Floods

27 June 2023 21:10

Road blocks, bridge collapse, caving roads, accidents and deaths have became everyday news from the "**Devbhoomi**" (Himalayas)

Recent collapse of under-construction yamunotri tunnel

The song of resistance sung by Ongyal Lepchas of Sikkim goes
"I can drown everything that stands.
Do tell them, so many rocks and hills I have cut through, how can these little hurdles hold me back?"
The song refers to the rage of the rivers at the slew of hydropower projects in Sikkim.
In 2023, the song proved to be prophetic for the Teesta River, when a GLOF wrecked havoc and swept away the Chungthang dam.

Data

1. According to Geological Survey of India,

nearly **12%** of India's total land area is prone to floods

2. According to National Flood Commission, **40 million hectares** of land in India is flood prome

Events

2013 - Flash flood in Kedarnath - cloud burst
2021 - Chamoli Disaster - Glacial rock slip - flash flood
2023 - Cloud burst, land slip, flash flood in HP
2023 - Yamuna floods
2023 - Glacial lake burst in Sikkim (Chungtham Dam breach)

India's Flood Hazard Zones - over lap with landslide zone

- Basins of major rivers
- Himalayas - Especially UK, HP, Sikkim, NE, Bihar
- Western Ghats - Kerala

Heavy rain - landslide - flash flood : interconnected

NCERT

- Floods are relatively slow in occurence
- Occur in well defined regions at expected times
- Surface runoff > carrying capacity -> flood

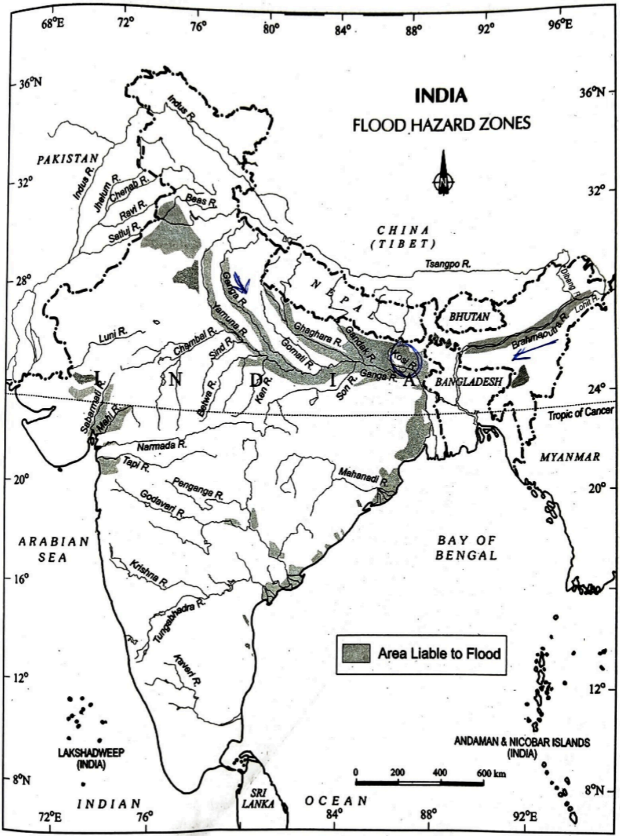
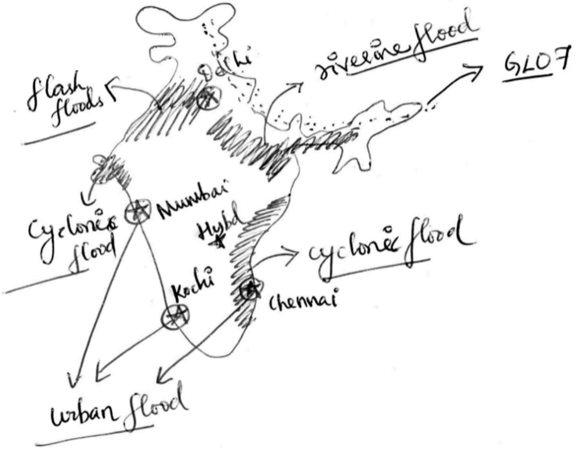


Figure 7.6 : Flood Hazard Zones

Types of Flood

1. Riverine floods
2. Urban floods
3. GLOF
4. Coastal floods - cyclones, storm surges



RIVERINE FLOOD

CAUSES

Natural

1. Heavy rainfall
   Eg. North East, Western costal plains
2. Sporadic rainfall
   Eg. Cloudburst in Himalayan states
3. Cyclonic rainfall
   Eg. Eastern coastal plains
4. Channel morphology of rivers
   Eg. Meandering areas prone to floods
5. Shifting river course
   Eg. In last 200 years Kosi river shifted West by 100 km - Sorrow of Bihar
6. Huge sediment load of certain rivers
   - Reduces carrying capacity and volume of rivers

