URBAN FLOODING: CAUSES, CONSEQUENCES AND LESSON LEARNT

Dr. L N Thakural
Scientist
National Institute of Hydrology
Roorkee

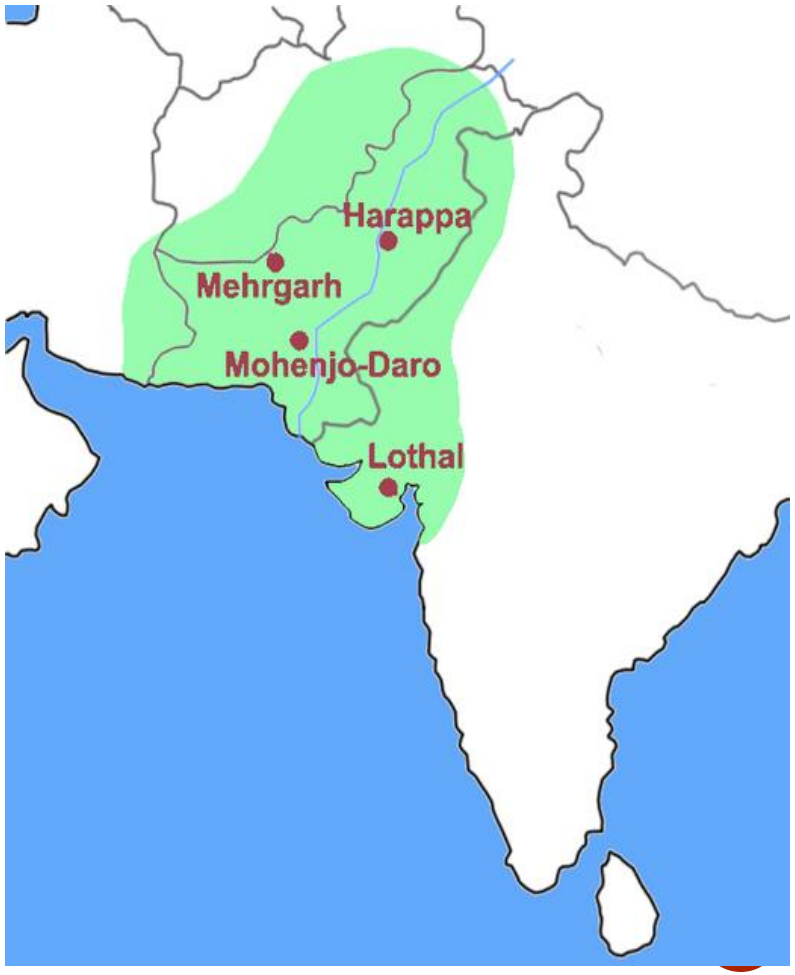
STORM WATER MANAGEMENT & URBAN FLOODING & ITS MITIGATION STRATEGIES
2-3 NOVEMBER,2020

OUTLINE

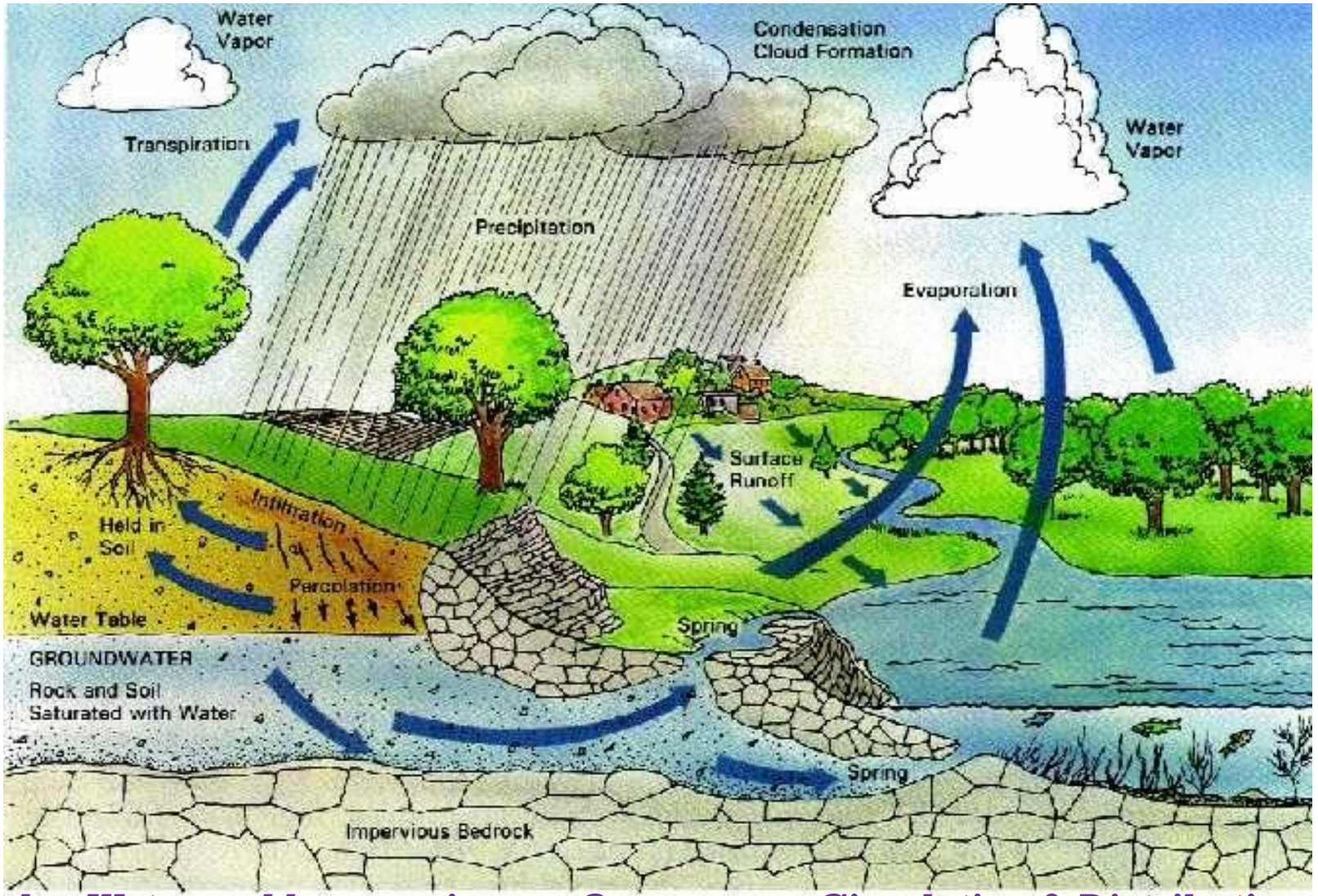
- Introduction
- Causes of floods
- Consequences of flood
- Case Studies
- Mitigation of flood
- Role of Remote Sensing and GIS

WATER

- Five great elements", of Hinduism- Earth, Water, Fire, Wind, space
- Major Human Civilization settlement
- Important both for biotic and abiotic



HYDROLOGICAL CYCLE



Hydro: Water and logos: science - Occurrence, Circulation & Distribution

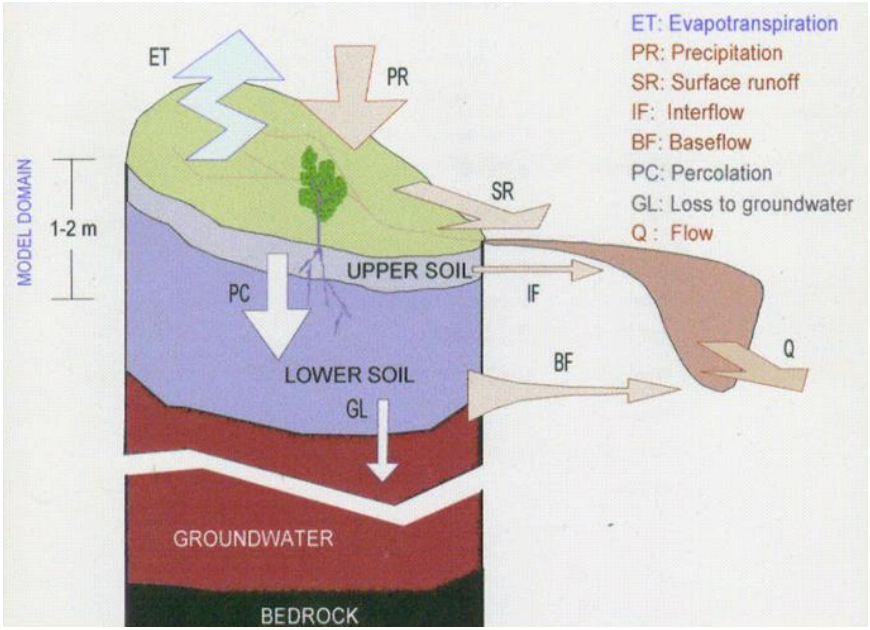
Two aspects-

Scientific and Engineering

HYDROLOGICAL CYCLE

The hydrological cycle is composed of a number of processes including

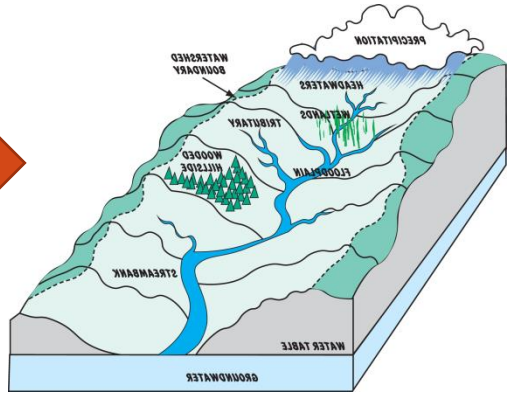
- ✓ Evapotranspiration
- ✓ Condensation and Cloud formation
- ✓ Precipitation
- ✓ Infiltration and Percolation
- ✓ Runoff and stream flow
- ✓ Subsurface interflow



Different applications emphasize different components, based on the domain of interest

Applied Hydrology:

- *Water Resources estimation,*
- *hydrological process,*
- *study flood & drought*

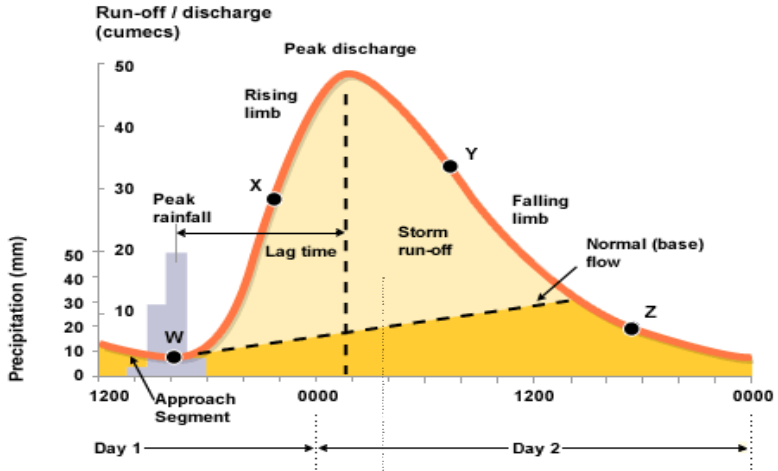


Hydrographs

Graph which shows **river discharge** over a given period of time and show the response of a drainage basin and its river to a period of rainfall.

Hydrograph –

- rainfall (in bars) and discharge (in a line).
- Peak rainfall is the **time** of highest rainfall.
- Peak discharge (the **time** when the river reaches its highest flow) is later because it takes **time** for the water to find its way to the river (**lag time**)



INTENSIFICATION OF HYDROLOGICAL CYCLE: CLIMATE CHANGE

Human alteration:

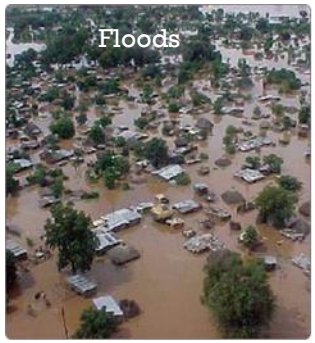
- Artificial rainfall
- Supressed evaporation
- Land use/Land cover change

Indicators of Climate change

- Increase in frequency of flood/flash flood.
- Drought
- Glacial Lake outburst flood (GLOF).
- Glacial retreat.
- Decrease in seasonal snow cover
- Rise in sea level

Major Concerns

- Quantity of Water
- Quality of Water
- Accessibility of Water



Extreme events

- Flood (excess)
- Drought (deficit)

Hazard: Floods

Abnormal progressive rise in the water level of streams or rivers which may result in overflowing.

- Results in flood : a complex interactions between rainfall and surface processes
- Generally, the more the rainfall, the greater the likelihood of flooding
- Amount of runoff generated plays a significant role in the flooding process

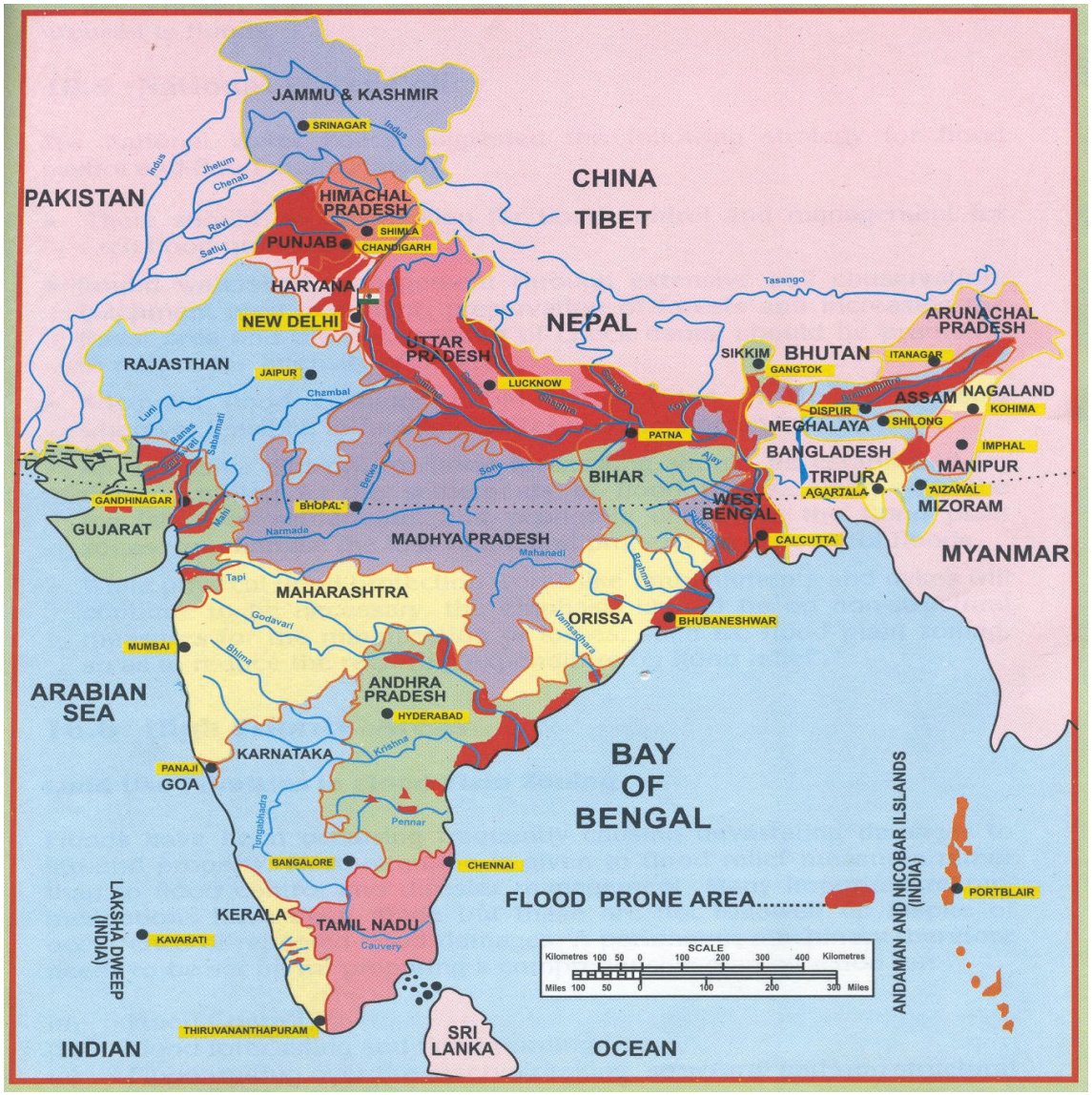





FLOOD PRONE AREA

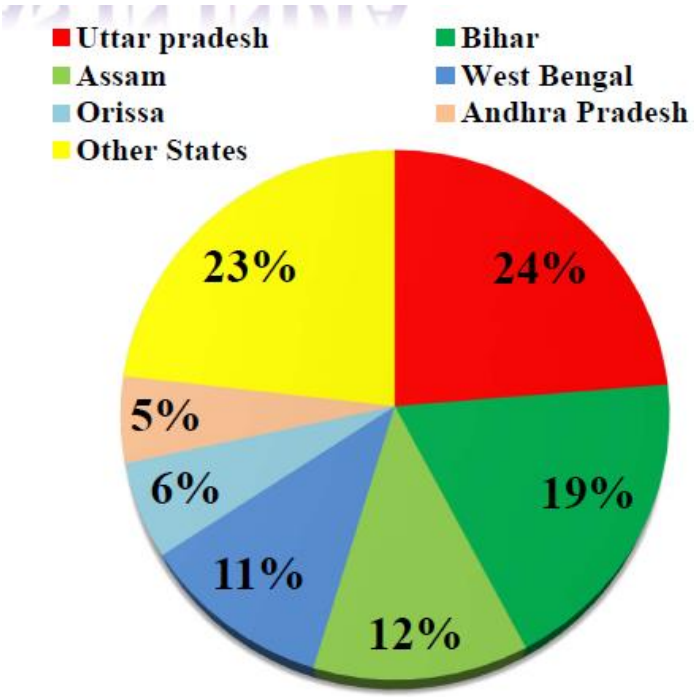
Flood prone Area	40 mha
Area which can be given reasonable protection	32 mha
Area protected prior to 1954	3 mha
Area protected till 2004	15.8 mha

FLOOD PRONE AREA



Four regions

- Brahmaputra & Barak (Meghna) basins;
- Ganga basin
- North West river basin
- Central India and Deccan rivers' basin



Year	Major Flood Events in the History of India Recent Past
1998	Assam has been suffering floods regularly since 1998.
2004	Bihar Flood
2005	Flooding in Maharshtra & Gujarat
2008	Kosi Flood in Bihar
2009	Flooding occurred across many parts of South India in Oct
2010	The Leh floods occurred on 6 August 2010
2012	Brahmaputra Flood
2013	North India floods in Uttarakhand
2014	Jammu & Kashmir Flood

FLOODS - CAUSES

- Heavy rains including cloud burst, cyclones, Tsunami
- Inadequate capacity within banks of a river to contain high flows
- River bank erosion and silting of beds

- Land slides leading to obstruction of flow and change in river course
- Poor natural drainage in an area
- Synchronization of high flows in main river and tributaries

- Retardation of flow due to tidal and backwater effects, resulting in water stagnation and inundation, tsunamis
- Snowmelt and glacial out bursts

TYPES OF FLOODS

- Cloud Burst
- Flash Flood
- GLOF
- Coastal Flood
- Urban Flood

Cloud Burst

A **cloudburst** is an extreme amount of precipitation, sometimes with hail and thunder, which normally lasts no longer than a few minutes but is capable of creating flood conditions. Colloquially, the term cloudburst may be used to describe any sudden heavy, brief, and usually unforecast rainfall.

