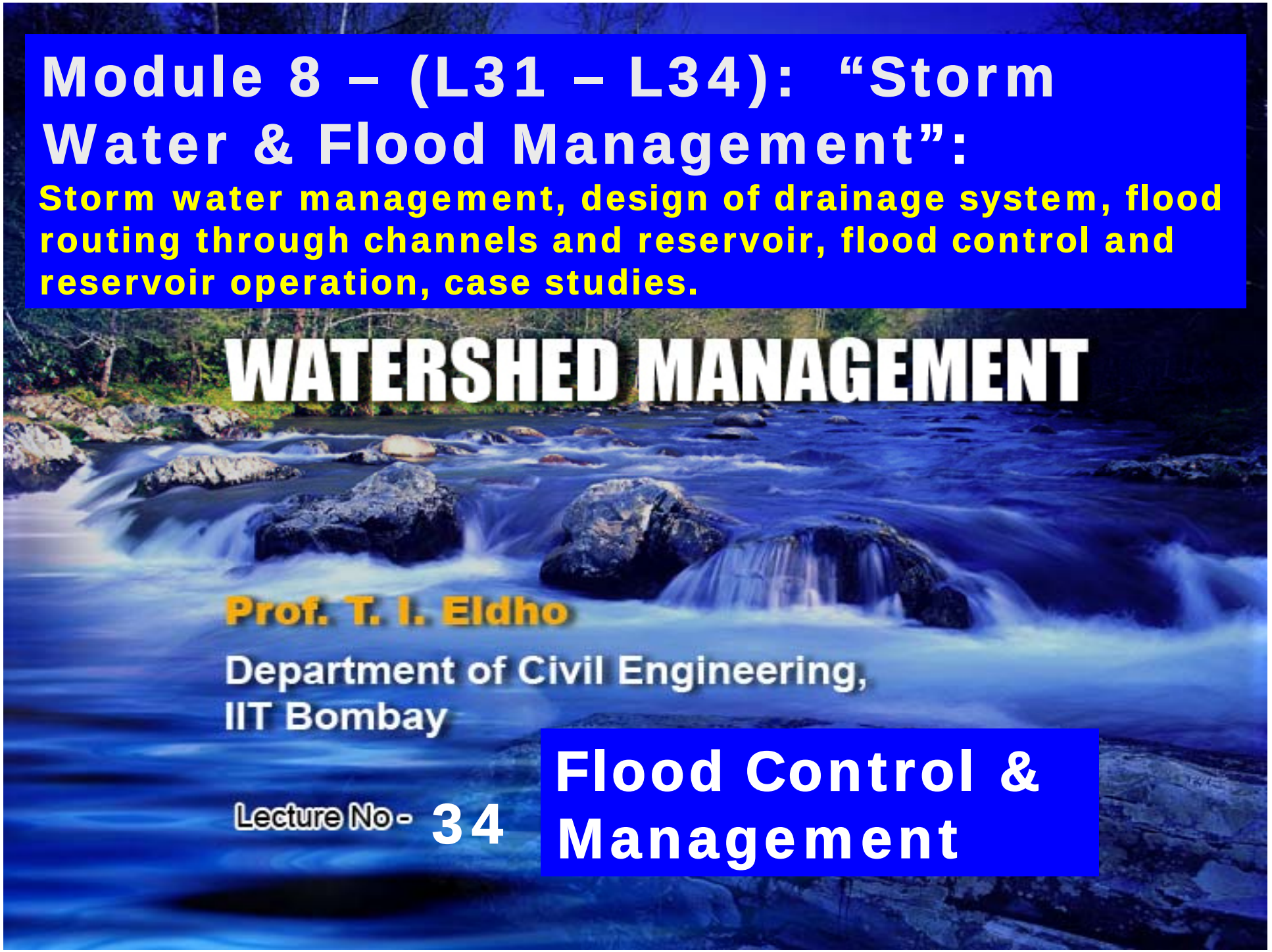
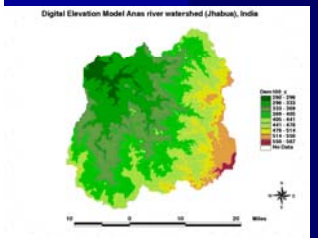
Module 8 – (L31 – L34): "Storm Water & Flood Management":

Storm water management, design of drainage system, flood routing through channels and reservoir, flood control and reservoir operation, case studies.