   Eg. Himalayan rivers - Brahmaputra
7. Morphology of river basin
   Eg. Hard rocks in penninsular India doesn't allow water percolation
8. Presence of hardpans in arid areas
   - Prevents percolation

   Eg. Short rainfall causes flooding in areas of Punjab

Anthropogenic

Agriculture

1. Deforestation for Shifting cultivation

Eg. Increased runoff and reduced percolation in North East

2. Flood irrigation in arid areas
   Eg. Creation of hardpans reducing percolation

Haphazard development

3. Wetland encroachment (acts as sponge)
   Eg. Floods in Kerala
4. Siltation of river bed - Eg. Sutlej, Beas etc.
   From dumping muck of tunnels constructed for run off river projects
5. Failure in dam management upstream
   Eg. Hathnikund barrage upstream Yamuna lead to Yamuna floods 2023
6. Construction on river flood plain
   Eg. Commonwealth Games village, Delhi Secretariat on Yamuna flood plain

Climate change

1. Changed rainfall pattern
   Eg. Flash floods in Rajasthan
7. Increased intensity and frequency of tropical cyclones
   Eg. Biparjoy in Arabian Sea
8. Glacial melting
   Eg. Causes GLOF and sea level rise

9. Unpredictable climatic events
   Eg. Early arrival of Western disturbance and interaction with Monsoonal system

Challenges

1. Lack of legislative focus on individual disasters
   - DM Act 2005 focuses on multi hazard risks
   - Act missess the fact that floods can be predicted
2. Bypassed laws
   - NGT ban on construction on Ganga flood plains in Uttarakhand has been bypassed
3. Central policies not binding on states
   Eg. Regarding policy to protect flood plains
4. Land mafia politician nexus
5. Outdated flood forecasting
   Eg. **Deterministic model** employed gives low lead time

Mitigation Methods

Pre-disaster

- Prepadeness

1. Real time **crowd-sourced data** from Twitter used by IITB for making Flood maps of Bombay
2. Flood risk analysis and flood **zoning** - by Geological Survey of India
3. Flood forecast - early warning by IMD - could employ technology like **Doppler radars** for accurate weather prediction
4. Achieve **lead time** of over 7 days
   Eg. Employ **Ensemble Model** of flood forecast - IMD employed **Pratyush and Mihir** to test ensemble model
5. Augment statistical model with AI
   Eg. **Google AI** issues flood alert
6. Real time alerts - **Floodwatch App** by Central Water Commission (forecast and warning)
7. Flood management plans
8. Flood shelters
9. Flood proofing of infrastructure
   - Raising levels of essential components

- Mitigation

10. Depopulating flood plains
11. Scientific embankments to prevent river overflow

12. Structures to control flood water
    Eg. Dams and reservoir
13. Detention basins - to collect flood water
14. Desilting of rivers
15. Afforestation
16. Natural buffers conservation
    Eg. Wetlands
17. Community awareness and training

During Disaster

- Response

1. Emergency relief
2. Search and rescue

Post Disaster

- Rehabilitation

1. Livelihood support

- Reconstruction

2. Resilient constructions for flood risk management
   Eg. **Stilt houses of Mishing and the Miyah communities along the Brahmaputra**

- Restoration of flood plains
- Climate smart infrastructure

3. Regulate land use pattern

Eg. Protection and reclamation of wetlands

4. Long term actions to minimise climate change
5. Respect rivers right to expand
   Eg. **Room for the river project** by Kerala
6. Adopt successful international models after fine-tuning to geography of the region
   Eg. **Netherlands model** of flood mitigation
7. The **National Disaster Mitigation Fund** was allocated for the first time to *Chennai after flood caused by cyclone Michaung*
8. Create a cadre of multi purpose front line public health workers

Impact

According to IPCC AR6, floods due to climate change will increasingly affect the costal states and hill states of India

ECONOMY

1. Loss of agriculture lands
2. Destruction of infrastructure

HEALTH

1. Spread of water borne & vector diseases - typhoid, cholera, hepatitis, dysentery, leptospirosis, malaria, dengue

SOCIAL

1. Exacerbate inequality due to disproportionate impact on poor dwellings in the slums
2. Loss of life and livelihood
3. Temporary loss of conncetivity

ENVIRONMENT

1. Plastic pollution on costal region especially post cyclonic flood
2. **Oil spills**
   Eg. Flood due to cyclone Michaung caused flooding of Chennai Petroleum Corporation Ltd and oil getting to BoB via Buckingham canal

