SAARC Regional Training Programme
on
"Community Based Flood Risk Management"

25-27 October 2017

GIDM, Gandhinagar

Organized by:

SAARC Disaster Management Centre (Interim Unit), Gandhinagar

&

SAARC Division, Ministry of External Affairs, Govt. of India

Understanding Dynamics of Flood Disasters for CBDRR&R

Government of India

nidm

Towards a disaster free India.....

Surya Parkash, Ph.D.

Knowledge Management & Communication Division

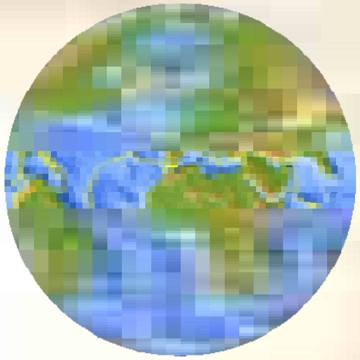
National Institute of Disaster Management

Ministry of Home Affairs, GoI

suryanidm@gmail.com

www.nidm.gov.in/surya.asp

Mobile: +91 98689 15226



Misfortunes Enter When Window Is Left Open to Them

- a Czechoslovakian Proverb

When heaven sends down calamities there is a hope of weathering them, but when man brings them upon himself there is no hope of escape

WCDRR

- In accordance with a UNGA resolution, ten-year period from January 1990 was designated as the **International Decade for Natural Disaster Reduction (IDNDR)**.
(Designation of the International Day for Natural Disaster Reduction, promotion of DRR measures, establishment of the secretariat for UNISDR in Geneva)

- **World Conference on Natural Disaster Reduction (May 1994, Yokohama)**
 - Conducted interim review of the IDNDR
 - Adopted the **Yokohama Strategy** and Plan of Action for a Safer World

- **World Conference on Disaster Reduction (January 2005, Kobe)**
 - Held in the city affected by Great Hanshin-Awaji Earthquake, at its 10th anniversary
 - Released a joint statement for building a tsunami warning system in response to the Indian Ocean Earthquake that occurred at the end of 2004.
 - Adopted the **Hyogo Framework for Action 2005-2015 (HFA)**

- **World Conference on Disaster Risk Reduction (March 2015, Sendai)**
 - Adopted the **Sendai Framework for Disaster Risk Reduction**, as a new framework for 2015 through 2030, committed to continue the action.
 - Held in Sendai, which was affected by the Great East Japan Earthquake in March 2011

Sendai Framework for Disaster Risk Reduction 2015-2030

Structure

Expected Outcome

The substantial reduction of disaster risk and losses in lives, livelihoods and health and in the economic, physical, social, cultural and environmental assets of persons, businesses, communities and countries

Goal

Prevent new and reduce existing disaster risk through the implementation of integrated and inclusive economic, structural, legal, social, health, cultural, educational, environmental, technological, political and institutional measures that prevent and reduce hazard exposure and vulnerability to disaster, increase preparedness for response and recovery, and thus strengthen resilience

Global Targets

① Number of deaths
② Number of affected people
③ Economic loss
④ Damage to medical and educational facilities
⑤ National and local strategies
⑥ Support to developing countries
⑦ Access to early warning information

Priorities for Action

Focused action within and across sectors by States at local, national, regional and global levels

Priority Action 1	Priority Action 2	Priority Action 3	Priority Action 4
Understanding disaster risk	**Strengthening disaster risk reduction for resilience**	**Investing in disaster risk reduction for resilience**	**Enhancing disaster preparedness for effective response, and to "Build Back Better" in recovery, rehabilitation and reconstruction**

Roles of Stakeholders

Civil society, volunteers, organized voluntary work organizations and community-based organizations to participate (In particular, women, children and youth, persons with disabilities, and older persons)	Academia, scientific and research entities and networks to collaborate	Business, professional associations and private sector financial institutions to collaborate	Media to take a role in contributing to the public awareness raising

International Cooperation and Global Partnership

General considerations	Means of implementation	Support from international organization	Follow-up actions