L34– Flood Control & Management

- **Topics Covered**
- Floods, Causes, Flood damages, Flood forecasting & warning, Flood control, Reservoir operation, Flood Management
- Keywords: Flooding, flood control, flood Management.



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Flooding Problems

- Floods affect lives of more than 65 million people per year
- More than any other type of disaster, including war, drought and famine
- In East & Southeast Asia, during the monsoon season, rivers swell to over 10 times the dry season flow
- About 13% (of 45,000) of all large dams in the world – in more than 75 countries – have a flood management function
- Flood Damage:
- Injuries and loss of life; Social disruption; Income loss
- Emergency costs; Physical damage
  - Structures, utilities, autos, crops, etc.
- Lost value of public agency services
  - Police & fire protection, hospitals, etc.
- Tax loss: Property and sales

Causes of Floods

- **A Flood** can occur when a river exceeds its bank full stage and water will subsequently inundate the adjacent surrounding area.
- ***Heavy rainfall*** - long periods of heavy rainfall will lead to an increase in surface runoff and increase in river level.
- ***Snow melt*** - water in storage is often freed by Spring melts increasing surface runoff.
- ***Deforestation*** - cutting down of trees leads to a reduction in interception rates and an increase in surface runoff. This may also lead to rapid erosion rates due to a lack of stability in the soil subsurface.

Causes of Floods

- ***Urbanization*** - tarmac and concrete surfaces are impermeable and lead to an increase in surface runoff.
- After urbanization the lag time is shortened, peak flow is greatly increased, and total run-off is compressed into a shorter time interval – favourable conditions for intense flooding.
- For example, in a city that is totally served by storm drains and where 60% of the land surface is covered by roads and buildings, floods are almost six times more numerous than before urbanization

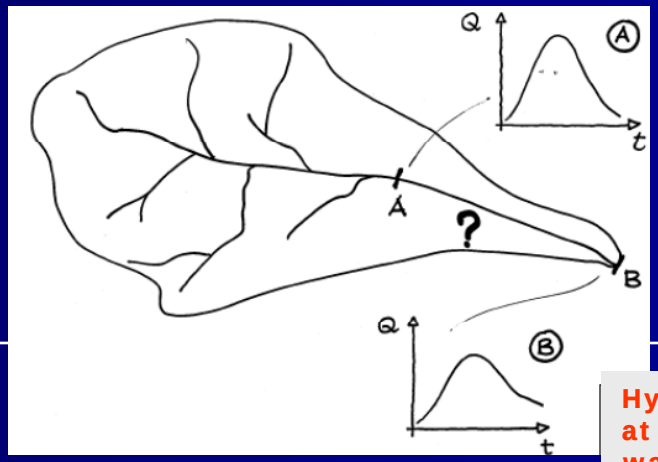
Causes of Floods

Heavy rainfall?

Snow melt?

Rivers are more liable to flood? – besides these?

Urbanisation

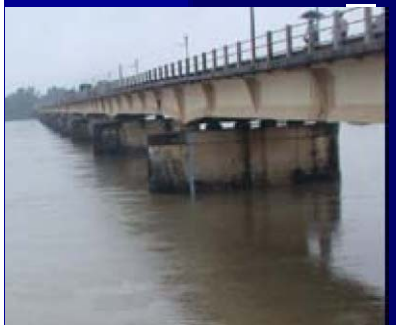


De-forestation

Hydrograph at outlet of watershed

Results of Flooding

- Flooding greatly increases the river's energy so it can do more work. The deeper and faster flowing river can carry more load
- Most rivers turn brown because of the large amount of sediment carried in suspension.
- The amount of erosion carried out by hydraulic action and abrasion is greatly increased.
- How does this happen?
- In the lowlands many features are formed during flooding:
  - Levees
  - Flood plain deposition
  - Ox-bow lakes



Flood Damages

- **Short term**
- Loss of life
- Destruction of property
- Crop damage
- Loss of communication
- Fresh water pollution
- Loss of power
- **Long term**
- Replacing what is lost or damaged
- Governments have the funds to rebuild the infrastructure- e.g. roads, water treatment etc
- Crop destruction can lead to famine

Flood Forecasting

- **Flood forecasting** - use of real-time precipitation and stream flow data in rainfall-runoff & stream flow routing models to forecast flow rates and water levels for periods ranging from a few hours to days ahead, depending on the size of the watershed or river basin.
- Flood forecasting can also make use of forecasts of precipitation to extend the lead-time available.
- Forecasting system may account for:
- snowmelt;
- flood plains and washlands;
- flood defenses, including control-gates etc.;
- tidal effects near the sea, and sea-surges.