POSITIVES

1. Recharge soil fertility
   Eg. Paddy cultivation in Majuli after annual Brahmaputra floods

URBAN FLOOD

Recently, Yamuna river breaching safety levels lead to flooding in Delhi

Mumbai - **Mithi** river
Hyderabad - **Muzi** river
Chennai - **Coovam** river (siltation due to solid waste dumping), **Adayar** river (encroachment of flood plain)

Significance

1. Impact larger population
2. Heavy lose of infrastructure
3. **Inequality** in impact of urban floods
   Eg. Disproportionately on slum dwellers, sub urban population etc

Causes

Natural

1. Heavy rainfall
   Eg. Cyclonic rainfall

2. Location of cities
   - Along rivers (Delhi), coast (Mumbai, Chennai)

     # ASSAM - geography

Anthropogenic - **Reduced percolation & blocked drainage**

1. Increased concretisation of city leads to low percolation
2. Blocked natural drainage of rivers due to infrastructure projects
3. Encroachment into river flood plain
   Eg. Commonwealth Games village, Delhi Secretariat on Yamuna flood plain, Chennai airport on Adayar river flood plain
4. Wetland encroachment
   Eg. Lakes in Gurugram declined from 600 to 100 in 60 years
5. Unscientific urbanisation - levelling of land
   Since 1985, human settlements in flood-prone areas have more than doubled - World Bank report
6. Infra development on eco-fragile land w/o EIA
   Eg. Chardham Mahamarg Vikas Pariyojana bypassed EIA

7. Failure in desilting drains in the city
   Eg. Obselete drainage master plan of Indian cities dating back to 1970s
8. Inadequate storm water drainages

Climate Change

1. According to IPCC AR6, floods due to climate change will increasingly affect the costal states and hill states of India
2. Urban heat island - Conventional rainfall

Solutions

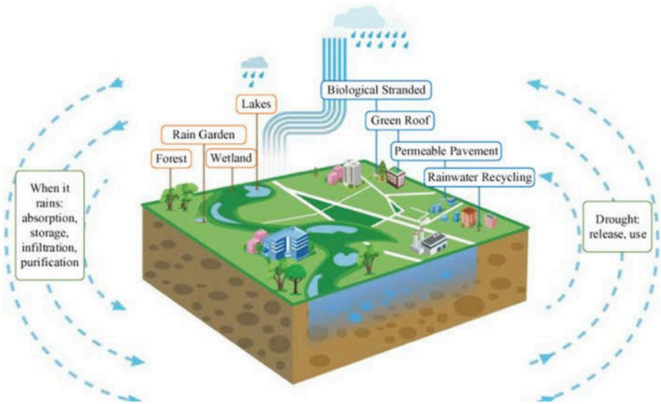
1. Implementation of **National Action Plan for conservation of Aquatic Ecosystems**

- **Wetland Mitras** - to ensure local efforts in Wetland conservation
- **Wetland Health Card** - to moniter condition of wetland
- Integrated Management of wetlands

2. **SPONGE CITIES**

- Can be delivered along the lines of the Atal Mission for Rejuvenation and

Urban Transformation (AMRUT), National Heritage City Development and Augmentation Yojana (HRIDAY) and Smart Cities Mission



Features

- Use of permeable asphalt
- Green infrastructure
- Construction of new canals and ponds
- Rain water harvesting
- Restoration of wetlands

Importance of sponge cities in mitigating floods

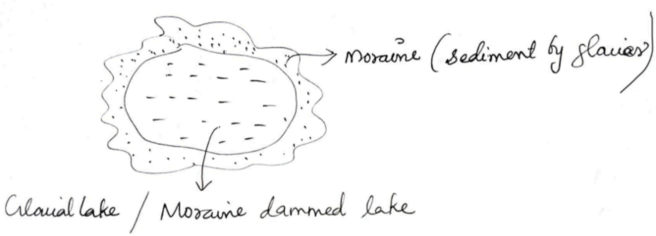
1. Rainwater Absorption and Retention
   Eg. Rooftop gardens, permeable pavements, and open green spaces

