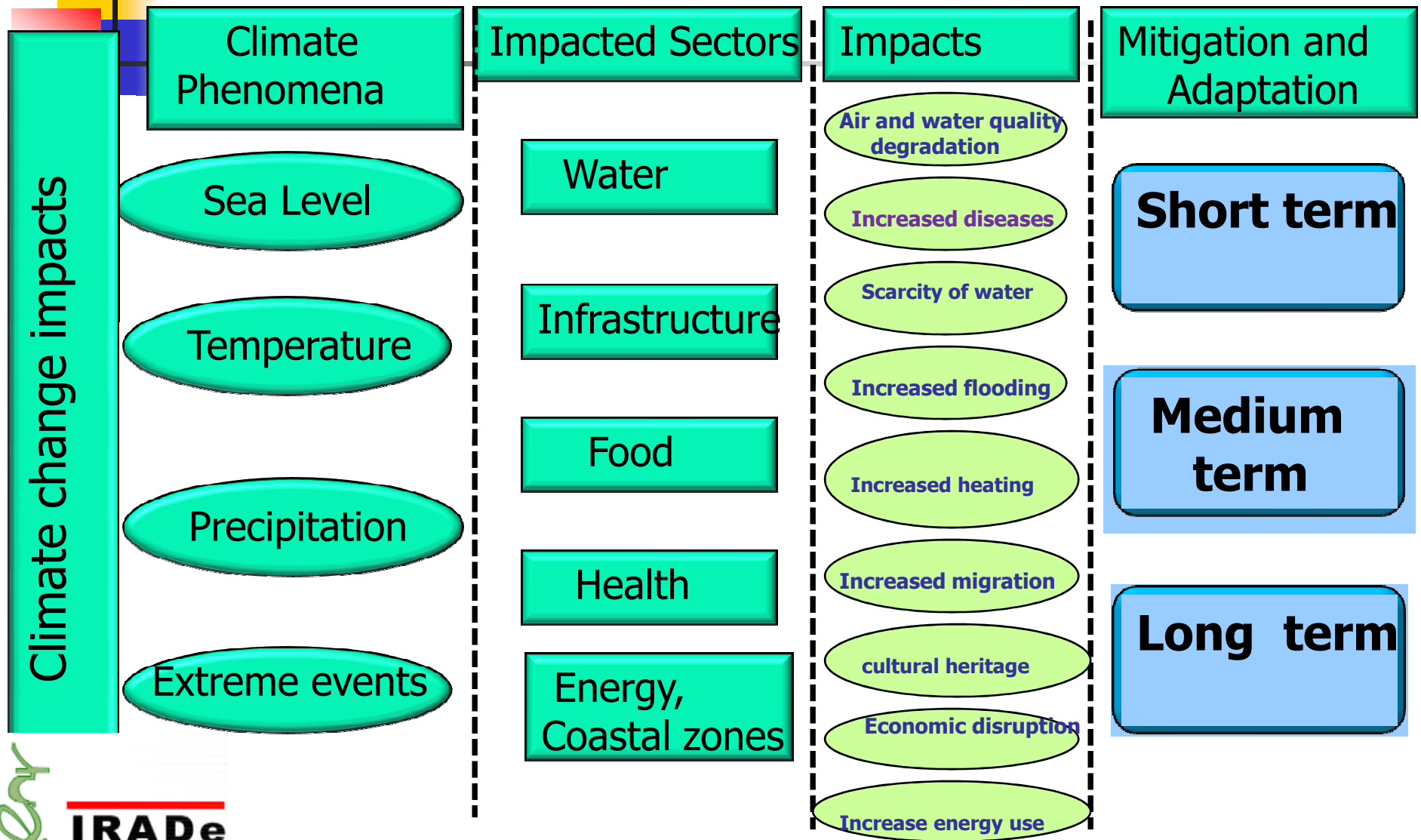
# Vulnerable Groups

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## Women:

- Men control income distribution, property, access to credit and decision- making. This exacerbates the vulnerability of women in disasters.
- Women are largely excluded from city planning and decision- making. This has impact on planning priorities related to climate change.
- Women are more prone to the effects of climate hazards because of the work they do and the discriminations they face in terms of access to resources, income or housing. (Nunan and Satterthwaite, 1999)