Flood Forecasting & Warning

- Flood forecasting through range of hydrodynamic/ snowmelt / flood routing models.
- Flood forecasting is an important component of flood warning,
- Distinction between the two is that the outcome of flood forecasting is a set of forecast time-profiles of channel flows or river levels at various locations,
- "Flood warning" is the task of making use of these forecasts to make decisions about whether warnings of floods should be issued to the general public or whether previous warnings should be rescinded or retracted.

Flood Control Measures

- Flood control measures – Structural & nonstructural
- Structural measures:
  - Levees: embankment constructed parallel to the course of stream to prevent inundation of large areas – Design consideration: location, slope stability, seepage, interior drainage, top width & free board, erosion & scour protection
  - Groins: dikes extending from the bank of river – protect bank against erosion
  - Cutoffs –artificial excavated cutoffs to straighten channel
  - Flood Bypass – divert a portion of flood flow

Flood Control Measures

- Structural measures:
  - Channelization –clearance, straightening, widening, deepening & lining
  - Bridge modification – removal, replacement, widening, raising
  - Flood proofing – floodplain or flood hazard zones – by ring levees or flood wall
  - Detention basins – small impoundments designed to temporarily store storm runoff & release gradually.

Flood Control Measures

- Non-Structural measures:
- Establishment of regulatory floodplains
- Storm water regulations
- Flood zones
- Watershed management plans
- Flood emergency planning
- Relocation of flood prone units
- Flood insurance – based on flood risk zones
- Flood forecasting & warning.

Flood Control Management

- There are a number of ways managing floods:
- 1. ***Afforestation*** - planting trees increases interception rates and reduces surface runoff.
- 2. ***Dams and Reservoirs*** - these hold back and regulate the flow of river water. Can be used as fresh water supply and generation of HEP.
- 3. ***Diversion Channels and basin*** - overflow channels which take surplus water out of a river in times of flood.
- 4. ***Channel Straitening and Dredging*** - smoothens the channel to increase the speed (velocity) of the river and get water out of the drainage basin as quickly as possible.

Flood Control Management

- ***5. Artificial Levees*** - makes river banks higher therefore holding more water.
- 6***. Culverts*** - semi circular, smooth channels increase velocity and gets water away from urban areas as quickly as possible.
- 7. ***Revetments, Channel Walls, gabions*** - strengthen river banks from erosion using large lumps of stone – see over
- ***8. Restricted use of flood-plains*** - legislation, higher selective insurance premiums/refusal to insure particular locations.
- ***9.Co-ordinated flood warning*** and emergence reaction procedures e.g. Environment Agency Flood watch

Flood Control & Reservoir Operation

- Dams & Reservoirs have helped immensely in attaining self sufficiency in food grain production besides flood control and drought mitigation.
- Flow depth in rivers – depends on reservoir releases
- A reservoir is a depository for the storage of water, up to a maximum level.
- Since spilling water implies passage through a critical hydraulic section, a dynamic storage volume can be filled up only during spills.
- Operational pool - volume between the minimum level at which controlled releases can be made & maximum static full pool.