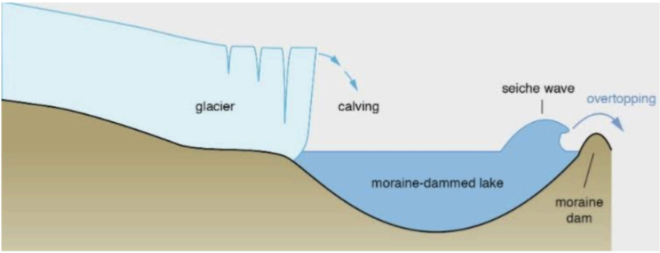
2. Agumenting Natural Buffers for Water Storage
   Eg. **Tianjin Eco-City in China** incorporates wetlands
3. Green Infrastructure
   Eg. **Singapore's Marina Barrage** features an urban forest prevents downstram floods
4. Improved Drainage System
   Eg. **Sponge City in Wuhan** involves upgrading drainage networks and using sensors to monitor water levels in real time
5. Improved water table
   Eg. **Permeable pavements of Melbourne** reduced surface runoffs
6. Floodplain Management
   Eg. **Thames Barrier** in London prevents inundation
7. Climate Resilience: Sponge cities are more resilient against increased rainfall due to climate change
   Eg. **Copenhagen** has adopted a sponge city approach to address rising sea levels and heavy rainfall, incorporating green roofs and permeable surfaces.

GLOF

According to satellite data, Glacial Lake Outburst Flood caused or exacerbated Sikkim floods in 2023.

GLOFs occur when lakes formed by melting glaciers suddenly burst open.


Moraine (sediment by glaciers)
Glacial lake / Moraine dammed lake



Data:

1. According to study published in Nature,

90 million people live in basins containing Glacial Lakes

2. NRSC's Glacial Lake Atlas of 2023 shows that Indus, Ganga and Brahmaputra are home to 28000 glacial lakes
3. Indian subcontinent (Himalayas) - Third Pole of Earth - 15000 glaciers and 12000 km3 water

Threat to nearly 10 percent of the world’s population, located in India, Pakistan, China & Peru.

Previous occurences:

1. 1929 - Indus flooding Chong Khumdan Glacier in Pakistan
2. 1941 - Peru
3. 1985 - Dig Cho glacial lake outburst in Nepal
4. 2013 - Kedarnath Flood

Causes:

Natural:

1. Glacial melting - end of ice age
- 8 bn tonnes of ice getting lost every year

- Galaciers are thinning at 1 m per year (The Global Climate 2011-2020 report by WMO)

2. Erosion
   - Unconsolidated rock materials
3. Avalanche
   Eg. Of heavy rocks or snow
4. Earthquake
   Eg. Cryoseism
5. Volcanic eruptions
   Eg. Glaciovolcanoes of Iceland
6. Extreme cloud burst or snowfall
   Eg. Lhonak Lake Sikkim

Anthropogenic:

1. Increased melting of glaciers (Permafrost thawing)
   Eg. Due to global warming
   According to MoES, Himalayan region experienced **1.3°C rise in T since 1950**

- Increase in no. of glacial lakes
- Increase in water content in lakes
- Unconsolidated lake walls
  Eg. Made up of moraine

Solutions:

Pre-disaster:

1. Hazard potential mapping
   Regions with a tectonic activity, landslide potential and GLOFs to be identified
   Eg. **NDMA's national guidelines 2020** provides States with hazard risks zonation
2. Conduct Hydrodynamic Assessment of high risk lakes
   Eg. Use of **digital elevation models** by **Central Water Commission**
3. Moniter spatial changes
   Assessment of lake’s volume, moraine stability and potential displacements
   Eg. **Glacial Lake Atlas of 2023** - NRSC's atlas provide high resolution data
4. Early warning system
   Eg. Developed by Peru after 1941 GLOF
5. Draining of increasingly filling glacial lakes
   Eg. Done by Nepal
6. Constructing spillways - for lakes to drain without breaching
   Eg. Peru Model
7. Construction of catchment dams
   To cut speeed of outflow

8. Awareness generation and traning of locals
   Eg. Mock drills

During Disaster

1. Technology aided rescue operation
   Eg. Use of drones
2. Ariel survey to map victims
3. Resource mobilization

Post Disaster:

1. Philanthropy and counselling
2. Prevent encroachment on river beds
   Eg. Studies showed vurnerabliliy of constructions on Teesata river bed
3. Building codes and land management
4. Reduce intensive dam construction in Himalayan ecosystem
   Eg. Chungtham dam breach intensified GLOF
   Ravi Chopra Committee reccomended halting of 23/24 ongoing dam construction in Himalaya
5. Proper EIA & SIA
6. Awareness generation

Wayforward:

- Hazard Risk Vurnerablliliy Assessment
- Multi-hazard alert and warning system
  for the Himalayan region - Reccomended by Parliamentary Standing Committee on Water Resources
  (real time coordinated monitering mechanism for cloudburst, landslide, avalanche, GLOF, earthquake etc. in the region)
- Multistakeholder approach involving glaciologists, disasterologists, meteorologist, disaster response team, community, state
- **Specialised Disaster Response Force**
  for hilly region
  Eg. Odisha Model in handling cyclones
- **Build Back Better** as per Sendai Framework
- **PM's 10 point strategy for DRR**