CLOUD BURSTS

- Sudden heavy rain due to climatic conditions
- Cyclonic circulations in monsoons may lead to cloud burst
- In 2000, coastal dist. Of AP had such situation
- In July 1981, stations around Jaipur recorded 3-day rainfall which was more than annual normal
- Annual rainfall here varies from 550 mm to 700 mm
- In storm, daily RF 250-590 mm, 2-day RF 430-800 mm

Human activities

- Sudden breaches in dams may cause devastating floods
- Machhu-ii failed in 1979 due to over topping, severe damages in Morbi
- Record of India in dam safety has been very good

Cloudburst in Himalayas

July, 1971: Cloudburst in the upper catchment area led to a 15 metre rise in the Alaknanda river in Uttarakhand. Entire river basin, from Hanumanchatti near the pilgrimage town of Badrinath to Haridwar was affected. An entire village was swept away

August 15, 1997, 115 people were killed when a cloud burst came bustling and trail of death are all that is left behind in Chirgaon in Shimla district, Himachal Pradesh.

August 17, 1998: A massive landslide following heavy rain and a cloudburst at Malpa village killed 250 people including 60 Kailash Mansarovar pilgrims in Kali valley of the Kumaon division, Uttarakhand. Among the dead was Odissi dancer Protima Bedi

July 16, 2003, About 40 persons were killed in flash floods caused by a cloudburst at Shilagarh in Gursa area of Kullu, Himachal Pradesh

Cloudburst in Himalayas

July 6, 2004, At least 17 people were killed and 28 injured when three vehicles were swept into the Alaknanda river by heavy landslides triggered by a cloudburst that left nearly 5,000 pilgrims stranded near Badrinath shrine area in Chamoli district, Uttarakhand

August 16, 2007, 52 people were confirmed dead when a severe cloud burst occurred in Bhavi village in Ghanvi, Himachal Pradesh

August 7, 2009, 38 people were killed in a landslide resulting from a cloudburst in Nachni area near Munsiyari in Pithoragarh district of Uttarakhand.

On September 15, 2010: cloud burst in Almora in Uttrakhand has drowned away two villages one of them being Balta, leaving a few people alive and rest entire village dead and drowned. Almora has been declared as a town suffering from the brunt of cloudburst by authorities of Uttrakhand.

Cloudburst in Himalayas

August 18, 2010 : 18 children killed in school roof collapse in Uttarakhand's Bageshwar district

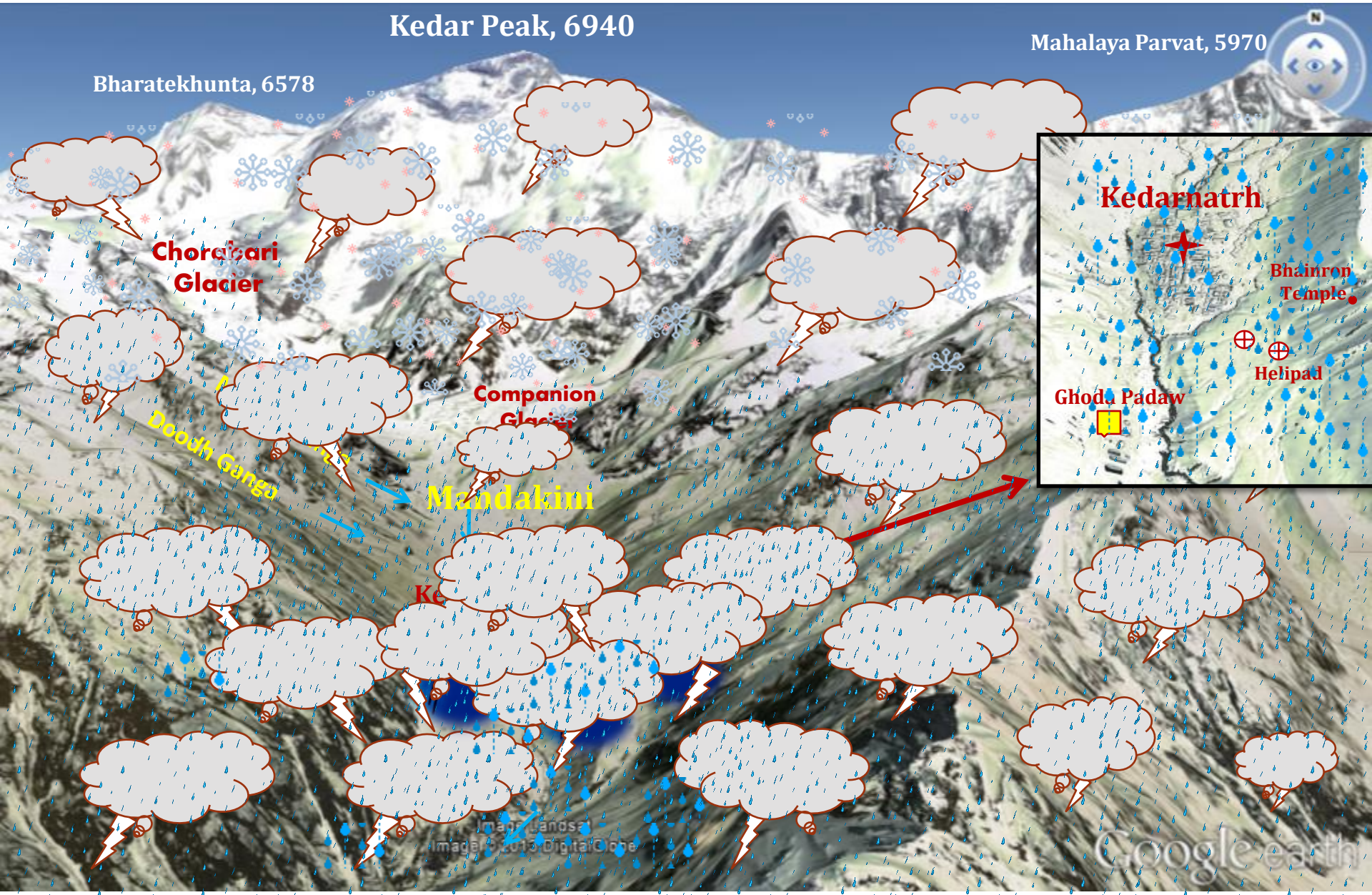
June 9, 2011, near Jammu, a cloudbursts left 4 persons dead and over several injured in Doda-Batote highway, 135 km from Jammu.Two restaurants and many shops were washed away

September 14, 2012: in Rudraprayag distirct there was a cloudburst and 39 people died

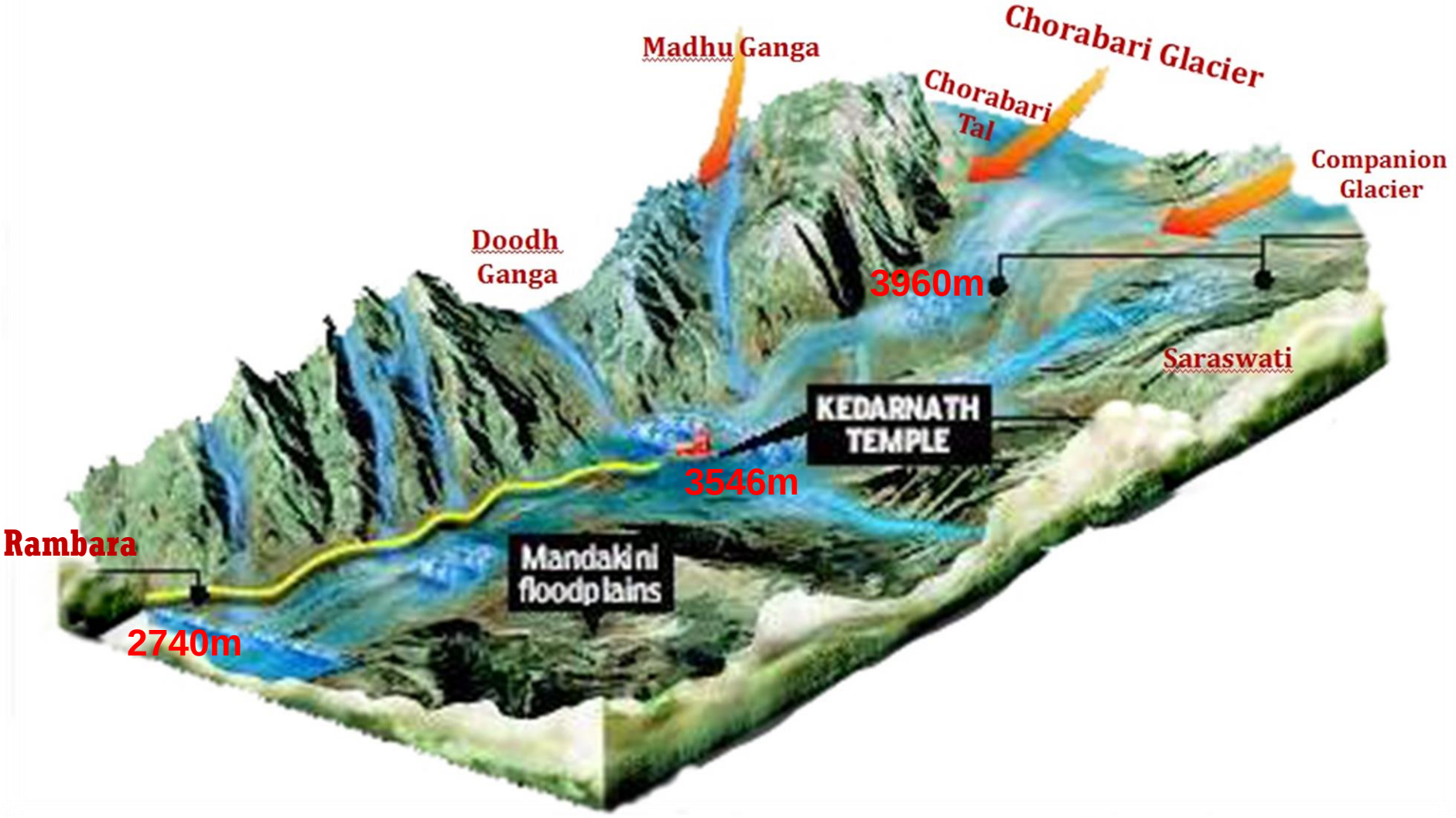
2013:Uttarakhand received 220 mm of rain during the 2013 cloudburst that killed more than 5,000 people.

2016: Pithoragarh and Chamoli, 30 people were killed

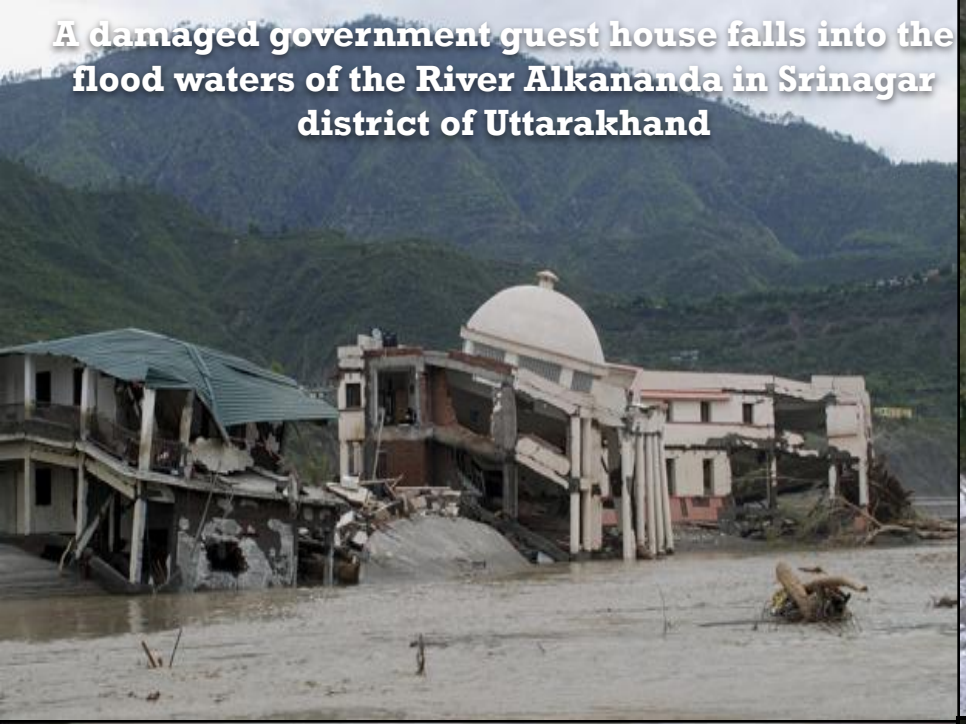
HEAVY RAINFALL 15-16 June 2013



View of Lake Burst Flood in Kedarnath Town



A VIEW OF KEDARNATH AFTER THE CALAMITY

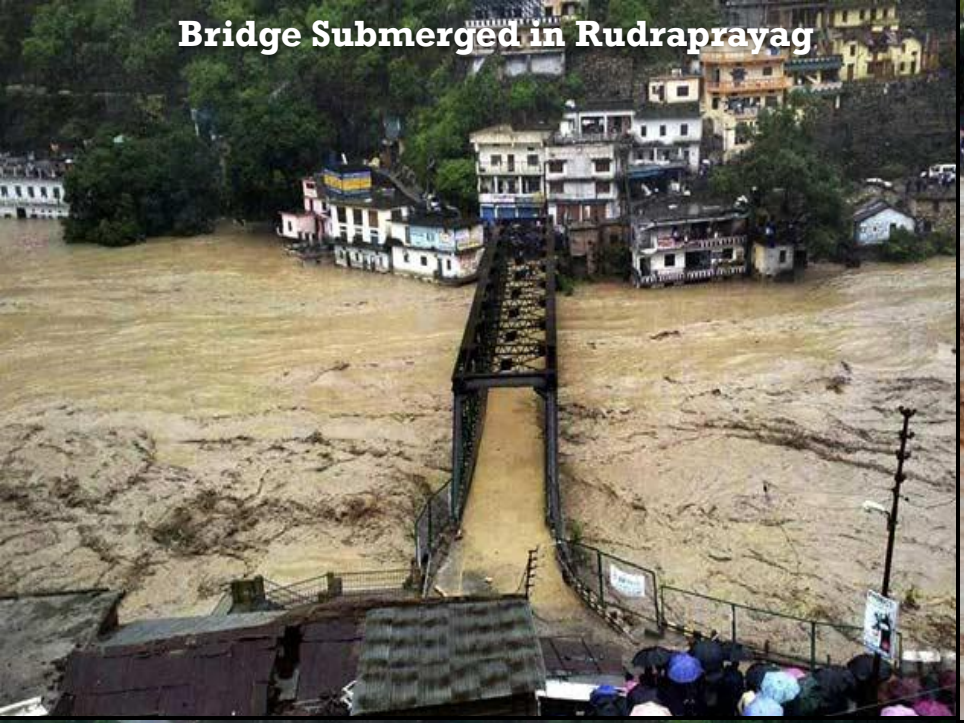


A damaged government guest house falls into the flood waters of the River Alkananda in Srinagar district of Uttarakhand

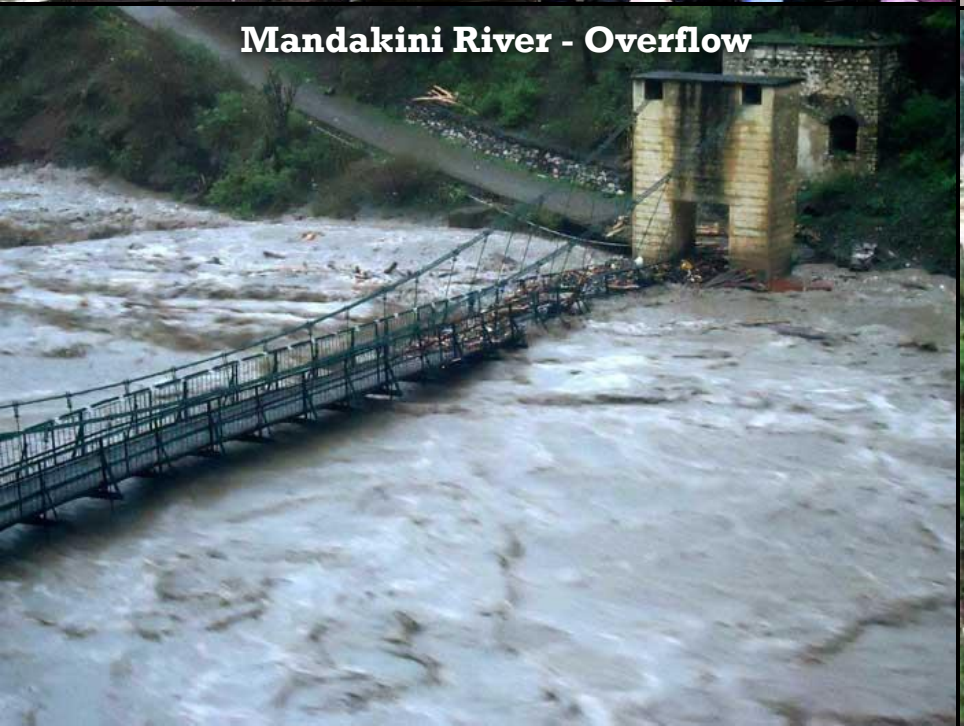
Flood waters flow into a residential complex in Uttarakhand.