Flood Control & Reservoir Operation

- Operational pool is conceptually divided into conservation and flood control pools.
- Maximum possible empty space is desirable for flood control, while water storage is required for the remaining objectives of water supply, irrigation, hydropower, etc.
- Since flood risk differs according to the season, the flood control pool typically varies according to the time of the year.
- Single reservoir – controlled operation
- Flood control through system of reservoirs -A cascade of Reservoirs is more effective in terms of peak delay than the equivalent storage capacity combined in one reservoir

Flood Reservoir Management

- Flood control management approach - consider the flood pool as a restriction for the optimization or simulation of the conservation pool.
- Operation under flood conditions can be performed through a previously set rule curve or within a real time framework.
- The second approach uses as much real time information as possible from the whole system, as well as its near future.
- Decision system is closely related to the real time operational forecasting and warning availability.
- Real time flood management
- Sediment related problem

Flood Control vs. Flood Risk Management

- Floods have occurred throughout time, and are not necessarily damaging
- Early legislation authorized **"flood control"** in response to devastating losses
- We can't really ***control*** floods, but we can modify water flows in space and time
- Corps' mission is to assist with and provide leadership in managing flood risk; this includes making Govt. investments for ***reducing damages*** from floods
- "A complete description of a plan includes all structural, nonstructural, legal, and institutional features, both proposed & existing, that contribute to intended flood control outputs."