Highlights

- Seven concrete global targets were specified
- The targets include important policy focuses, such as mainstreaming DRR, prior investment, "Build Back Better", multi-stakeholders' involvement, people-centered approach, and women's leadership


THE GLOBAL GOALS


THE KEY ELEMENTS OF THE PARIS AGREEMENT
A text with universal scope, adopted by 195 countries
The aim: to keep the increase in global average temperature to well below 2°C and to 1.5°C if possible.
The objective: to level off greenhouse gas emissions as soon as possible.
The principal: to differentiate between developed and developing countries. Developed countries must lead the way for reduction of emissions and support developing countries in implementing this. Other countries with the ability to do so may also contribute their support on a voluntary basis to achieve this target.
The means: Countries must submit Intended Nationally Determined Contributions (INDCs) which are revised upwards every 5 years. The 1st report is due in 2023. North-South technology transfer.
The financing: from 2020 rich countries must contribute at least $100 billion per year. This amount will be reviewed in 2025.
The new mechanism: loss and damage. Measures must be taken to avert, minimize and address the concrete effects of climate change, in order to help the most vulnerable countries.
Entry into force: 2020 if the Agreement is ratified by 55 countries accounting for 55% of global greenhouse gas emissions.
$$$


PARIS CLIMATE AGREEMENT
Historical document that legally binds the whole World to participate in climate change fight.
196 countries
5 years
2°C
1.5°C


NATIONAL DISASTER MANAGEMENT STRUCTURE
GOVT OF INDIA
CABINET COMMITTEE ON MANAGEMENT OF NATIONAL CALAMITIES
CABINET COMMITTEE ON SECURITY
NDMA
NEC
NATIONAL INSTITUTE OF DISASTER MANAGEMENT
MINISTRIES & DEPARTMENTS OF GOVT OF INDIA
STATE GOVTs
NATIONAL DISASTER RESPONSE FORCE
DISTTs
DDMAs
SCIENTIFIC & TECHNICAL INSTITUTIONS
ACADEMIC INSTITUTIONS
PROFESSIONAL BODIES
COMMUNITY

ELEMENTS OF RISK

***Risk* = f (*Hazard, Exposure, Vulnerability, Location*).**

HAZARD- probability of occurrence of a damaging event of given Magnitude at a given place and a given time.