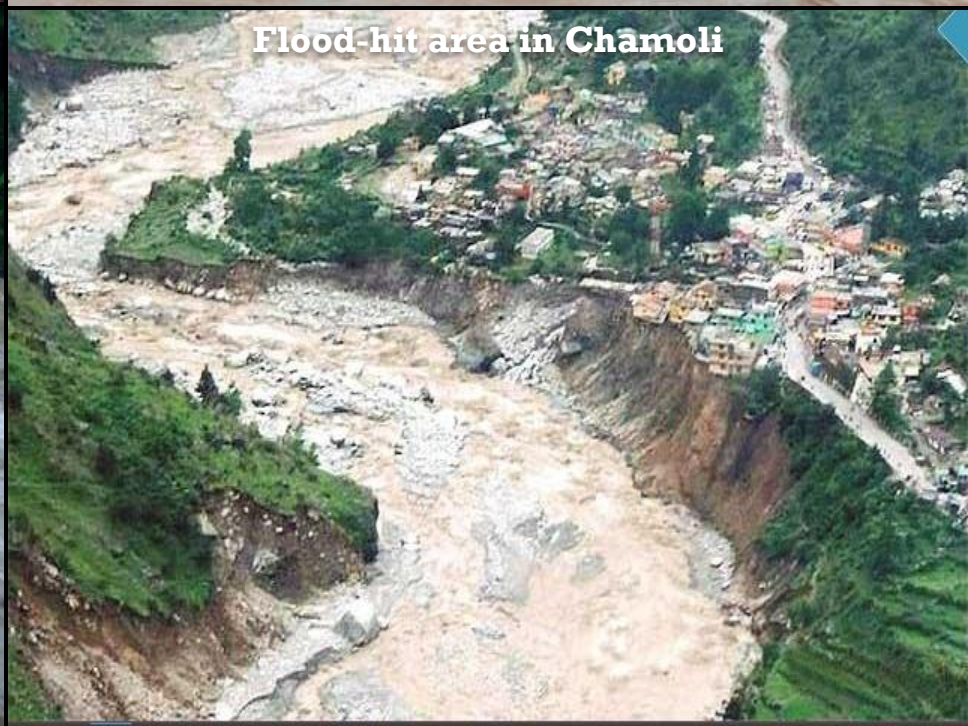
Building Collapse in Srinagar

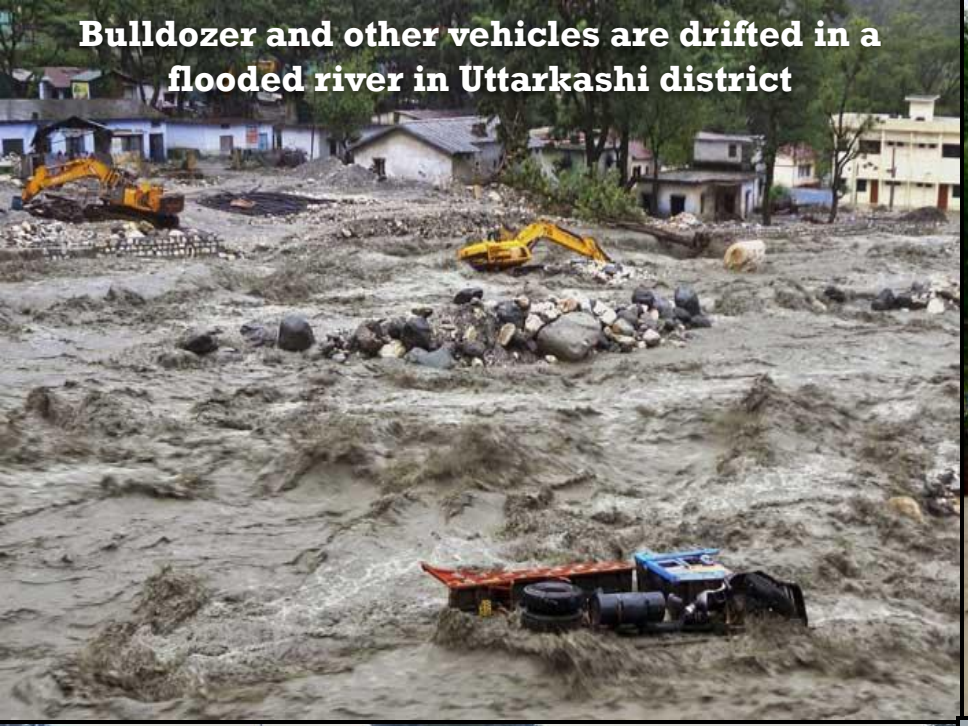
Landslide near Hemkund shahib


Bridge Submerged in Rudraprayag


Ganga flowing above danger mark in Rishikesh


Mandakini River - Overflow

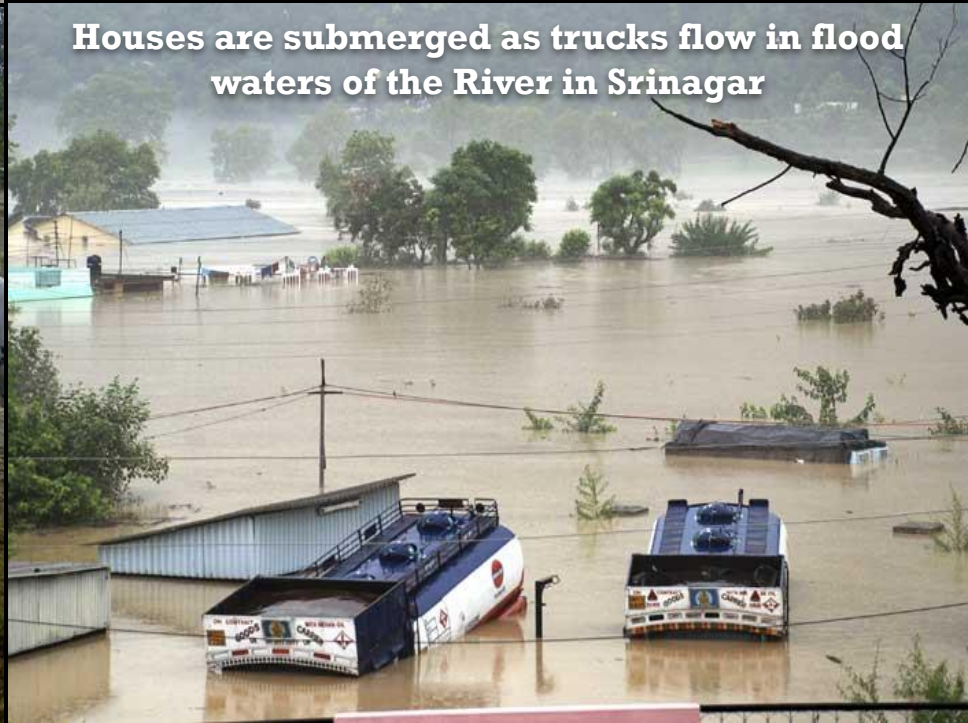

Flood-hit area in Chamoli



Bulldozer and other vehicles are drifted in a flooded river in Uttarkashi district

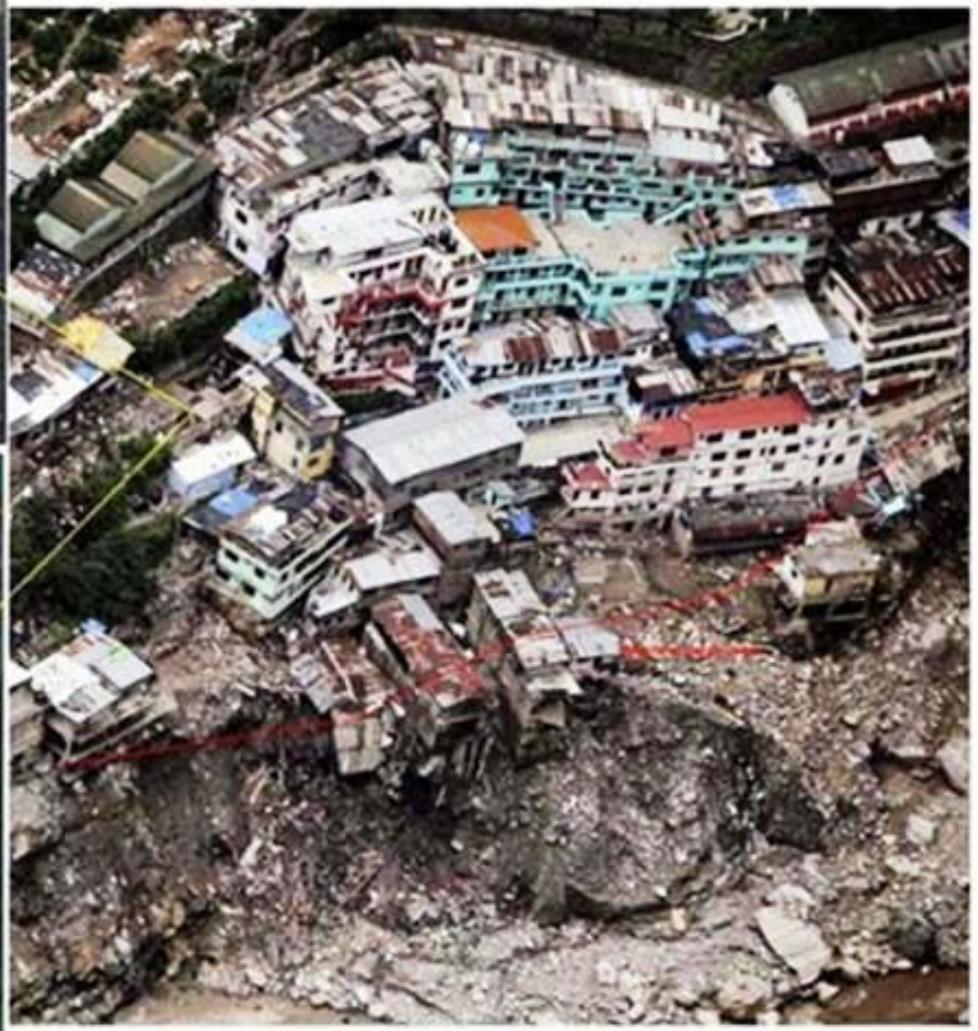
Cars and Buses between the deposited Sediment on the Chamoli-Rishikesh highway

People gather at the site of a road accident on the Hardiwar-Mana national highway



Houses are submerged as trucks flow in flood waters of the River in Srinagar

Post Satellite Image of Gaurikund



Landslide near Hemkund Shahib & Shrinagar

Flood waters flow into a residential complex in Uttarakhand. The massive rains led to landslides and flooding devastating vast swathes of the hill state.

People were forced to vacate their houses in the wake of landslides

Damaged houses are seen at a village in Rudraprayag, in the the worst affected districts in Uttarakhand.

Flood waters from the Alaknanda river destroyed buildings after heavy rainfall in Govindghat town, Uttrakhand on 17th June. More than 150 people had lost their lives due to the flooding but the final count could be much higher.

Ganga River during high floods in Rishikesh

A damaged government guest house falls into the flood waters of the River Alkananda in Srinagar district of Uttarakhand

Building Collapse in Srinagar

Alkananda river in Srinagar

Flooded Mandakini River in Chamoli

Laxman Jhula in Rishikesh

Bridge Submerged in Rudraprayag

Mandakini River - Overflow

Army personnel busy in rescue operations at Pindari glacier

FLASH FLOODS

- Short-term events, occur within minutes or hr
- Very fast rise and recession of water
- High damages because of suddenness

- Occur in hilly regions and sloping lands where heavy RF, thunder storm or cloud burst are common
- States affected include UK, Punjab and HP

Storage reservoirs in areas prone to flash flood can absorb flood wave and protect the area

A flash flood experienced in HP on 31st July and 1st August, 2000

- ***Discharge in Sutlej at Rampur rose from 54,000 to 1,80,000 cusec in 2.5 hrs***
- ***Discharge at Suni d/s of Rampur rose from 64,600 to 215,000 cusec in 2 hours***
- ***Widespread damage to life and property in Kinnour district***

Types and Causes of flash floods

Based on the underlying processes causing flash floods, they can be categorised into three main types:

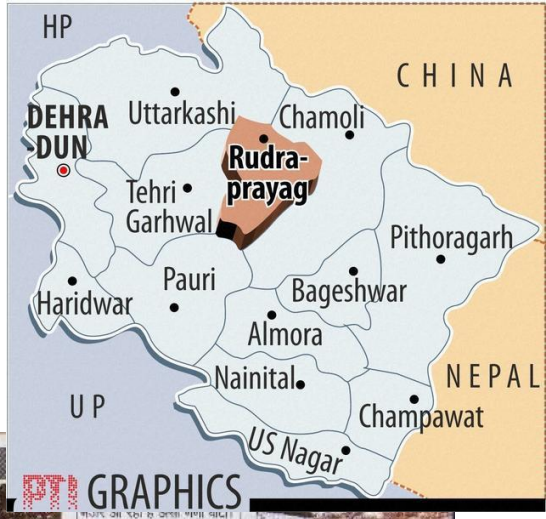
- Intense rainfall floods,
- Landslide dam outburst floods,
- Glacial lake outburst floods. In addition, flash floods
- can also be caused by bursting of artificial structures *(leeve failure, dam break)*

Broadly classified into two main groups

-meteorological (intense precipitation)

-geo-environmental

Flash Floods



असी गंगा घाटी में हालात खौफनाक

अलग-थलग गांवों में पहुंचा इंटर एजेंसी ग्रुप

अमर उजाला ब्यूरो

उत्तरकाशी। असी गंगा घाटी में तबाही की असल तस्वीर भयावह है। इस क्षेत्र में जगह-जगह लोग फंसे हुए हैं। न खाने का अनाज है और न पीने को पानी। जहां पहले घर हुआ करते थे वहां अब बस मलबा ही मलबा है। इस क्षेत्र का सर्वे करके लौटी स्वयंसेवी संगठनों के समूह इंटर एजेंसी ग्रुप की टीम ने ऐसे कई चौंकाने वाले खुलासे किए हैं।

टीम का कहना है कि इस क्षेत्र में प्रशासन का सूचना तंत्र है ही नहीं। इसलिए प्रशासन के पास कोई जानकारी नहीं है। क्षेत्र से पटवारी गायब हैं, तो ग्राम विकास अधिकारी भी नदारद। स्कूलों में शिक्षक भी नहीं, जबकि इन्हें तैनाती स्थल पर या आसपास वास होना चाहिए था।

टीम इलाके का चप्पा-चप्पा कर लौटी है, जहां पहुंचने की त प्रशासन अभी तक नहीं पा रहा था। तीन अगस्त को ल फटने फटने के छह दिन तक प्रशासन को इस क्षेत्र के में कोई जानकारी नहीं थी। एजी से जुड़कर कार्य कर रहे ीएमए के भूपेंद्र रावत, अंकित ा, परमेंद्र सिंह एवं हितेष ाल ने जोखिम भरे रास्तों से गांवों तक पहुंच लोगों को िक चिकित्सा मुहैया कराने के ी विस्तृत सर्वेक्षण कर उनकी कारी एकत्र की।

शासन बुधवार को गजोली से दूर महर्षि महेश योगी के न तक हेलीकाप्टर से राहत

बुरा है घाटी का हाल

- असीगंगा घाटी के सात गांवों की आबादी 3007 है।
- ऊपरी हिस्सों में 150 वन गूजर मवेशियों समेत फंसे हैं।
- उन गांवों में 20 गर्भवती महिलाएं हैं, जिनमें से तीन की डिलीवरी हाल में ही संभावित है।
- डाणगा और देवलग्वाड़ में पांच लोग गंभीर रूप से बीमार हैं।
- पेयजल लाइनें क्षतग्रस्त होने से गदेरों का गंदा पानी पीने से बच्चों में डायरिया और फोड़े-फुंसी होने लगी है।
- अलग-थलग पड़े गांवों में पांच दिनों का राशन है।
- स्कूल बंदा कल्डियाणी हाईस्कूल का जाना निशान नहीं। 42 बच्चों का भविष्य अंधेरे में।
- 24 जुलाई को दूसरी बार बादल फटने के बाद से झाला में फंसे 65 परिवारों का जीवन खतरे में।
- डाणगा गांव के ऊपर दरार से 75 वर्षीय गारुणा देवी को छोड़ शेष लोग रात को दूसरे गांव में शरण लेकर सुबह घर लौटते हैं।
- मुख्य पड़ाव संगमचट्टी बाजार पूरी तरह तबाह होने के बाद 30 मीटर अंदर तक मलबे से पटा है।
- गांवों के तलाब भराट बह चुके हैं।
- गजोली, गंगोली, डाँगीव, डाणगा गांव के ऊपर जमीन में दरारें।
- अगोड़ा गांव के सभी घरों की निचली मंजिल में भूमिगत चोट से पानी ही पानी।
- 2010 की आपदा में अनोला के कई घर खतरा होने के बाद भी पुनर्वास सूची में नहीं हैं।
- भू धंसाव से मलबा आगे होने से असी गंगा और कल्दीगाड़ घर कई जगह झील बनने की स्थिति पैदा हो रही है।