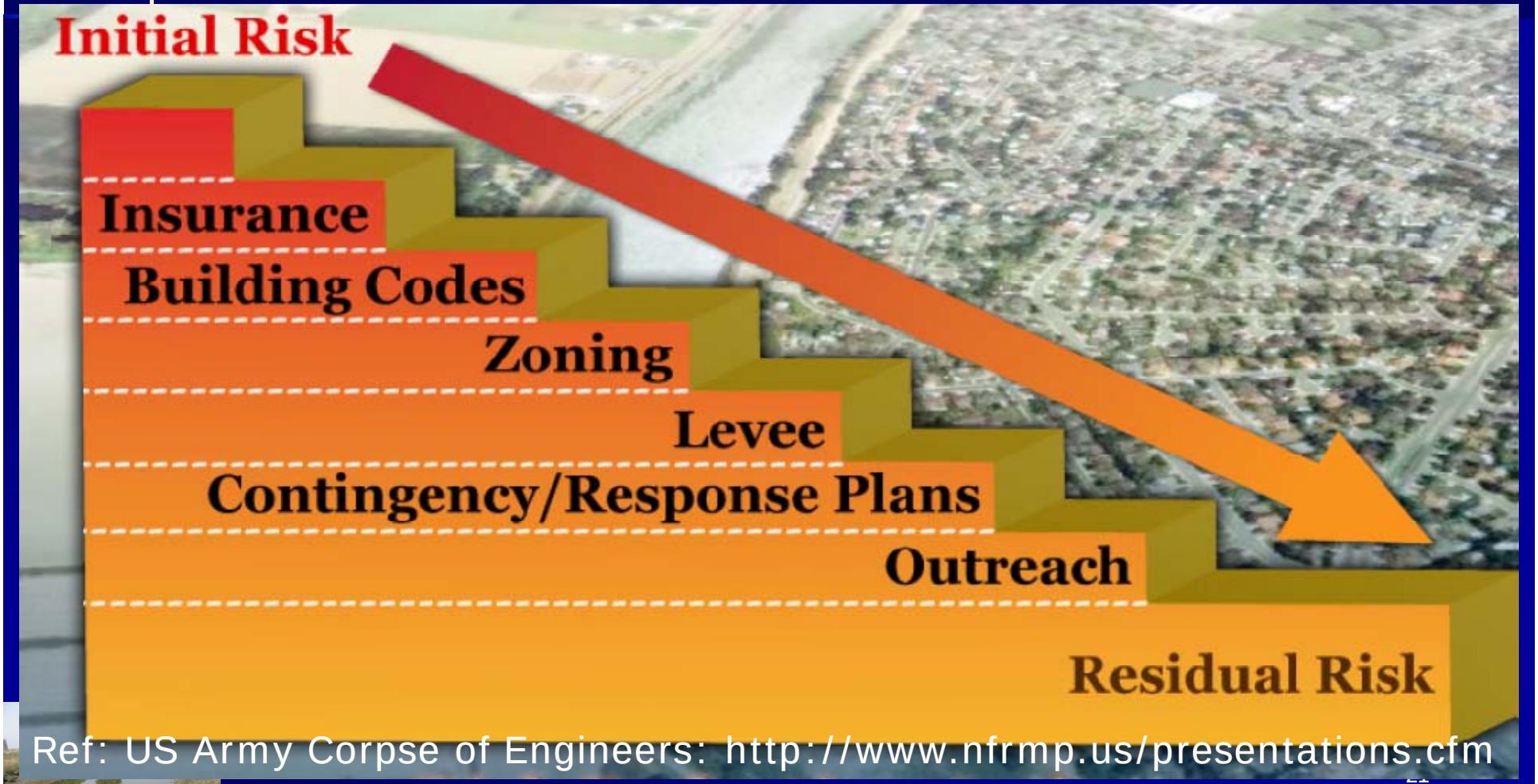
Reservoir in main channel

Flood Risk Management

Strategic Goals

1. Provide current accurate floodplain information to the public and decision makers.
2. Identify and assess flood hazards posed by aging flood damage reduction infrastructure.
3. Improve public awareness and comprehension of flood risk.
4. Integrate flood damage and flood hazard reduction programs across local, state, and Federal agencies.
5. Improve capabilities to collaboratively deliver and sustain flood damage reduction and flood hazard mitigation services to the nation.

Risk Reduction Actions



Ref: US Army Corpse of Engineers: http://www.nfrmp.us/presentations.cfm

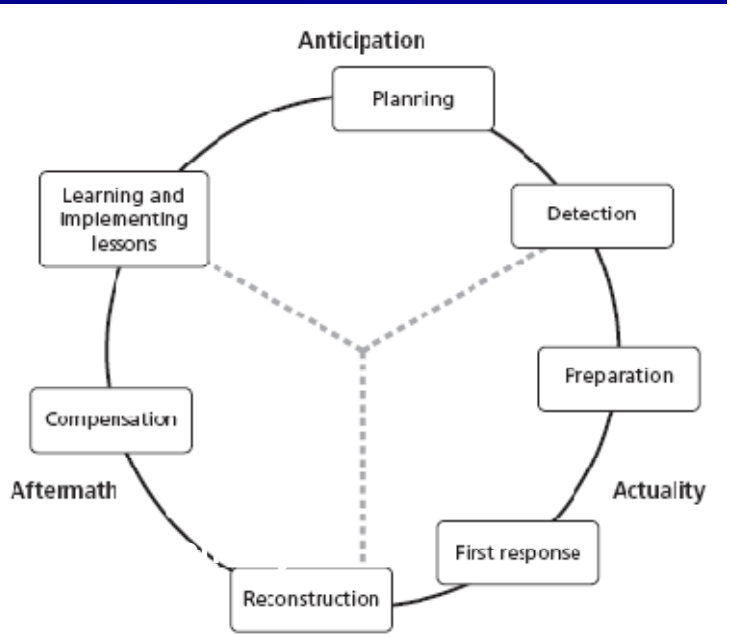
Flood Problem - Uncertainty

- In flood damage-reduction planning, uncertainties include
  - Future hydrologic events: stream flow and rainfall
    - choice of distribution and values of parameters
  - Simplified models of complex hydraulic phenomena
    - geometric data, misalignment of structure, material variability, and slope and roughness factors
  - Relationship between depth & inundation damage
    - structure values and locations, how the public will respond to a flood
  - Structural and geotechnical performance when subjected to floods

Flood Problem & Restoration

- **Planning-** Before event threatens
- **Detection-** ongoing information-gathering system- provide warning to monitor prevention & mitigation systems.
- **Preparation-** Communication, needed resources, evacuation etc
- **First response-** Once the event has occurred, the negative consequences can be minimized - appropriate action to save lives; provide food, shelter, & clothing to survivors.
- **Reconstruction-** rebuilding - restoration.

http://www.nfrmp.us



Floods in India

- Floods occur in almost all rivers basins of India.
- Heavy rainfall, inadequate capacity of rivers to carry the high flood discharge, inadequate drainage to carry away the rainwater quickly to Streams/ Rivers are the main causes of floods.
- Ice jams or land slides blocking streams; typhoons and cyclones also cause floods.
- Excessive rainfall combined with inadequate carrying capacity of streams resulting in over spilling of banks is the cause for flooding in majority of cases.