# Climate Change Impacts on Cities



# Solutions for Flood Mitigation

Urban flooding can be reduced with measures like;

- Maintaining existing drainage channels,
  - Providing alternative drainage paths (may be underground),
  - On site storage of rainwater,
  - Control of solid waste entering the drainage systems,
  - Providing porous pavements to allow infiltration of rainwater,
  - Reserve low-lying areas for playgrounds and parks,
  - Using state-of-the-art technologies to address current problems
- The use of flood plains be regulated and\_a suitable legislation for flood plain zoning\_be enacted and enforced

# Flood Plain proofing

In case of urban areas,

Measures required as soon as flood warning is received, are;

- Installation of removable covers such as steel or aluminium bulk heads over doors and windows,
- Permanent closure of low level windows and other openings,
- Keeping store counters on wheels,
- Closing of sewer wells, anchoring and
- Covering machinery and equipment with plastic sheets, etc



# WHAT CITIES SHOULD DO

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- Local governments should use their authority over **land-use planning, waste-management, energy consumption** and **transportation** to tackle climate change
- Through **planning** and **regulation**, local governments should take pro-active role in **adaptation** of climate change.
- Climate change already has impact on large cities in the **coastal or low-lying** zones. Therefore, local governments have to take **adaptation** measures.



# Climate Resilience: 6 Major Risks

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- Temperature and precipitation variability
- Flooding and extreme rainfall
- Cyclone and storm surge
- Sea-level rise
- Environmental health risks
- Drought



# Adaptation

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## **Disaster management: Floods and Cyclones**

- Building shelters
- Changes in land use
- Controlled Inundation areas

## **Infrastructure: Engineering/Architectural**

- Flyovers, Bridges, Dykes
- Drainage systems, storm sewers
- Green roofs
- Storage of flood waters for drought periods



# Climate Resilience Measures

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- Develop appropriate risk assessment
- Building Retrofitting and Strengthening
- Lifeline Infrastructure Development
- Hazard Modification
- Relocation and Rehabilitation
- Improve water, sanitation and housing deficiencies in the poor neighborhoods of urban settlements



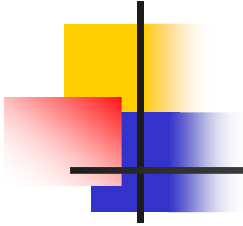
# Adaptation in the urban areas

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*Cities will need to adapt for future floods, droughts, storms and heat waves through following:*

- Remodeling drainage system that can accommodate sudden downpour.
- High Capacity water supply and storage systems for drought periods.
- Embankments of low-lying areas especially for coastal cities.
- Stronger buildings, bridges, flyovers, also water supply and treatment plants that withstand storms.

Conti.... 1



## Disaster Management

- Incorporate Disaster Management Plan as part of the Master Plan
- Build stronger database for the city to increase preparedness
- Frame higher safety standards for contractors and builders

### ■ Flood control initiatives

- No Encroachment /Construction in risk area
- Protective hard embankment
- River trenching

Emergency response centre

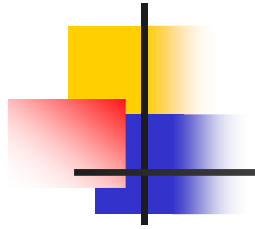
Emergency plan – Place & training

Conti.... 2



## The techniques consist of;

- Providing raised platforms for flood shelter for men and cattle,
- Raising the public utility installation especially
  - The platforms for drinking water hand pumps and bore wells above flood level
- In the existing developed areas,
  - Possibilities of protecting against submergence
  - Or relocating to safer areas vital installations like;
    - Electricity sub-stations/ power houses,
    - Telephone exchanges,
    - The pumping stations meant for drinking water supply etc.