होमगार्ड के जवान की मौत

उत्तरकाशी। बुधवार रात को छुट्टी से अपने गांव उत्तरी लौट रहे होमगार्ड के जवान प्रताप सिंह की भूस्खलन से गिरे पेड़ के नीचे दबने से मौत हो गई। ऐसे में ग्रामीण शहर की ओर और शहर में रहने वाले लोग अपने गांव जाने से कतराने लगे हैं।

घाटी के सातों गांवों का आपसी सामग्री अब तक शेष गांवों तक

बढ़ता जा रहा आपदा में मरने वालों का आंकड़ा

अमर उजाला ब्यूरो

- पिलंग में भूधंसाव से हुई थी भादर सिंह की मौत
- कल्डियाणी में दो साधुओं की मौत की आशंका

उत्तरकाशी। प्रशासन अब भी आपदा से हुई मौत का आंकड़ा 28 और लापता लोगों की संख्या छह की मान रहा है। मुख्यमंत्री को भी यही जानकारी मुहैया कराई गई है। हालांकि जिस तरह से जानकारी मिल रही है, उससे मृतकों की संख्या अधिक होने की संभावनाएं है। जानकारी मिली है कि आपदा की रात को पिलंग गांव के भादर सिंह की भूधंसाव से मौत हुई थी। हालांकि प्रशासन की सूची में उनका नाम नहीं है। कल्डियाणी को आई बाढ़ में दो और साधुओं के मरने की सूचना है।

आपदा प्रभावित क्षेत्रों में सरकारी तंत्र को गैर मौजूदगी से मृतकों के बारे में सही आंकड़ा अब तक सामने नहीं आ पाया। खरसाली जिस तरह से धीरे-धीरे जानकारियां मिल

रात को पिलंग गांव के भादर सिंह की भी भूधंसाव की चपेट में आकर मौत हो गई थी। क्षेत्र के लोगों के अनुसार कल्डियाणी स्थित शिव मंदिर में तबाही की रात को मुख्य साधु के साथ दो साधु और थे। निश्चित ही वे भी काल का ग्रास डालकर मुख्यालय तक पहुंच रहे ग्रामीणों से मिल रही जानकारियां इस जासदी में मृतकों की संख्या ज्यादा होने की ओर इशारा कर रही हैं। इधर नई दिल्ली से यहां पहुंची एनडीआरएफ की टीम ने डॉग स्क्वाड के साथ गंगोरी से असी गंगा के तटों को खंगालना शुरू कर दिया है। बाढ़ की भेंट चढ़े फायर सर्विस के जवान और इस घाटी में निर्माणाधीन परियोजनाओं पर कार्यरत मजदूरों के शव नदी तटों पर मलबे में बरामद होने की उम्मीद जताई जा रही है। देर शाम तक 6 दो प्रशिक्षित कुत्तों के साथ टीम के 25

Cloudburst in Uttarakhand kills 30, several people missing

SOME TIPS TO STAY HIGH AND DRY:

- Know your proximity to rivers, streams and dams
- During heavy rain, avoid underpasses, underground parking garages and basements
- Avoid hiking or camping if thunderstorms are predicted
- Develop an evacuation plan for your family
- Turn off the electricity and other utilities

Glacial Lakes and Glacial Lake Outburst Floods

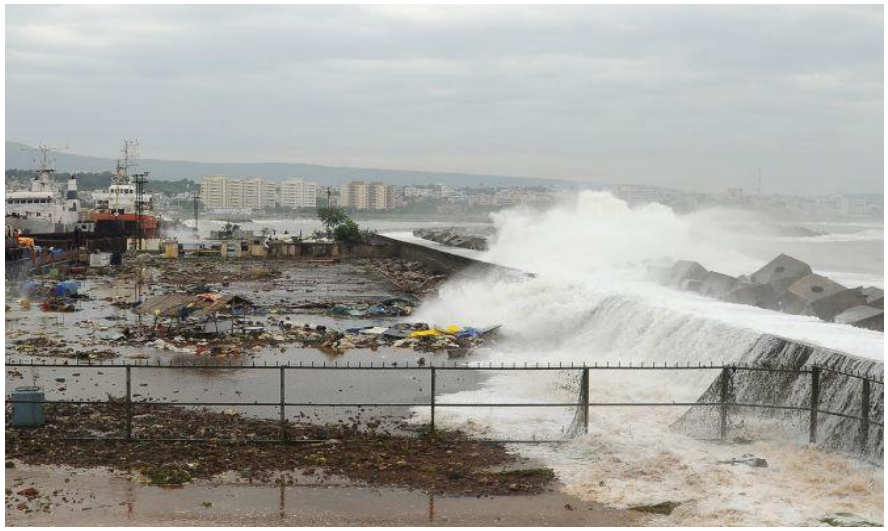
- Glacial lakes are formed due to the melting of ice and snow from glaciers
- Due to the faster rate of melting from the glaciers, possibly due to global warming, water is accumulating at an increasing rate in these lakes
- Sudden outburst results in Glacial Lake Outburst Flood (GLOF) downstream causing destruction of life and property

COASTAL FLOODS

- Floods in coastal areas may be caused by rainstorms associated with low pressure systems
- This kind of flooding is usually connected to hurricanes, tsunamis or tropical storms.
- When low pressures occur in a storm over the ocean, they suck the water toward the center.
- As long as the eye is over deep water, problems are minimized, but as the storm moves toward land it carries a dome of water that can exceed 25 feet (7.6 meters) in diameter.
- When the dome reaches the shoreline, it can cause significant damage.

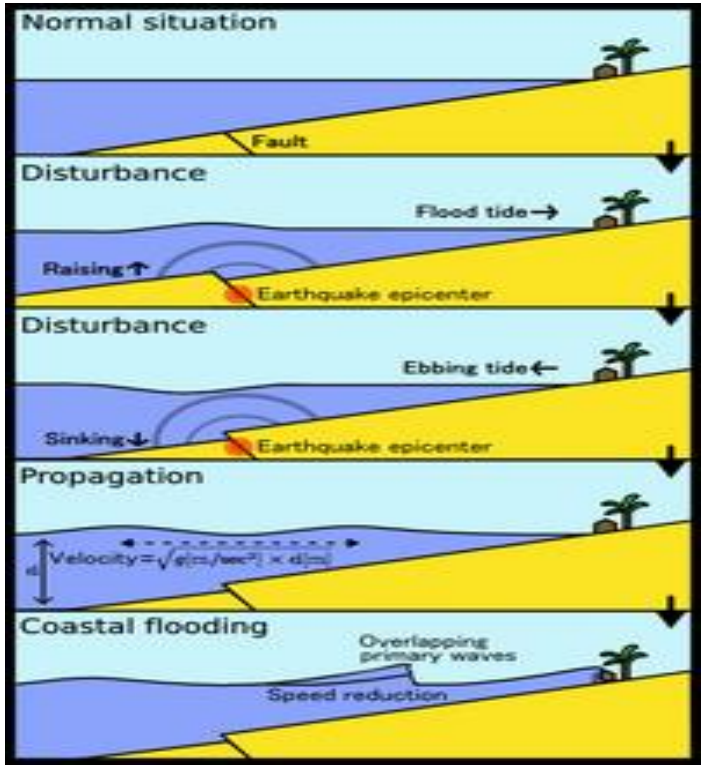
- At the same time, waves breaking along the shoreline assault beaches and structures, with destructive potential.
- On an average, 10 tropical cyclones and depressions originating in Bay of Bengal and Arabian Sea move across India
- Passage of storms in quick succession leads to severe floods
- Coastal areas of AP, Assam, Orissa, TN and WB, experience such flood
- Flood due to super cyclone in October 1999 in coastal Orissa

Coastal areas affected by flood



TSUNAMIS

- A tsunami is a series of large waves generated by an abrupt movement on the ocean floor
- Resulting from an earthquake, an underwater landslide, volcanic eruption or meteorite strike (very rare).
- Tsunami comes from two Japanese words “tsu - harbor" and “nami-wave."
- Damage is usually worst in areas closest to the undersea quake, often because the fast-moving waves will hit land so quickly.



TSUNAMIS

- In Dec. 2004, waves generated by an earthquake near Indonesia caused severe flooding and extensive loss of life and property in and. & Nic. Islands, coastal TN
- Govt. Of India is setting up a comprehensive warning system

URBAN FLOOD

common & annual event in Indian cities

Reasons are

- Rapid urbanization and uncontrolled development
- encroachment of the flood areas
- Inadequate drainages
- absence of proper regulations & maintenance.

URBAN FLOODING

- Many cities witness flooding even after moderate rainfall
- Frequently rain water mixes with drain water
- Unhygienic conditions lead to spread of epidemics
- Absence of planned urban drainage makes situation worse
- People living in low-lying areas pertain mostly to poorer sections

FACTORS

VEGETATION COVER
This varies seasonally. The type and amount will affect interception and stemflow/throughfall. Overland flow is reduced. Lag time will be increased.

ROCK TYPE
Impermeable rocks prevent groundwater flow and encourage through flow and overland flow. These rocks will decrease lag time. Permeable rock will have the opposite effect.

CLIMATE
The distribution of rainfall over the year and the temperatures will affect the lag times.

LAKES & RESERVOIRS
These will store floodwater and thus reduce lag time and control river response to heavy rainfall.

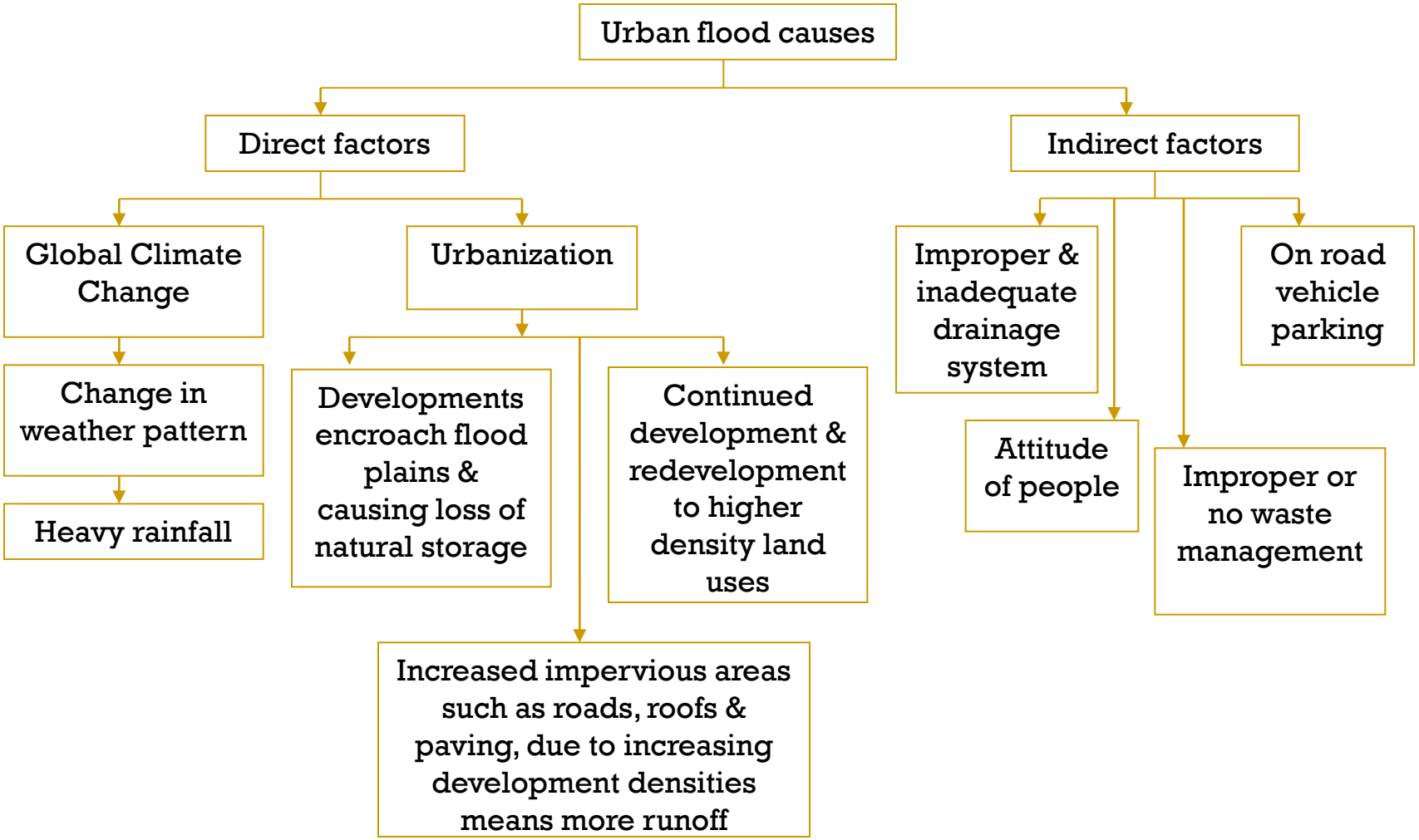
SLOPES
Steep slopes will encourage overland flow and gentle slope will slow run off down.

RAINFALL INTENSITY & DURATION
Intense rain will increase overland flow and reduce lag times. Gentle rain over a longer time will allow more infiltration.

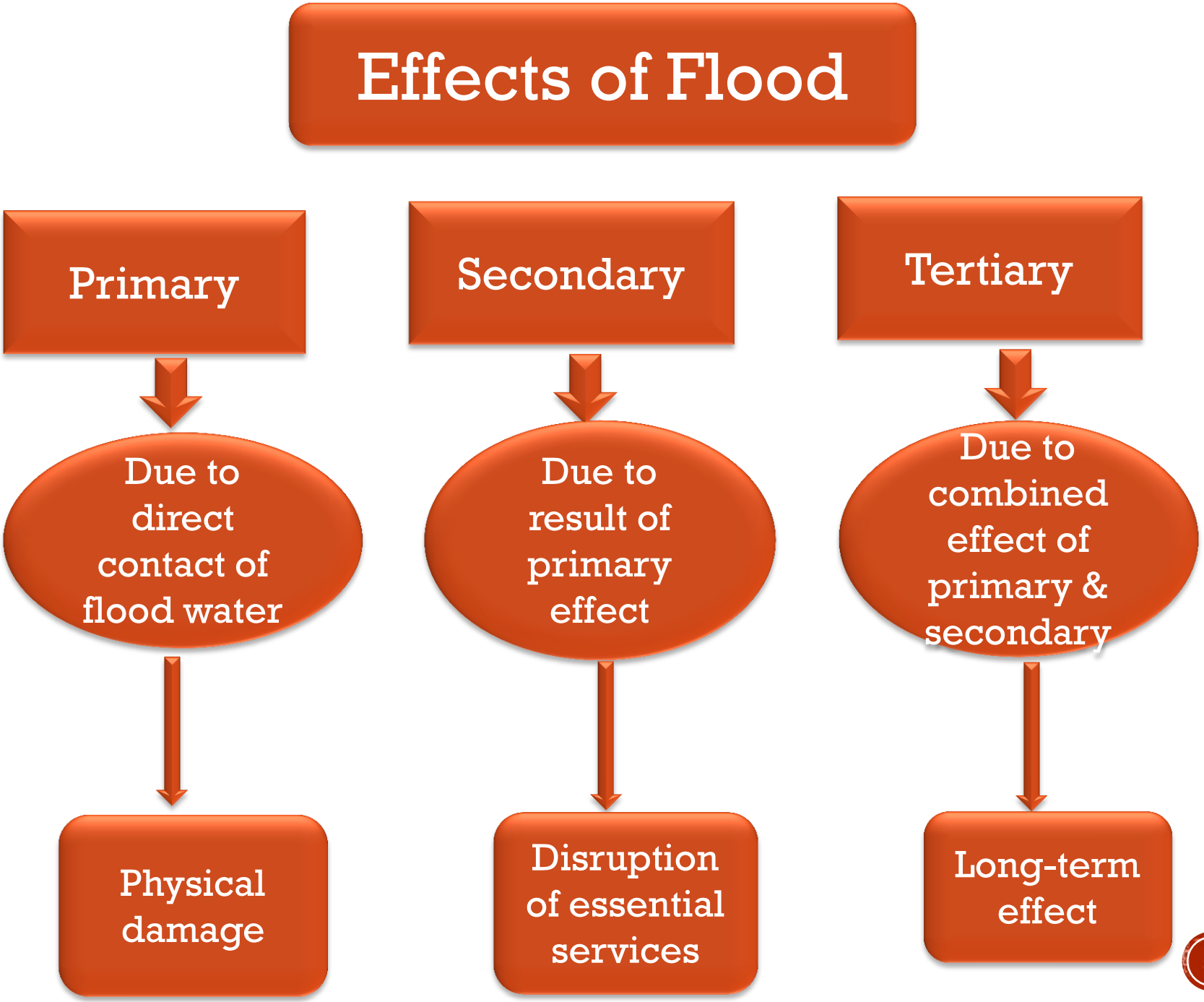
LAND USE
Impermeable surfaces created by urbanisation will reduce infiltration and encourage overland flow. Different types of crops affect interception rates e.g. cereals 7-15%.

SOIL TYPE & DEPTH
Deep soils store more water, pipes in the soil encourage through flow. Soils with small pore spaces will reduce infiltration and increase overland flow.

CAUSES OF FLOODS IN URBAN AREAS



Effects of Flood



Effects of flood

Primary effect

effect

Secondary effect Tertiary

Flood Impacts

- Loss of lives and property
- Loss of livelihoods
- Disruption of Transport services
- Communication breakdown
- Spread of water-borne diseases
- Economic and social disruption
- Mass migration
- Physiological effects

CASE STUDIES

Hyderabad

- **Urban flooding**
- record breaking torrential rain, 14 October 2020, heavy rains
- Hyderabad experiencing 32 cm rainfall in 24 hours – the highest in a century
- Leading to Urban flooding in Hyderabad city
- Experts have attributed this turn of events to *poor urban planning, a woeful drainage system and the pitiable condition of the Musi river, multiple streams and water-storage tanks*, as a result of unplanned urbanization.
- Most parts of Hyderabad lost power and
- internet connectivity for two days following the floods.

https://science.thewire.in/environment/hyderabad-floods-rains-poor-urban-planning/

https://www.insightsonindia.com/2020/10/19/why-floods-occur-in-hyderabad/

BUT, WHY FLOODS OCCUR IN HYDERABAD?