Floods in India

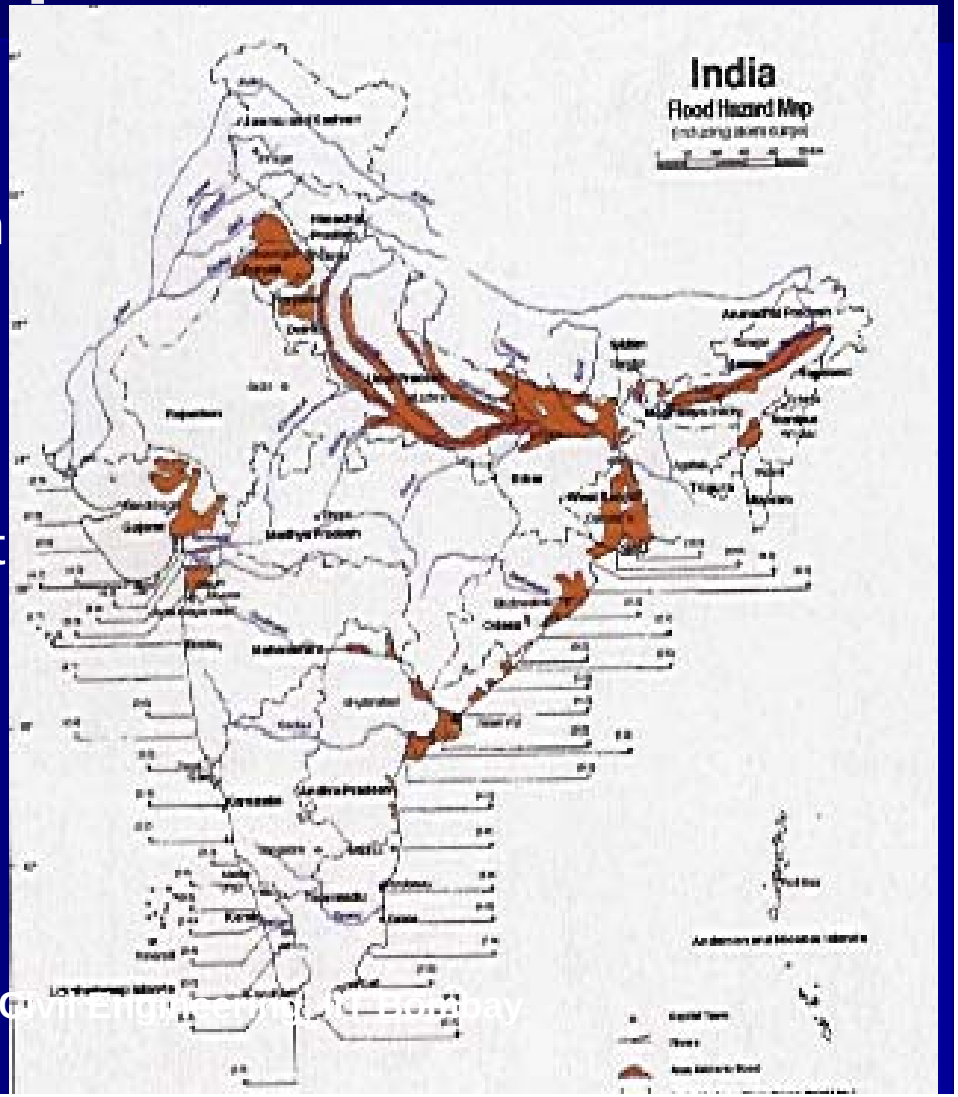
- MOWR has assessed the area liable to floods as 35 million hectares State Area liable to Floods

State	Area liable to Floods (million Ha.)
1. Andhra Pradesh	1.39
2. Assam	3.15
3. Bihar	4.26
4. Gujarat	1.39
5. Haryana	2.35
6. Himachal Pradesh	0.23
7. Jammu & Kashmir	0.08
8. Karnataka	0.02
9.Kerala	0.87
10. Madhya Pradesh	0.26
11. Maharashtra	0.23
12. Manipur	0.08
13. Meghalaya	0.02
14. Orissa	1.40
15. Punjab	3.70
16. Rajasthan	3.26
17. Tamil Nadu	0.45
18. Tripura	0.33
19. Uttar Pradesh	7.336
20. West Bengal	2.65
21. Delhi	0.05
22. Pondichery	0.01
Total	33.516