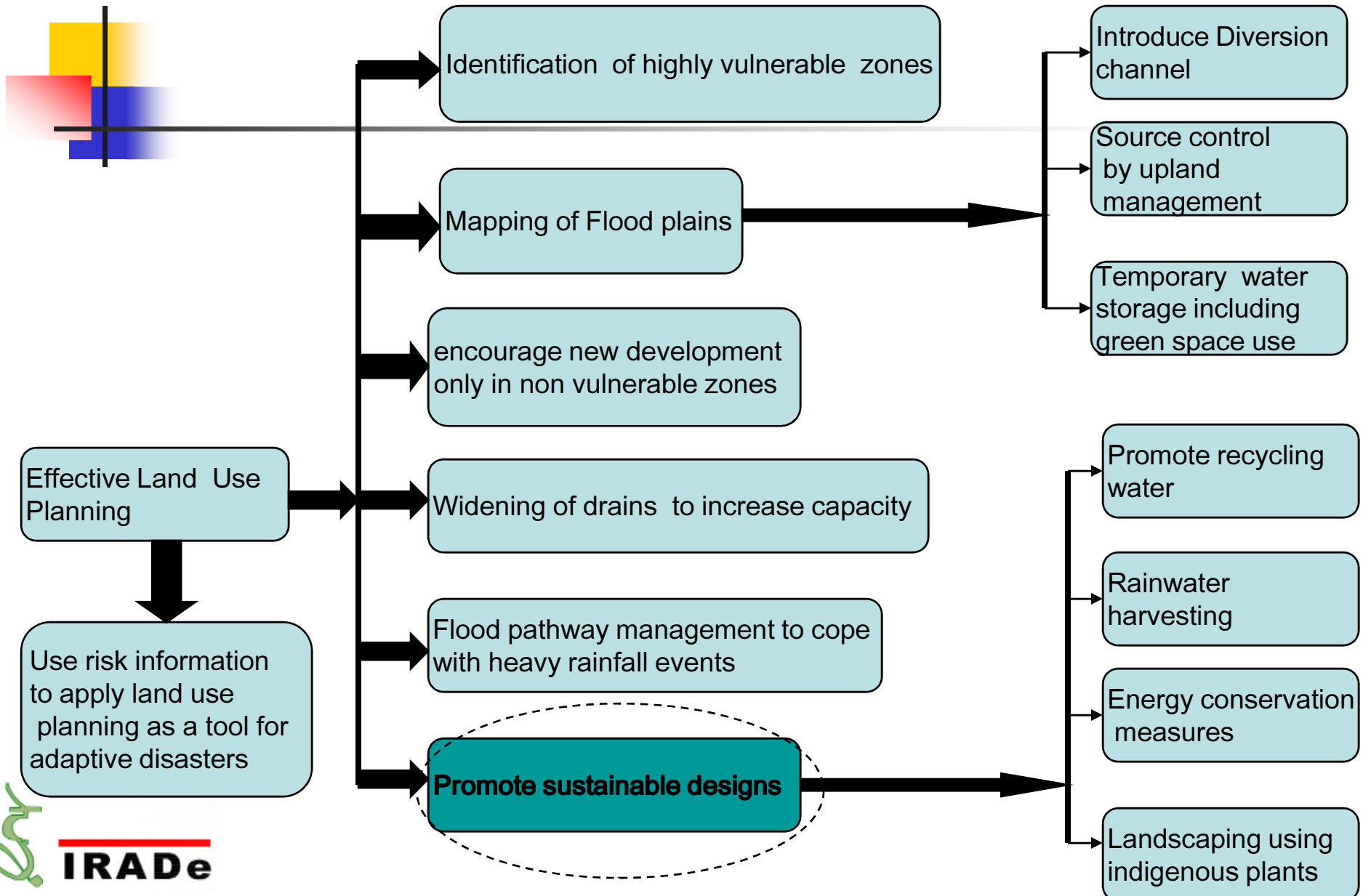


# IRADe Framework

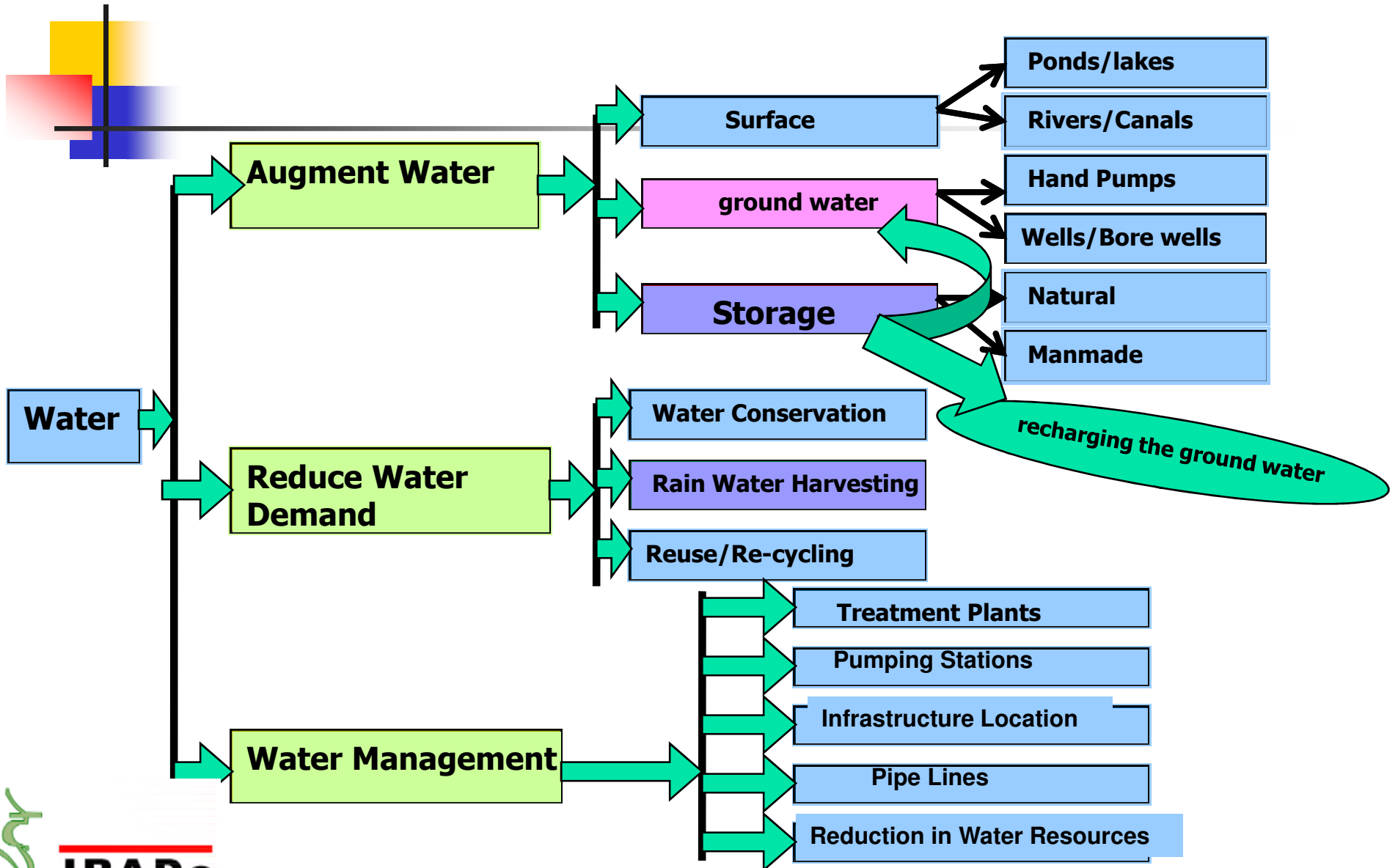
For

# Cities and Climate Adaptation

# Urban Design & Climate Resilience



# Adaptation Strategy for Water Management





# Storm Water Management

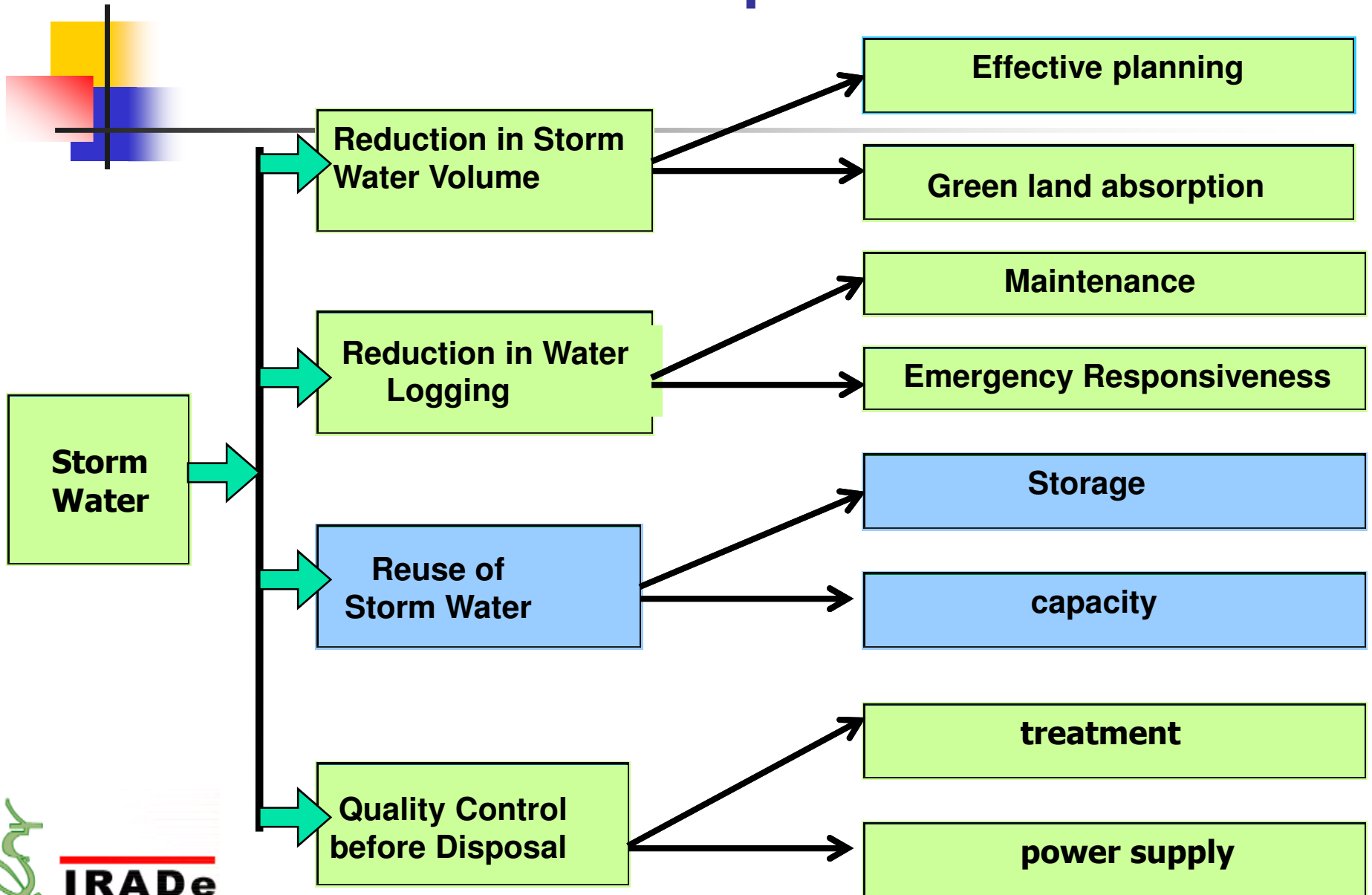
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- Rapid conversion of land to urban and suburban areas has altered the water flow pattern.
- During the flood increased volume of water and pollutants reduces the water quality.

## **The following adaptation strategy can be followed**

- Reduce the volume of storm water.
- Reuse and Reduce water logging to maintain smooth flow.
- Reduce the pollution levels of storm water.

# Limit Storm Water Impact and Reuse It





# Assess the climate-related infrastructural vulnerability

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1. Risk-hazard analysis of urban physical infrastructure, especially sensitivity to climate change impacts on water, built assets, waste management, and energy systems;
2. Socio-economic analysis of vulnerability arising from climate change urban infrastructural impacts due differential availability of and access to resources needed for adaptation

# Assessment for Indian Cities



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- Classification of Baseline Development and Climate Change Interface.( need broad classification like coastal, arid cities..)
- Further Classification Within the Above Categories Relevant to Adaptation .
- Basic variable could be Social, Economic, Infrastructure, Urban design, Governance etc.
- Accessing the scale and magnitude of adaption for Each City.



## Conclusion:

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- Action must be directed towards adaptation policy push for public-private partnership.
- Rapid review of infrastructure status and suggested adaptation strategy.
- Strong involvement of sustainable planning.



**IRADe**



**IRADe**



**THANK YOU**



**IRADe**



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