- Hyderabad is a system of catchments.
- The western edge is in the Godavari river basin.
- To the east, it's in the Krishna River basin.
- Also, Hyderabad is in the Deccan region, which has a chaotic drainage pattern — water here does not flow in a single direction as the slope is in multiple directions.

What needs to be done now?

- **Take stock of the entire drainage system, not just the nalas.**
- **See the whole city as a catchment area and begin to clear critical areas of encroachments.**
- **For all this, to be implemented, we need an executive and 'ecological' body like a "Lakes and Parks Authority",**
- **Risk mapping of the areas of the city should be done to assess the vulnerability, related to urban floods, using GIS technology.**
- **Town Planning department (GHMC) should regularly monitor the prohibited areas to prevent encroachments.**
- **Conserve and protect areas for groundwater recharge.**

https://www.insightsonindia.com/2020/10/19/why-floods-occur-in-hyderabad/

GHMC, INDIA LAUNCHED ‘MODEL PILOT PROJECT’: ‘PERVIOUS CONCRETE ROAD PAVEMENT’ AT SPORTS COMPLEX

DELHI

Delhi received around 70 mm of rain July 19, 2020, the most in the past five years,

last drainage master plan of the city was prepared in 1976, (@ 60 lakh population

(*Since then the population has increased about four times*)

Causes

- Yearly increase in the runoff-mainly due to unplanned urbanization- led to the concretization of roads and pavements.
- Choking and silting of drains
- disappearing waterbodies and encroachment

Consequences

- waterlogging in several parts of Delhi
- an increasing impact on life and property.

Measures

- Diversion of the runoff to nearby parks and waterbodies, recharged into the ground
- Emphasis on the need to restore urban waterbodies in this context.
- desilting of the drains is the main intervention
- Drainage Master Plan for NCT of Delhi

KERALA

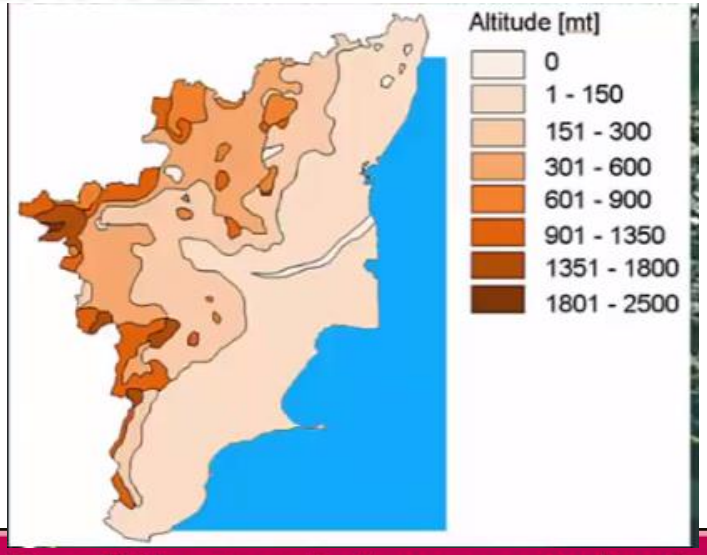
August 2018 was a devastating month for Kerala with high monsoon rainfall leading to the worst flood in Kerala after 1924.

Kerala was also flooded **in 2018 and 2019**

On 7 August 2020, due to heavy rainfall in the monsoon season,
severe floods affected Kerala, red alert for the 3 districts of Wayanad, Kozhikkode and Idukki

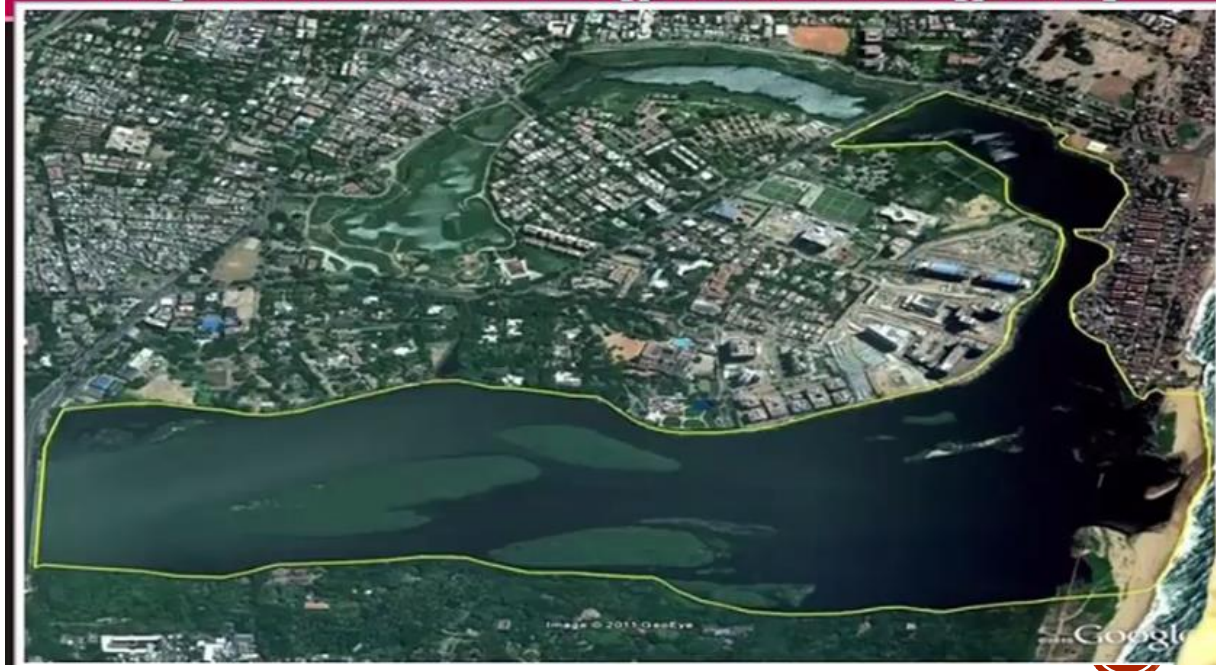
Causes. The unnatural increase in rainfall was **caused** by a monsoon surge, which was aided by a strong Somali Current or Somali Jet and a low-pressure on the Bay of Bengal which dragged strong monsoon winds towards the Western Coast of India.

CHENNAI



- heavy rainfall generated by the annual north east monsoon in November–December 2015.
- Causes
- severe encroachment on the Buckingham canal which is one of the major rain water drain of the city.
- strong El-Nino and consequent heavy rains resulting from the north east monsoon

Adyar River: Desilting not done regularly



Gurugram

Mumbai

Chennai

Jaipur

FLOOD MANAGEMENT

FLOOD MANAGEMENT

Cannot be absolutely controlled only managed to reduce flood losses

Aims of flood management

- Protection of people and property
- Reduction of flood risk
- Monitoring, research, forecasting & warning

FLOOD MANAGEMENT APPROACH

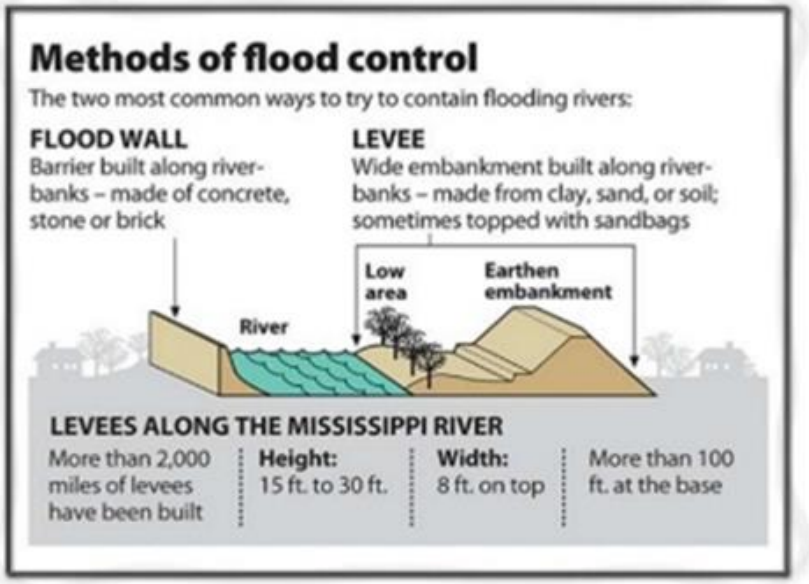
Structural measures

- Embankments
- Dams & reservoirs
- River diversions
- Channel improvement
- Drainage improvement
- Diversion of flood rivers

Nonstructural measures

- Flood Plain Zoning
- Flood preparedness
- Flood forecasting
- Afforestation
- Public relief

STRUCTURAL MEASURES



STRUCTURAL MEASURES

Structural measures for flood control which bring relief to the flood prone areas by reducing flood flows and thereby the flood levels are:

(a) Construction works:

embankments which artificially raise the effective river bank and thereby prevent spilling.

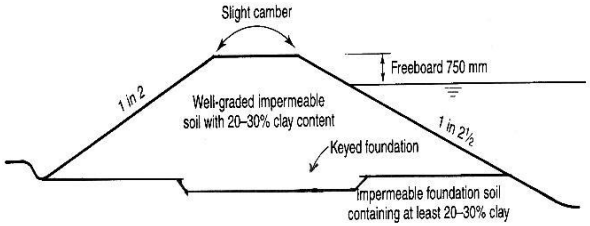
(b) Improvement works:

Improvement of existing channel and drainages, which artificially reduce the flood water level, confining within the river banks & prevent spilling.

STRUCTURAL FRM MEASURES

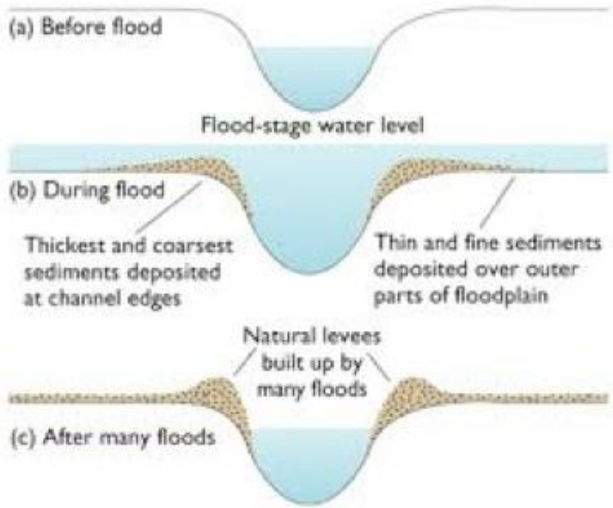
- Dams
- Reservoirs
- Flood walls
- Levees
- River diversions
- Channel Improvements
- Detention basin
- Closure structures
- Bridge modifications
- Pumping
- Channel diversions
- Beach Nourishment

Embankments



Dams and reservoirs

Levees

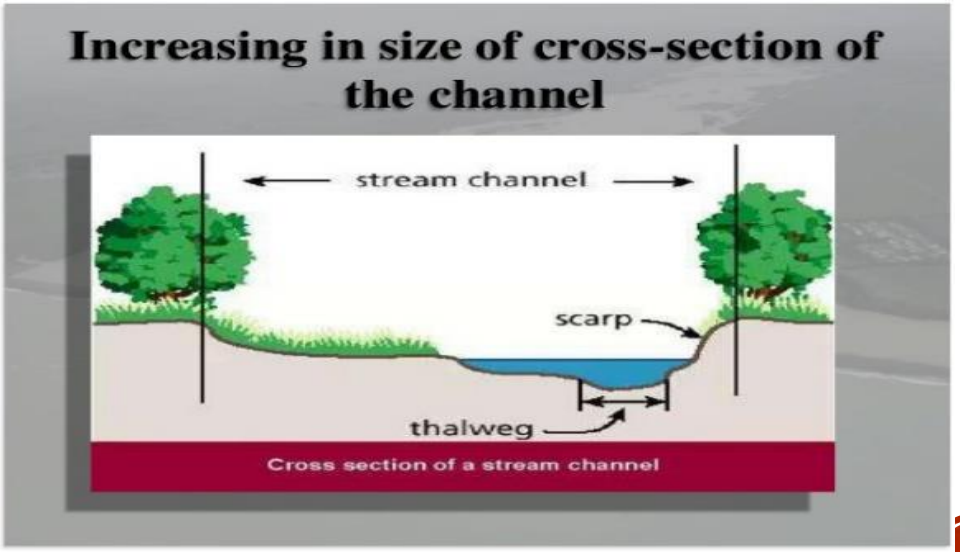


Flood wall

River diversions

Jhelum river by passing Srinagar

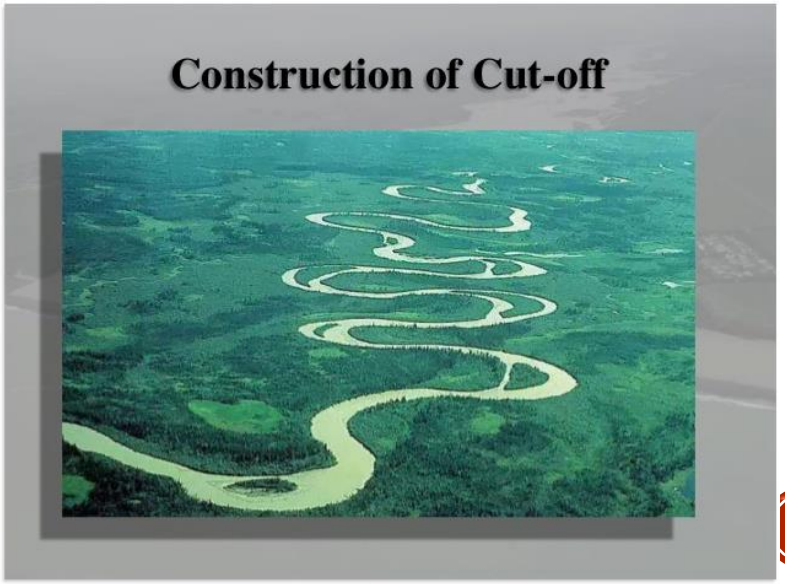
Channel improvement



Detention basin

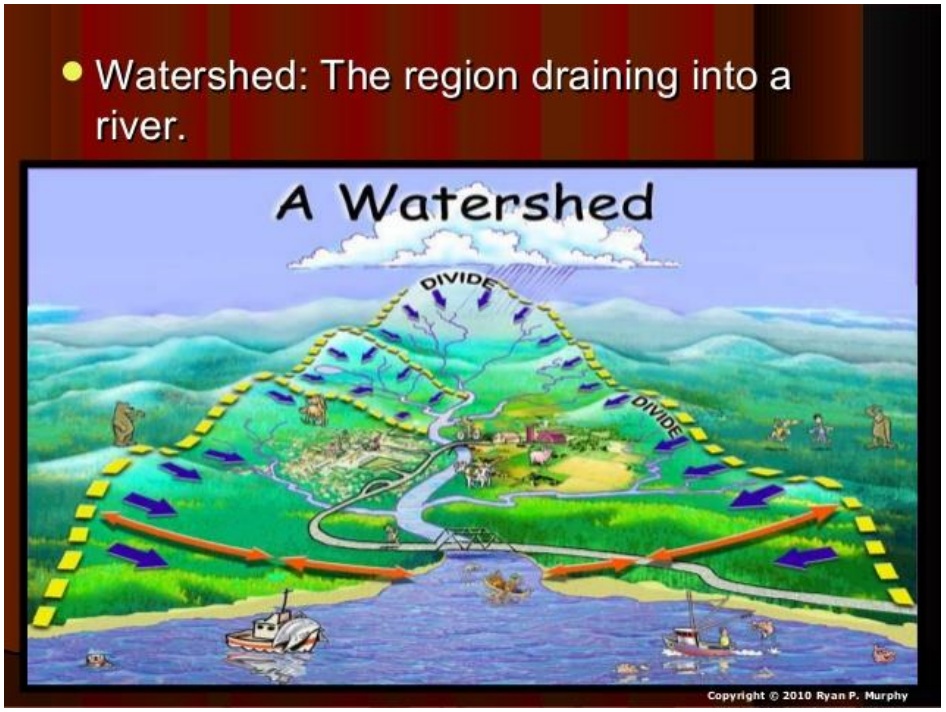
Cheap if depressions or swamp are available

Channel Improvements



CLOSURE STRUCTURE

Watershed Management
(a *structural mitigation measures)*



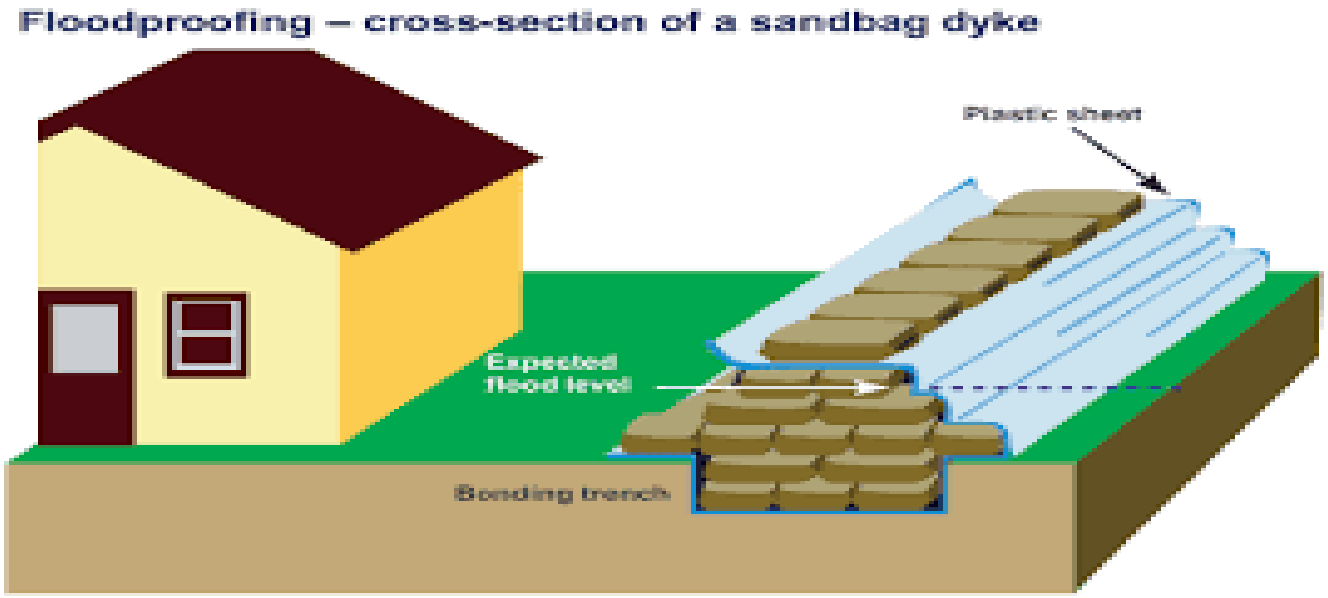
Runoff reduction by watershed management*: It is an indirect method applied to the watershed, which has long-term effect on flood disaster mitigation.*

Watershed Management

Different watershed management are

- Check dams
- Trenches
- Contour bunds
- Contour farming
- Grassed waterway
- Afforestation

Non-structural Measures



NON-STRUCTURAL MEASURES

Administrative methods endeavor to mitigate the flood damages by;

- Facilitating timely evacuation of the people and shifting of their movable property to safer grounds by having advance warning of incoming flood i.e. flood forecasting, flood warning in case of threatened inundation
- Discouraging creation of valuable assets/settlement of the people in the areas subject to frequent flooding i.e. enforcing flood plain zoning regulation.