Flood Hazard Map of India

- Floods being a natural phenomena, total elimination or control - not possible nor economically viable.
- Flood management aims at providing reasonable protection against damage at reasonable economic costs.

http://www.mowr.nic.in



Flood Hazards in India

- In India, systematic planning for flood management commenced with the launching of National Programme of Flood Management in 1954.
- During the last 58 years, different methods of flood protection structural as well as non-structural have been adopted in different states.
- Structural measures- storage reservoirs, flood embankments, drainage channels, anti-erosion works, channel improvement works, detention basins etc.
- Non-structural measures - flood forecasting, flood plain zoning, flood proofing, disaster preparedness etc.

Flood Hazards in India

- Various flood management measures undertaken:
- 1. Flood embankments 34397.61 km
- 2. Drainage channels 51317.50 km
- 3. Towns protection works 2400 Nos.
- 4. Villages raised 4721 Nos.
- Reservoirs constructed with exclusive flood control storage - Maithon, Panchet, Tilaiya & Konar in Damodar Valley; Chandil dam on Subarnarekha river, Rengali dam on Brahmani river etc.
- A live storage of 177 billion cubic meter created so far in the various reservoirs for irrigation, hydropower generation, drinking water etc. - help in reducing flood intensity by storing part of the flood waters in them.

Flood Hazards in India

- The flood management measures undertaken so far has provided reasonable degree of protection to an area of 16.5 million hectares through out the country.

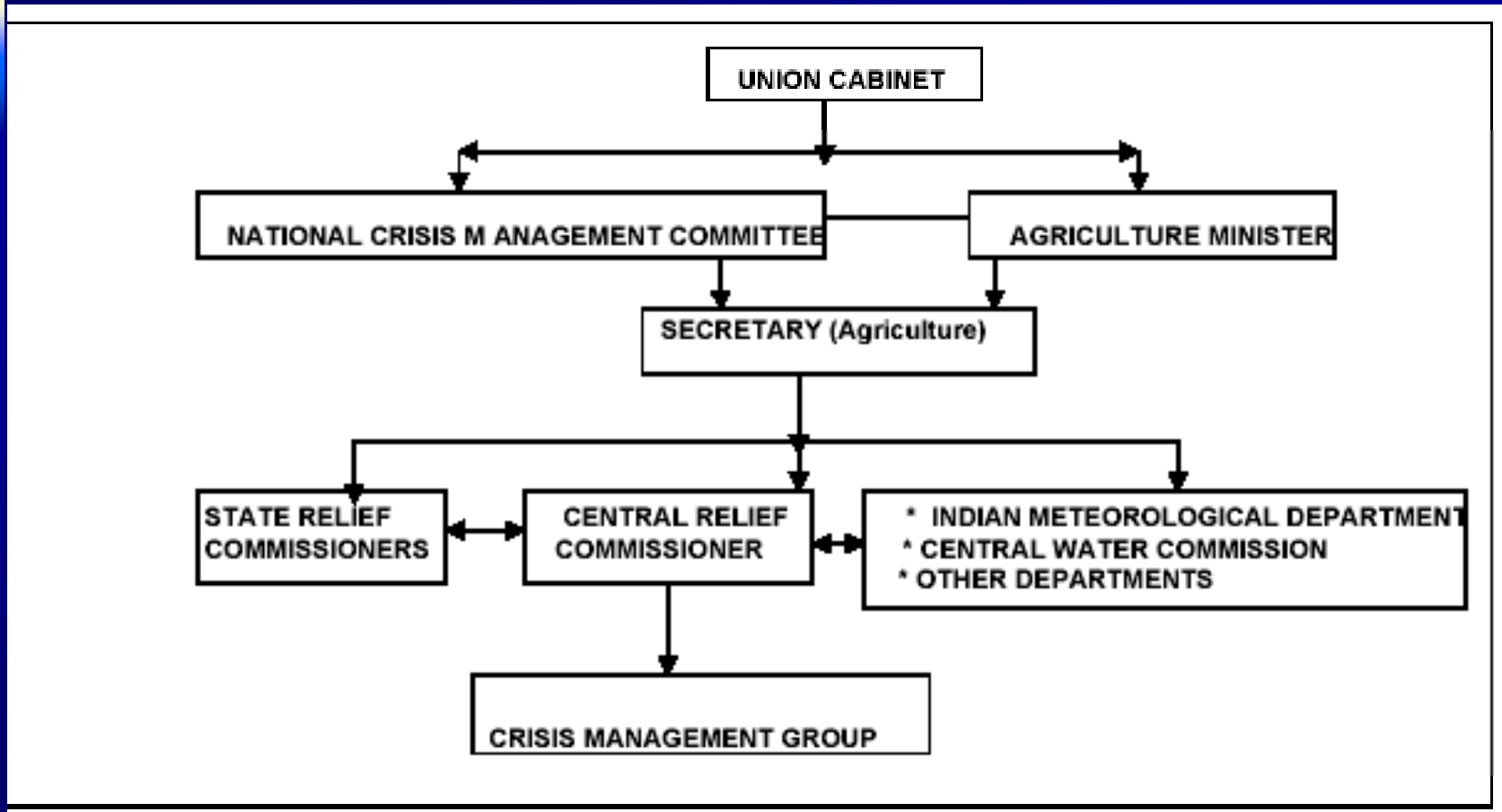
Area benefited (m.ha)	Length of embankment (Km)	Length of drainage channel (Km)	Town/ village protected (Nos.)	Villages on raised/ protected (Nos.)
16.4557	34397.61	51317.51	2400	4721