NONSTRUCTURAL MEASURES

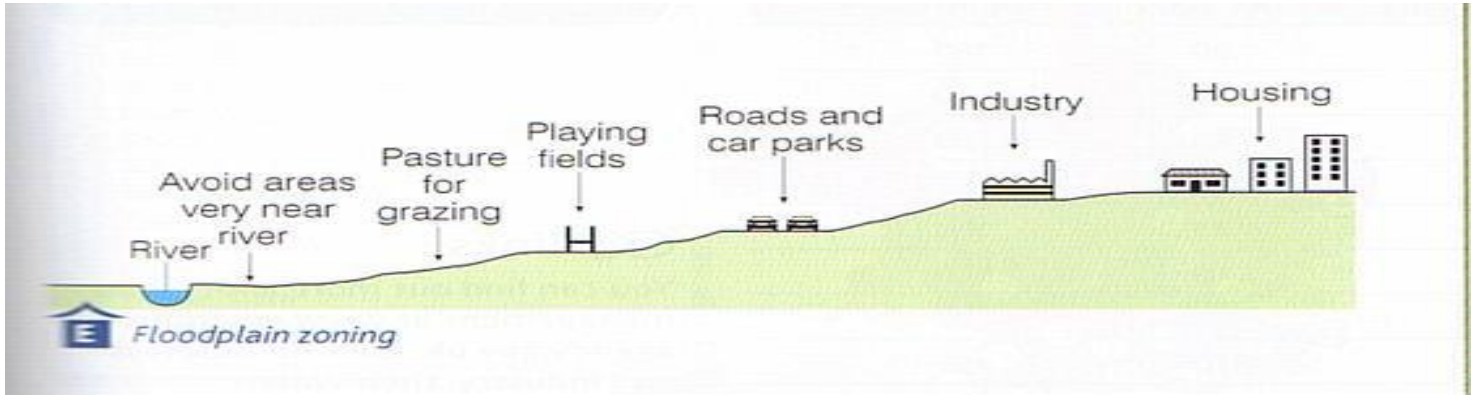
- Modifying the susceptibility to flood damage by
  - *Flood Plain Zoning*
  - *Flood preparedness*
  - *Flood forecasting*

Modifying loss burden by

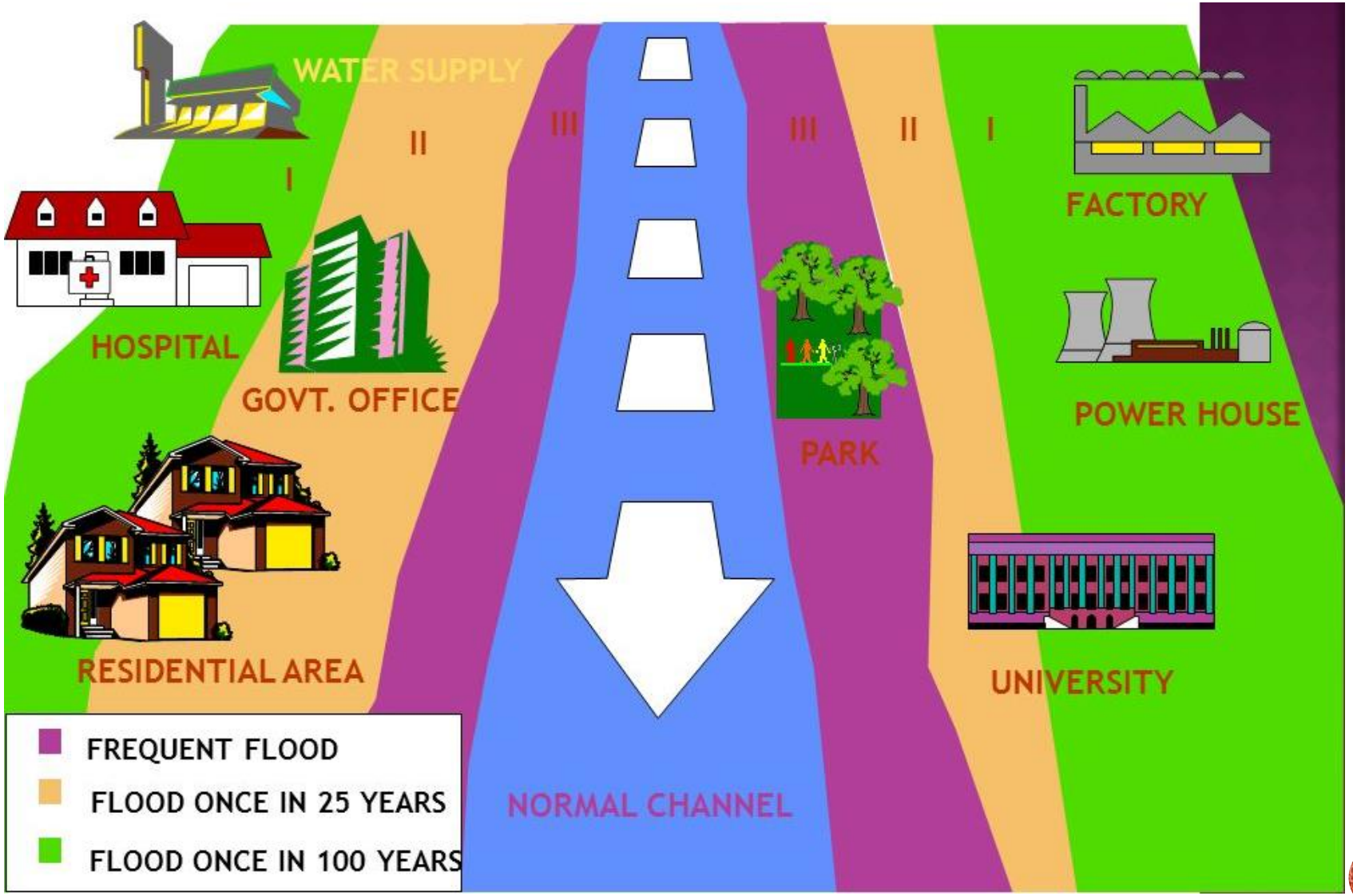
- *Disaster relief/relief funds*
- *Public awareness*
- *Flood insurance*

FLOOD PLAIN ZONING (FPZ)

- FPZ is a concept central to flood plain management.
- Any intrusion into or developmental activity in flood plain of a river must recognise the river's 'right of way'.
- FPZ measures aim at demarcating zones or areas likely to be affected by floods of different magnitudes or frequencies.
- Specify the types of permissible developments in these zones (damage can be minimized)



FLOOD PLAIN ZONING



Central Water Commission (CWC)

- Continuously impressing upon the states the need to take follow-up action to implement the flood plain zoning approach.
- A model draft bill for flood plain zoning legislation was also circulated by the union government in 1975 to all the states.
- It provides clauses about flood zoning authorities, prohibition of the use of the flood plains, compensation
- Most importantly removing obstructions to ensure free flow of water.

FLOOD PREPAREDNESS

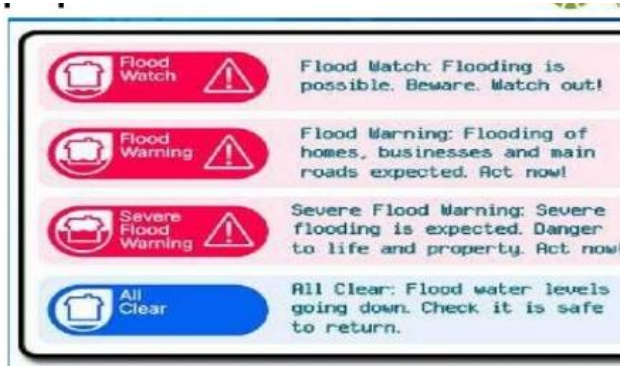
Preparedness is very crucial for water related disasters

- **Planning**

Evacuation plan : before a flood occurs can help avoid confusion and prevent injuries and property damage. *A thorough evacuation plan should include:*

- Conditions that will activate the plan
- Chain of command
- Emergency functions and who will perform them
- Specific evacuation procedures, including routes and exits

Education of the public



- Significance/implications of different type
- Action to be taken by them
- Generally reluctance to leave homes and villages
- Tendency to return while there is still flood danger
- Can be accomplished by meetings and classes
- Distribution of information pamphlets in local languages
- Placing large size posters in prominent places
- Pictorial illustration as far as possible

Disaster-prone area mapping

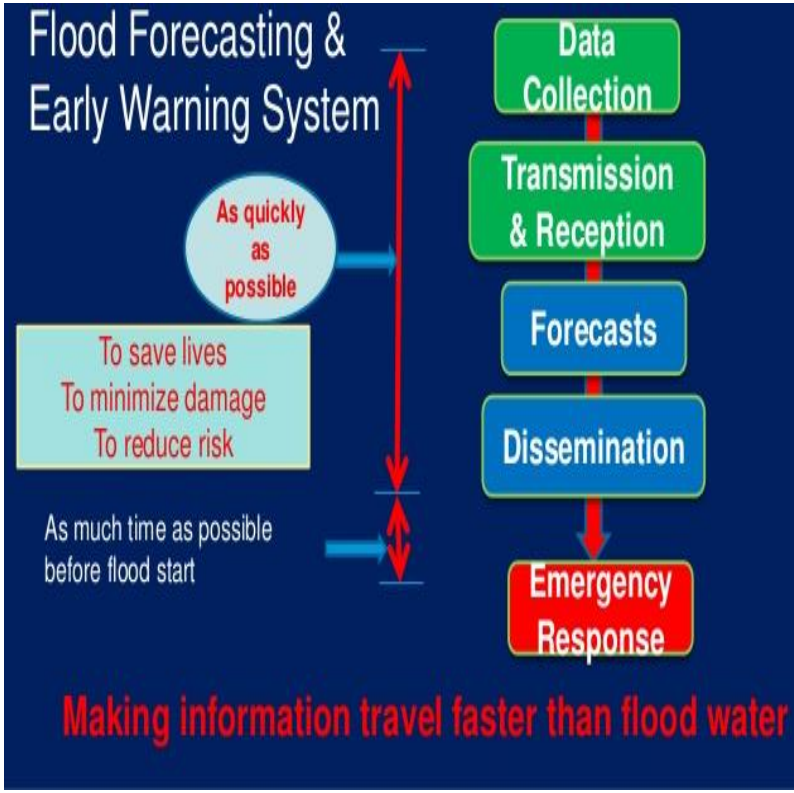
FLOOD FORECASTING & WARNING SYSTEM

Level forecasts: help the user agencies to decide

- mitigating measures like evacuation of people
- shifting people & their movable property to safer locations.

Inflow Forecasting: is used by various dam authorities

- in optimum operation of reservoirs for safe passage of flood downstream
- to ensure adequate storage in the reservoirs for meeting demand during non-monsoon period.



FLOOD FORECASTING AND WARNING

- ***Forecasting:*** Estimation of some variable at a specific future time or over a specified future time interval
- ***Prediction:*** Estimation of future conditions, without reference to a specific time
- ***Real-time forecasting:*** Forecasts are made based on the current conditions
- ***Lead time:*** Time (interval) over which a forecast is made

FLOOD FORECASTING AND WARNING

- Reliability of a forecast usually decreases with increase in lead time
- Longer the forecast lead time, greater will be its utility
- Need for proper balance between accuracy and lead time
- Certain minimum lead time necessary to organize remedial measures
- In India, a lead time of at least 10 to 12 hours needed
- Higher benefits if good forecasts are available
- Forecasting is one of the most useful and difficult problem of hydrology

PURPOSES OF FORECASTING

Objective	Percent of Cases
Flood protection	43%
Energy generation	19%
Navigation	2%
Water supply and sanitation	12%
Irrigation	6%
Others	8%

Forecast of river stage	43% cases
Discharge	36%
volume	12%

….

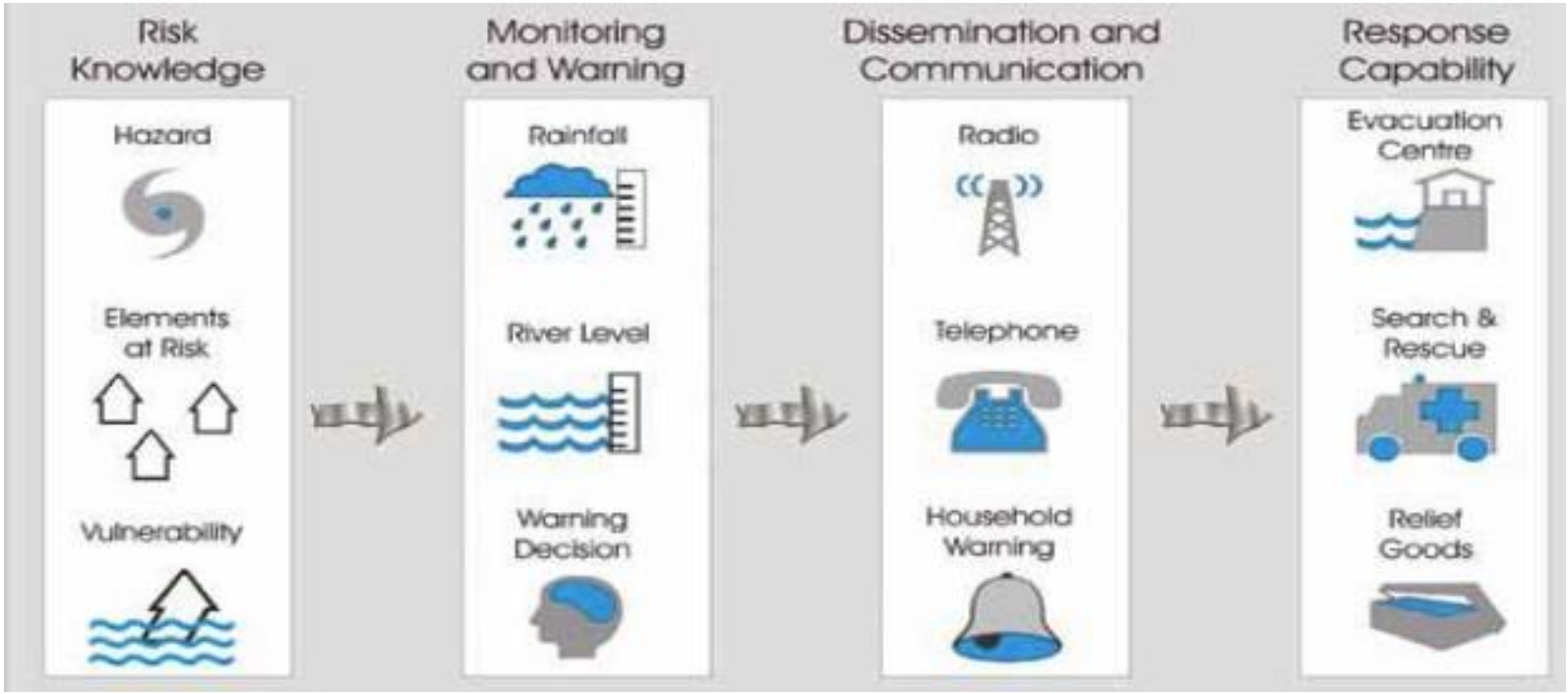
FLOOD FORECASTING ACTIVITIES IN INDIA

- Commenced in India in November 1958
- Flood Forecasting Unit in CWC for the river Yamuna at Delhi
- Disastrous floods in 1968 in many parts of the country necessitated the setting up of forecasting centers on interstate rivers.
- CWC have a National Network of FF Stations on all Inter-State Rivers.
- CWC has 175 Forecasting sites on 70 Inter-State Rivers.
- Accuracy of forecast is about 95.8%

KEY ELEMENTS OF EARLY WARNING SYSTEM

An early warning system mainly consists of four elements:

- Risk Knowledge
- Monitoring and Warning Services,
- Disseminations and Communication
- Response Capability



STEPS INVOLVED IN FLOOD FORECASTING

- Observation and collection: *hydro-meteorological data*
- Transmission and communication of data: *to forecasting center/control room*
- Formulation of forecast: *for Modeling*
- Dissemination of forecasts and warning: *administrative and engg. authorities*
- Analysis of forecast vs actual observations: *for improvement of models*

HYDRO-METEREOLOGICAL DATA FOR FLOOD FORECAST

A) meteorological data

- Rainfall
- Temperature
- Wind velocities
- Humidity
- Evaporation

B) hydrological data

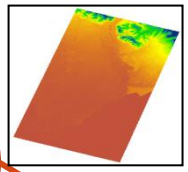
- River gauges
- River discharges
- Yields/runoff

FLOOD FORECASTING SYSTEM : DATA TRANSMISSION

- Wireless
- Telephone
- Fax
- Satellite
- Telegraph

MODELING

DEM



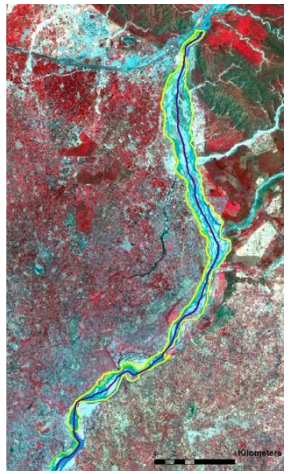
Satellite

Flood
(different return periods)
(Flood Frequency)

Hydrological Model

- HEC-GeoHMS
- HEC-GeoRAS
- MIKE BASIN
- MIKE-11
- MIKE-FLOOD

Flood Inundation maps



DISSEMINATION OF FORECAST

Forecast bulletins

- Must be very clear and include all necessary details
- Double-check information supplied
- Well-defined responsibility in offices authorized to issue forecasts
- Avoid dissemination of wrong information

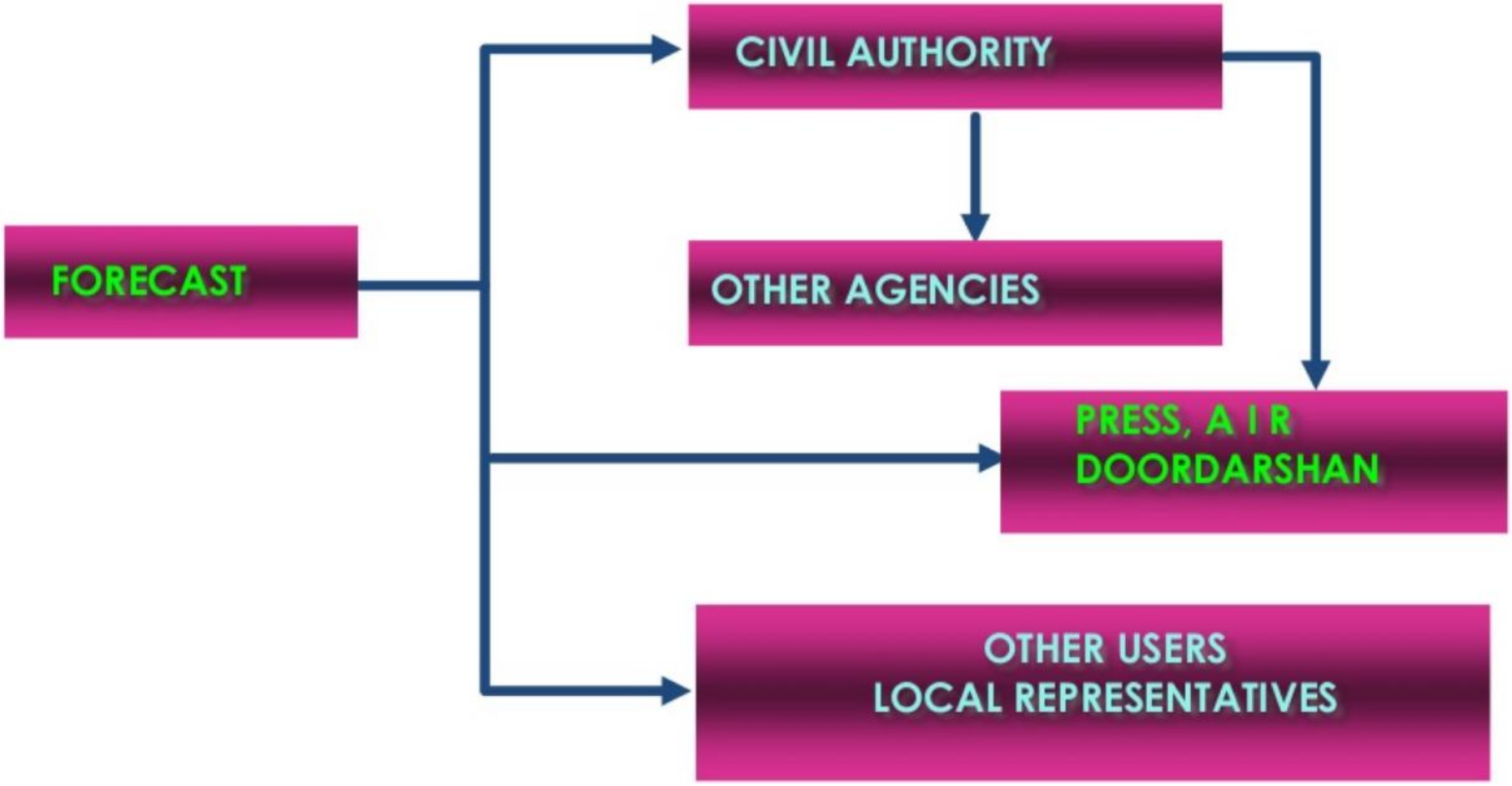
DISSEMINATION OF FORECAST

Distribution of information

- Military authorities
  - Help Civil administration
  - Protect their own set-up
- All India Radio / Doordarshan/ News Agencies
- Other agencies
  - Railways and highway authorities
  - Industries and important establishments
  - Non-governmental organizations

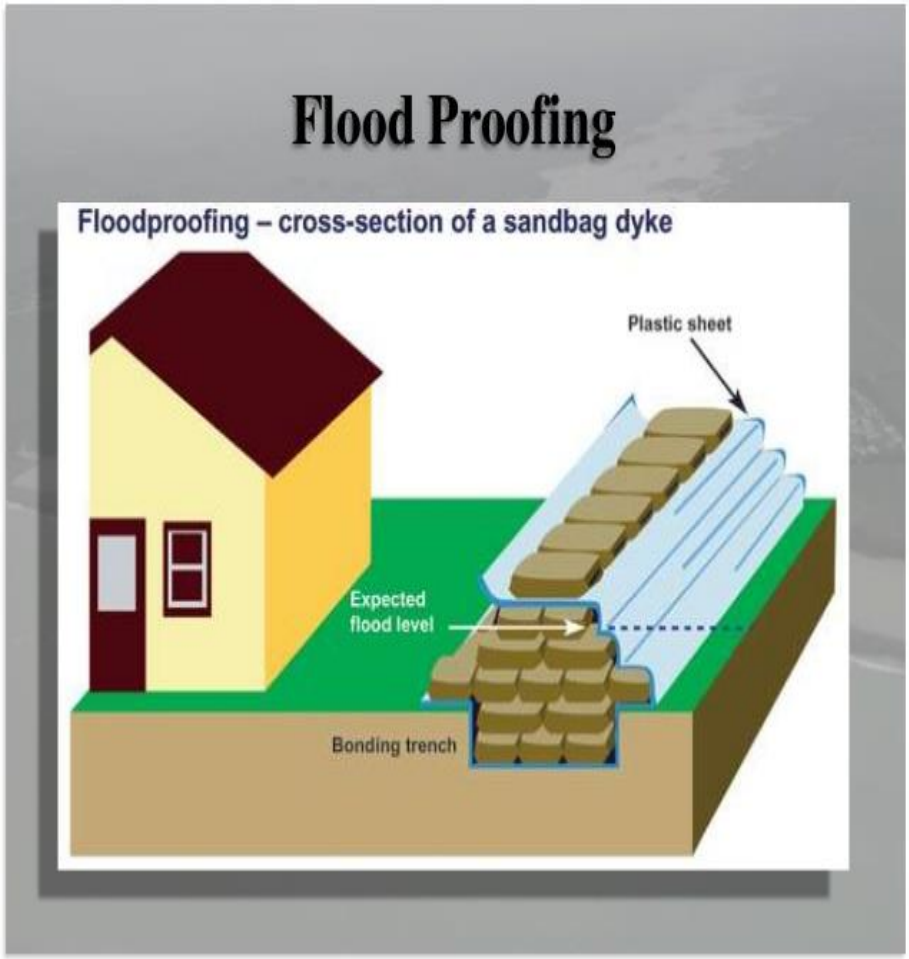
FLOOD FORECASTING

DISSEMINATION

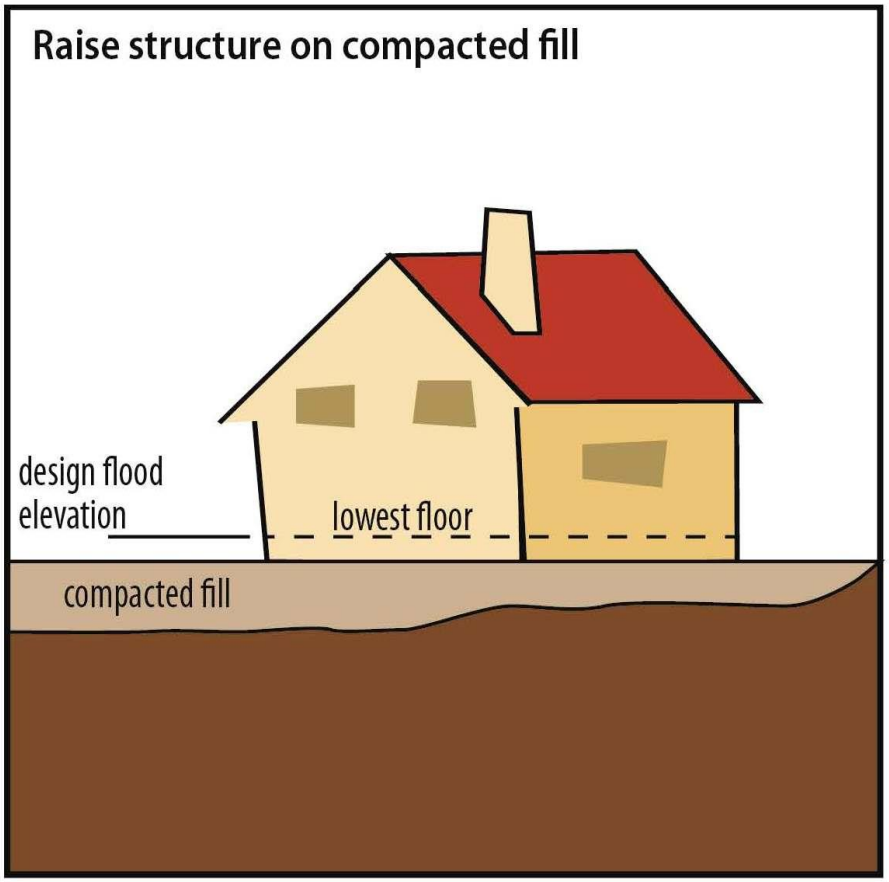


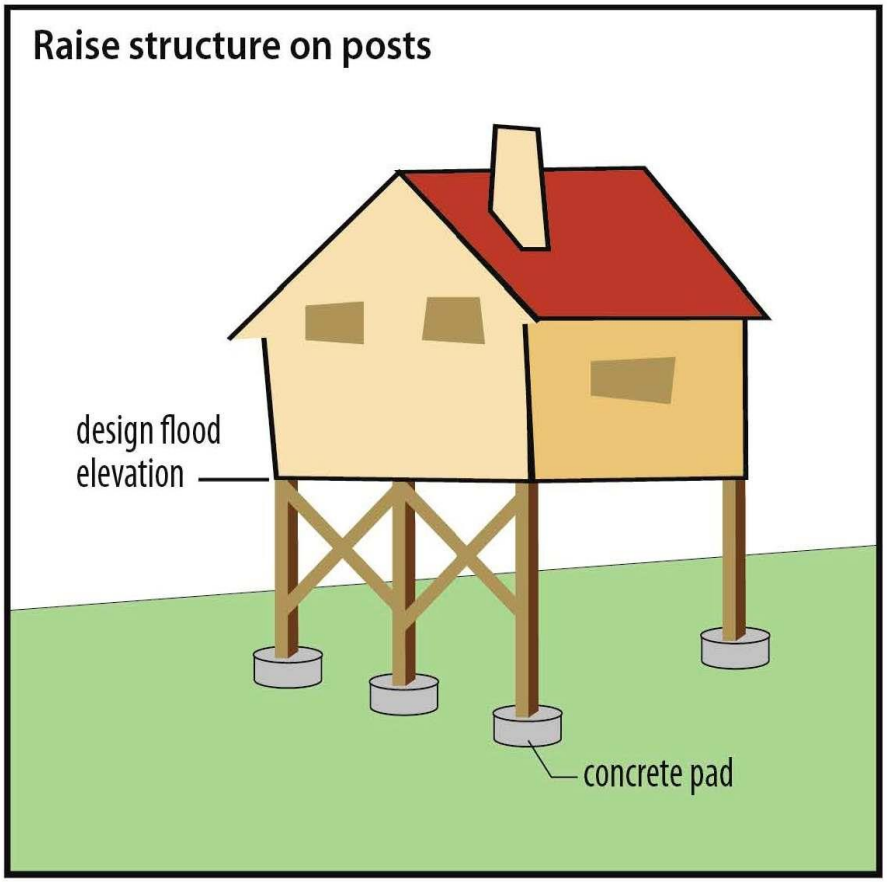
FLOOD PROOFING

Flood proofing can be defined as any combination of structural or non-structural additions, changes, or adjustments to a building that reduces or prevents flood damage to the structure and/or its contents. Simply stated, flood proofing includes any effort a property owner may take to reduce flood damage.

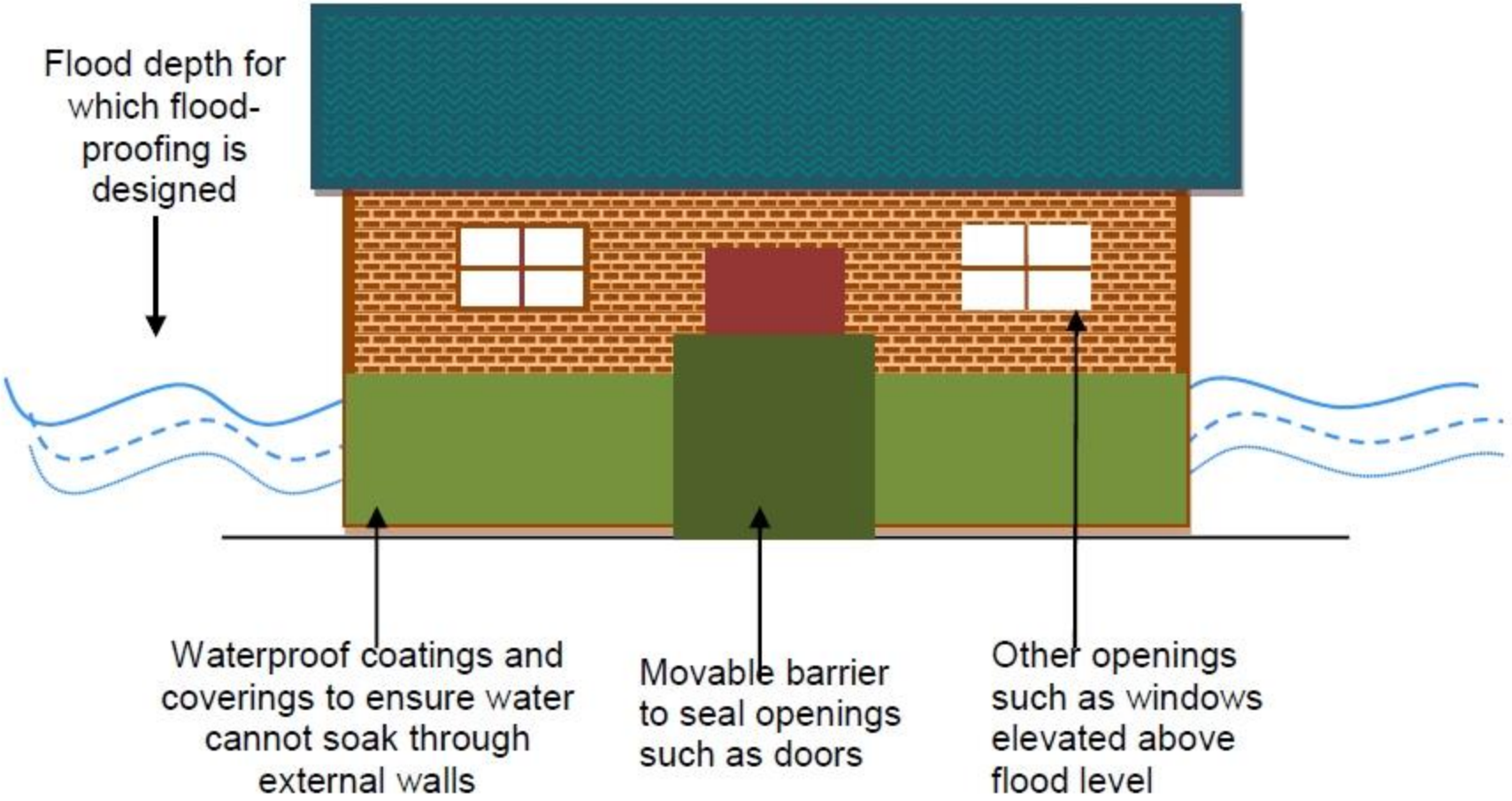


Flood proofing





Flood proofing



Dry Floodproofing

Floods

Quality

Quantity

Ministry of Jal Shakti

Jal Shakti Abhiyan

Catch the Rain

JAL SHAKTI ABHIYAN:
A WATER CONSERVATION CAMPAIGN
Time for Change

SANCHAN VIGYAN

Water Conservation: Now a National Priority

An integrated and sustainable approach to water resources on top of agenda:

- **Institutional integration - Jal Shakti Mantralaya**
- **Prime Minister's letter to all CMs, Sarpanches**
  - Nationwide shramdaan for water conservation on 22nd June
- **Time to make *Sanchay* – a jan andolan…**

PM's letter being read out in Kandhamal, Odisha

Minister, Jal Shakti, doing *shramdaan* in Jodhpur

Jal Shakti Abhiyan (JSA)

(inspired by Gram Swaraj Abhiyan)