http://wrmin.nic.in/

Flood Forecasting Network in India

- Flood forecasting has been recognized as one of the most important, reliable and cost-effective non-structural measures for flood management.
- Recognizing the crucial role it can play, Central Water Commission, Ministry of Water Resources has set up a network of forecasting stations covering all important flood prone interstate rivers.
- The forecasts issued by these stations are used to alert the Public and to enable the administrative and engineering agencies of the States/UT's to take appropriate measures.
- Coordination with ISRO, IMD & Tele-networks

National response mechanism



Example: AP cyclone hazard mitigation project outcomes

- Hazard mitigation studies (international consultants)
- IMD early warning capacity through Doppler radar
- Infrastructure creation and restoration
  - Floods – drains & embankments
  - Road restoration
  - Storm shelters
  - Electricity transmission and distribution
- What about system / process capabilities?

Concluding Remarks

- Recognition of linkage between natural hazards and development
- Connecting developmental programs to disaster management
- Forecasting and warning (technology use)
- Contingency planning
  - Food grains availability
  - Preparedness
- Adaptive capacity by creating a management *system*
- However, focus still on relief; recovery and adaptive capacity not thought through

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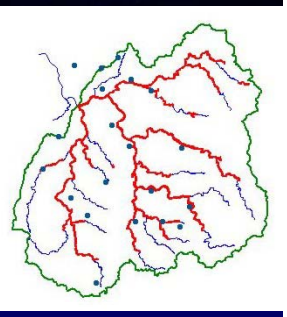
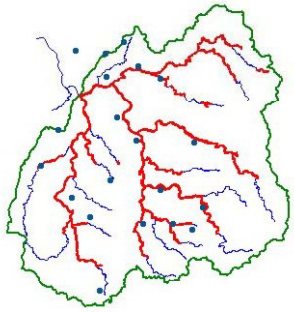


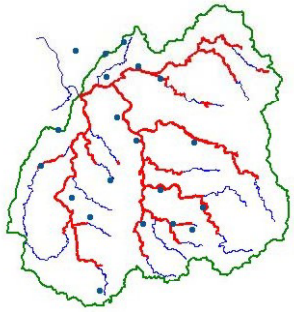
Tutorials - Question!.?.

- Critically Study the flooding problems in India (www.wrmin.nic.in)
- What are the measures taken by Govt. to reduce flood impacts?.
- How we can have better flood control measures on watershed/ river basin scale?.



Self Evaluation - Questions!.

- Describe flood and related problems.
- Illustrate short term and long term flood damages.
- Discuss various flood control measures. Differentiate between structural & non-structural measures.
- Illustrate flood control and reservoir operations.



Assignment- Questions?.

- What are the important causes of floods?.
- Discuss flood forecasting and warning.
- What are the important ways of flood control management?.
- Discuss the flood risk management & related issues?.

THANK YOU

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