Objective
Time bound, Mission mode, Water conservation campaign

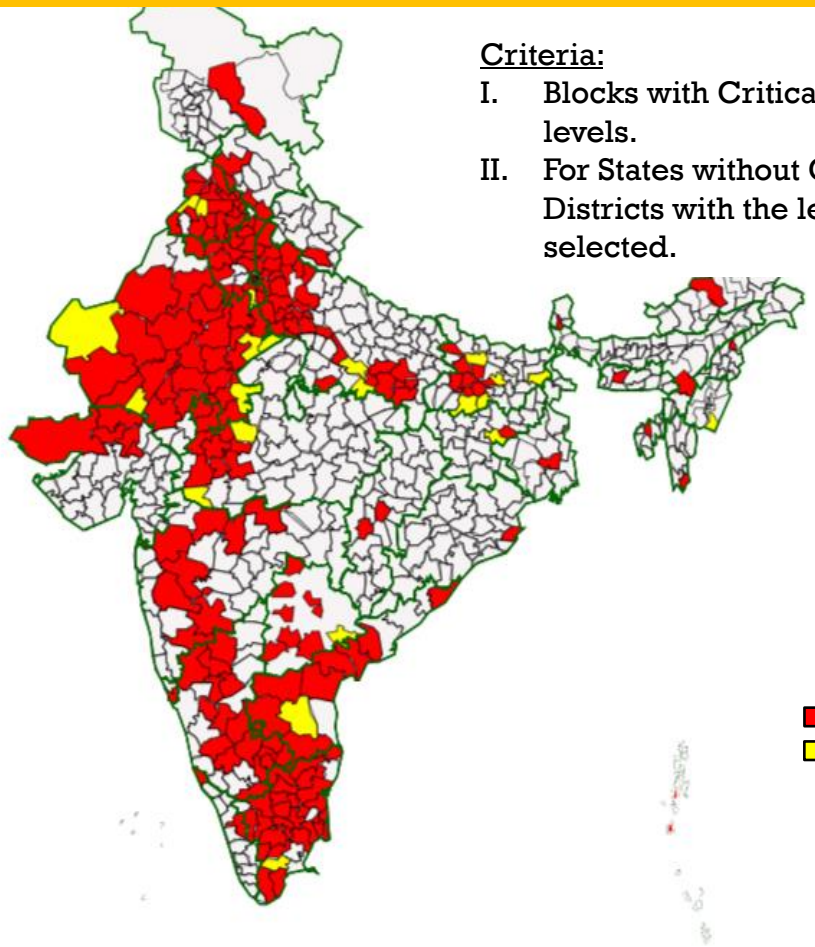
Duration –
Phase I: 1st July – 15th September 2019
Phase II: 1st October – 30th November for 4* States/UTs with the retreating monsoon

36 States/UTs **257** Districts **1592** Blocks (Map on next page)	**257** ASs/JSs **447** DySecy/Dir **447** Tech officers	**5** targeted Water Conservation Interventions areas	Targeted Communications Campaign Farmer / Community mobilization	Application of Space Technology for Water Resource Management	Real Time monitoring dashboard

** Andhra Pradesh (South), Karnataka (South), Puducherry and Tamil Nadu*

Water Stressed Blocks/Districts to be covered

	States / UTs	Blocks	Districts
1	Andhra Pradesh	68	9
2	Arunachal Pradesh	11	1
3	Assam	5	1
4	Bihar	30	12
5	Chhattisgarh	2	2
6	Delhi	24	10
7	Goa	7	1
8	Gujarat	30	5
9	Haryana	81	19
10	Himachal Pradesh	4	4
11	Jammu & Kashmir	15	1
12	Jharkhand	5	2
13	Karnataka	53	19
14	Kerala	3	2
15	Madhya Pradesh	29	11
16	Maharashtra	20	8
17	Manipur	3	1
18	Meghalaya	3	1
19	Mizoram	2	1
20	Nagaland	3	1
21	Odisha	9	1
22	Punjab	111	20
23	Rajasthan	218	29
24	Sikkim	8	1
25	Tamil Nadu	541	27
26	Telangana	137	24
27	Tripura	6	1
28	Uttar Pradesh	139	35
29	Uttarakhand	8	1
30	West Bengal	1	1
31	A&N Islands	3	1
32	Chandigarh	1	1
33	D&N Haveli	1	1
34	Daman & Diu	1	1
35	Lakshadweep	9	1
36	Puducherry	1	1
	Total	1592	257



Criteria:

I. Blocks with Critical/Over-exploited Groundwater levels.

II. For States without Critical/Over-exploited Blocks, Districts with the least groundwater availability are selected.

INDEX
[Total Districts: 257]

234 Regular Districts
23 Aspirational Districts

Lesson Learnt
Intervention Areas

1. Water conservation and rainwater harvesting
2. Renovation of traditional and other water bodies/tanks
3. Reuse, borewell recharge structures
4. Watershed development
5. Intensive afforestation

Concerned Departments: M/o Jal Shakti; M/o Rural Development; D/o Land Resources; M/o Agriculture & Cooperation and Farmers Welfare; D/o Agricultural Research and Education; M/o Environment, Forests and Climate Change; and M/o Housing and Urban Affairs

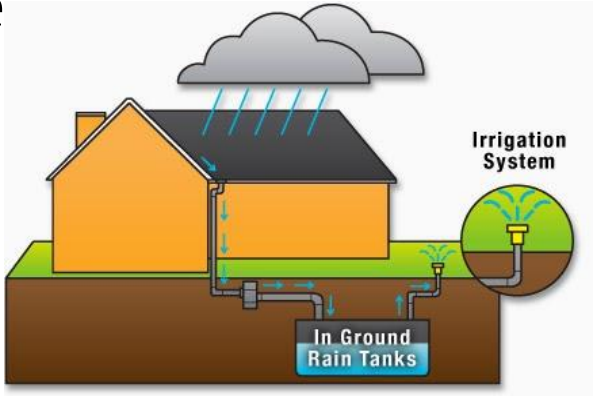
Water conservation techniques

- Rain water Harvesting structures
- Roof water Harvesting structures
- Renovation of traditional Water bodies
- Reuse a and recharge structures
- Watershed development
- Intensive afforestation

- Awareness
- Interaction
- Participation
- Tools

RAINWATER HARVESTING

- The harvesting of rainwater simply involves the collection of water from surfaces on which rain falls, and subsequently storing this water for later use.



- Normally water is collected from the roofs of buildings and stored in rainwater tanks. This is very common in rural Australia.
- Water can also be collected in dams from rain falling on the ground and producing runoff.

OBJECTIVES OF RAINWATER HARVESTING

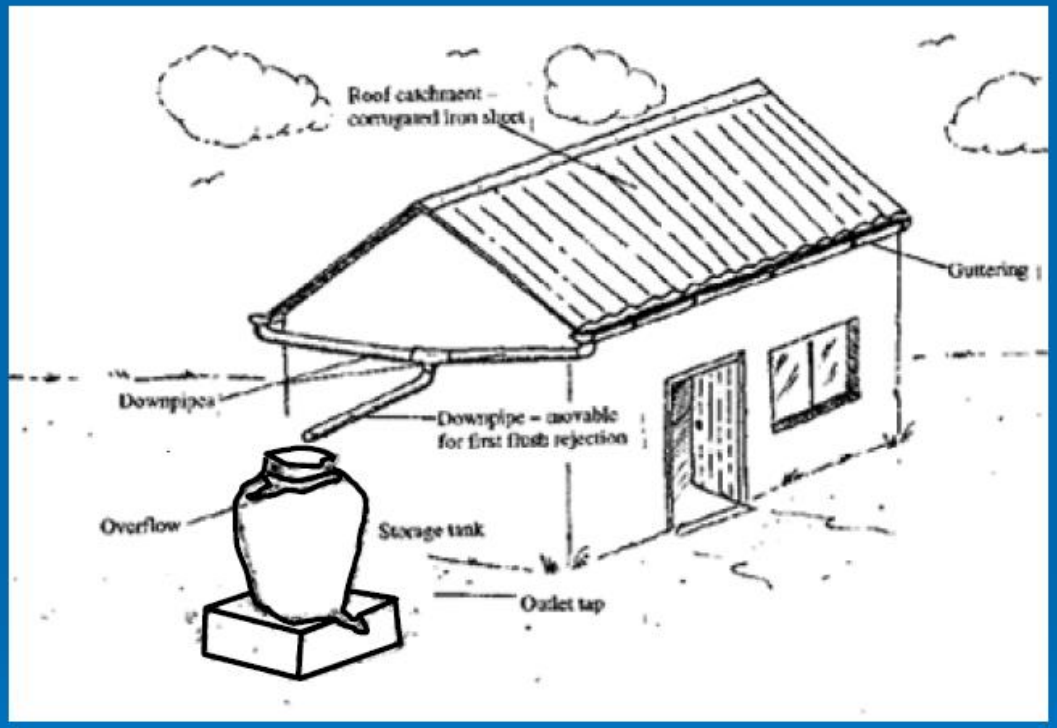
- To meet the increasing demand of water.
- To reduce the run-off which chokes the drains?
- To avoid the flooding of roads.
- To raise the underground water table.
- To reduce groundwater pollution.
- To reduce soils erosion.
- Supplement domestic water needs.

The concept is simple

Broadly there are two ways of harvesting rainwater.

- Surface runoff harvesting
- Roof top rainwater harvesting

Rooftop Rainwater Harvesting

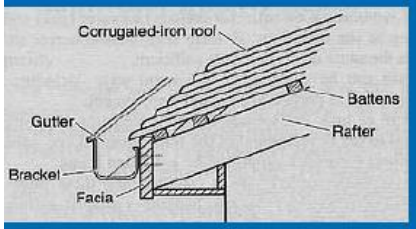


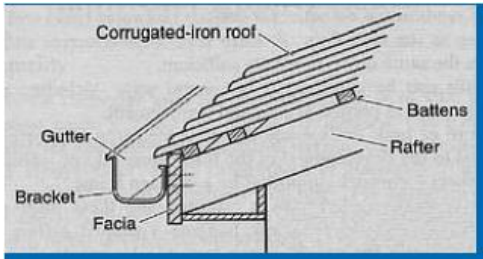
1

The Basics: a 20 square meter rooftop, in an area with 500 mm annual rainfall, can potentially produce enough drinking and cooking water for a family of 5 for a year. [2]

Components of a Rooftop System

- Catchment (Rooftop)
- Conveyance (Pipes)
- First Flush Separator
- Filtration
- Storage
- Usage
- Recharge





Materials Choices

Rooftops

- Types
  - Cement
  - Corrugated Steel
  - Tile
  - Thatch
- Issues
  - Slope
  - Runoff Coefficient
  - Bacteria
  - Availability and Cost

Pipes and Gutters

- Types
  - Plastic (PVC, etc.)
  - Folded Steel Sheeting
  - Wood / Bamboo
  - Other metal / ceramic
- Issues
  - Longevity
  - Ease of joining
  - Attachment to house
  - Environmental Impacts of PVC – Issue at Scale

ROOF WATER HARVESTING STRUCTURES

RENOVATION OF TRADITIONAL WATER BODIES

REUSE AND RECHARGE STRUCTURES

Watershed Development

Intensive Afforestation: *species with less water requirement*

Awareness


MATTY IS START OF LIFE
BEAUTY WINDSTRIDE
RISK IS PART OF LIFE


JSA

Interaction

Participation of school children

Tools and Techniques

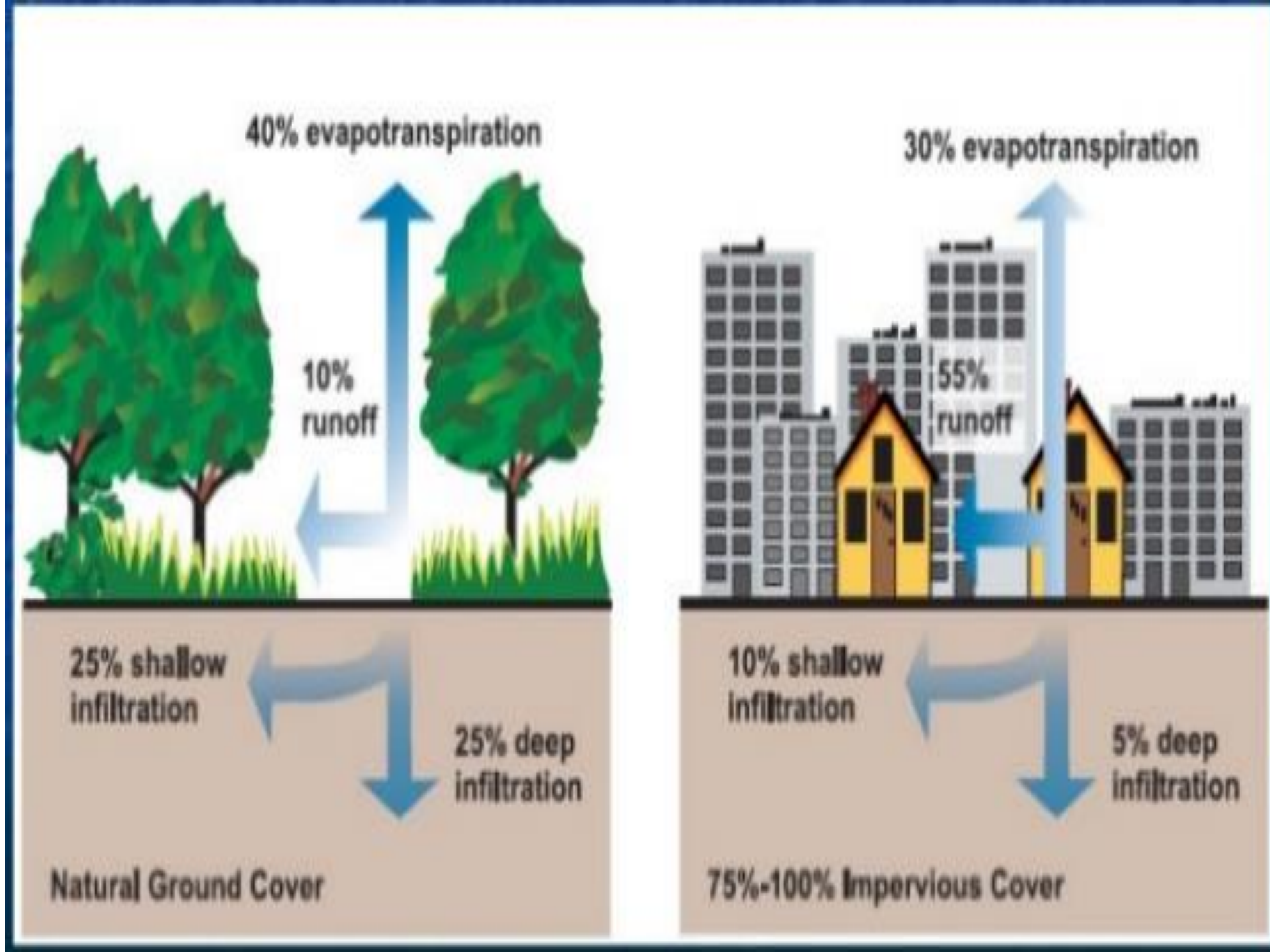

30-12-2017 02:38


स्वच्छता पखवाड़ा-2019
राष्ट्रीय जल विज्ञान संस्थान


Pledge with us to
make a stink free
India

WAY FORWARD

- Water Conservation may help in recharge ground water and reduce floods in Urban areas
- Rainwater harvesting may be a helpful tool
- Desilting of drainage channels
- Use of Pervious concrete parking lots, roads
- Flood management can minimize the impacts
- Geospatial tools: Remote sensing and GIS plays an important role in flood management


40% evapotranspiration
10% runoff
25% shallow infiltration
25% deep infiltration
Natural Ground Cover
30% evapotranspiration
55% runoff
10% shallow infiltration
5% deep infiltration
75%-100% Impervious Cover

Source: http://www.icewarm.com.au/userfiles/File/ICEWARM_Adelaide%20290506.pdf

THANK YOU

राष्ट्रीय जलविज्ञान संस्थान NATIONAL INSTITUTE OF HYDROLOGY
आपो हि ष्टा मयोभुवः

DR. L N THAKURAL
NATIONAL INSTITUTE OF HYDROLOGY
thakuralln@gmail.com

JSA Intervention Areas

1. Water conservation and rainwater harvesting

Existing scheme: MGNREGA

Ministry of Rural Development

Activity: No. of water conservation structures constructed:

a) rooftop rainwater harvesting structures
   - public
   - private

b) Check Dams

2. Renovation of traditional and other water bodies/tanks

Existing scheme: MGNREGA, and Repair, Renovation and Restoration of Water Bodies

Ministry of Rural Development, Ministry of Jal Shakti

Activity:

a) No. of traditional water bodies/tanks restored (includes individual household units)

b) No. of other water bodies restored

A series of trenches/*Khantis* along hill slopes hold rainwater and recharge water sources, Uttarakhand

Traditional water system, Maharashtra

JSA Intervention Areas

3. Reuse, borewell recharge structures

Existing scheme: MGNREGA

Ministry of Rural Development

Activity: No. of structure constructed

a) No. of borewell recharge structures
b) Soak pits
   - community
   - individual
c) Greywater* treatment ponds constructed

4. Watershed development

Existing scheme: Integrated Watershed Management Programme

D/o Land Resources, Ministry of Rural Development

Activity: a) Area under Watershed Development
b) No. of staggered trenches constructed
c) No. of gully plugs constructed
d) No. of percolation tanks constructed

**Waste water generated from household washing and bathing*

Community soak pit, MGNREGA

Watershed Management, Assam

JSA Intervention Areas

5. Intensive afforestation

Existing scheme: National Afforestation Eco-Development Board and MGNREGA

M/o Environment, Forests and Climate Change
M/o Rural Development

Activity: a) Seedlings planted
b) Area under plantation

(For trees consuming less water)

Imli, Deccan Plateau

TYPES OF FLOODS

According to Duration

Slow-onset flooding

Rapid-onset flooding

Flash flooding

According to Location

Coastal flooding

River flooding

Urban flooding