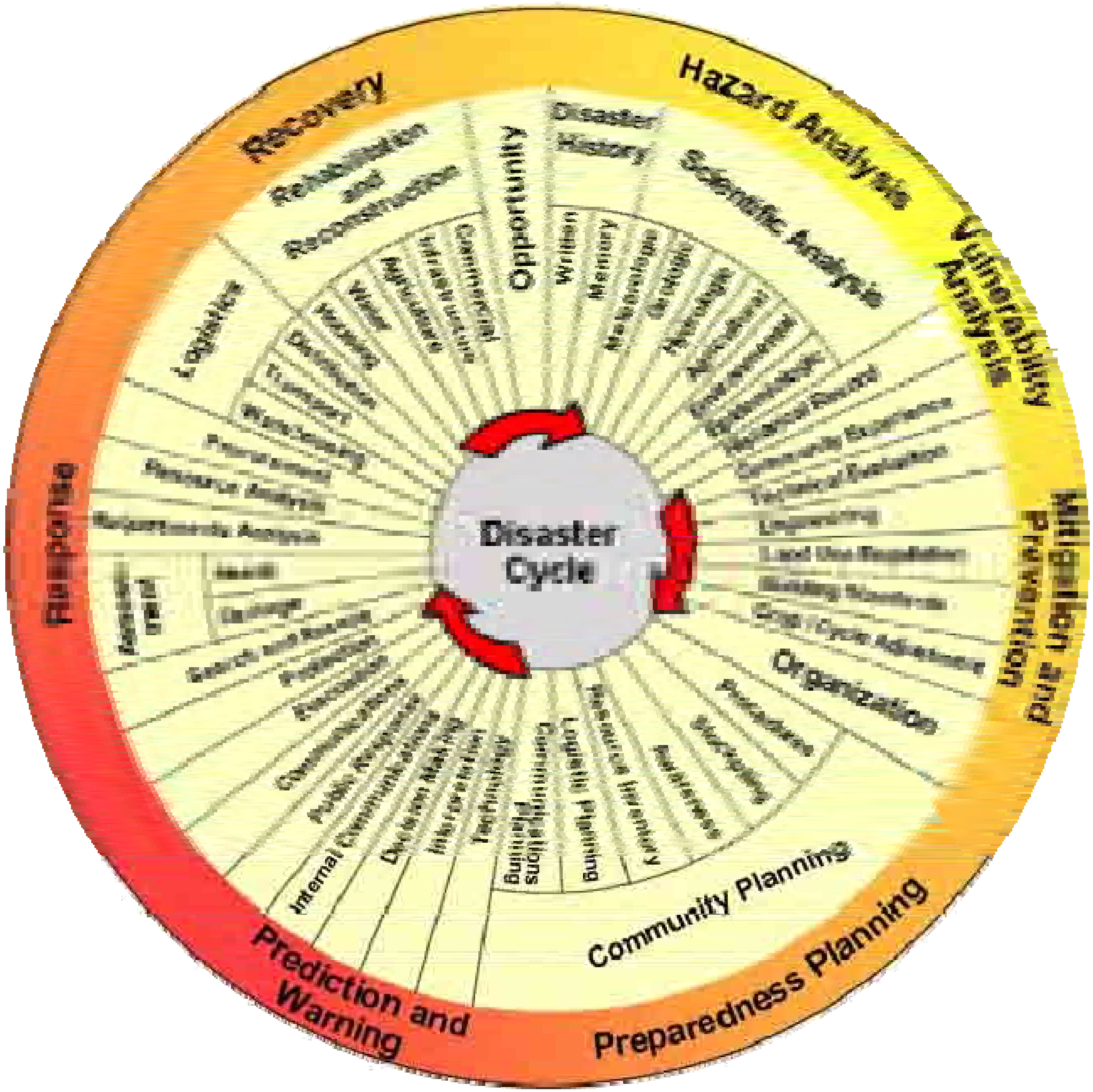
EXPOSURE- Objects and structures built by man which are exposed to the effects of the `*hazard*': buildings, bridges, dams, power plant, life-line structure, etc.

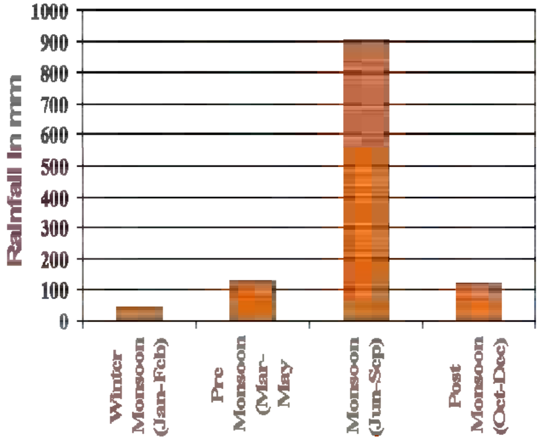
VULNERABILITY- Damageability of the `*exposure*' under the action of the hazard; weaker ones being more vulnerable and `risky' than the stronger ones.

LOCATION- (i) How far the `exposure' is situated from the *Hazard* location the nearer ones being in greater danger than those far away, and

(ii) Local site conditions which can modify the *hazard* and/or affect the stability of the exposure, such as topography, soil deposit, water table, etc.

DISASTER RISK MANAGEMENT CYCLE





Major Causes of Floods

- Temporal & spatial distribution of rainfall
- Drainage congestion
  - Inadequate drainage capacity
  - High tides, storm surges
- River erosion & Embankment breach
- Landslide Dams & Glacial Lake Outburst
- Transboundry rivers systems
  - Ganga
  - Brahmaputra & Barak
  - Indus, Jhelum

Flood Prone Area(s)

- Flood Prone Area: 40Mha (12% of country area of 329Mha)
  - Annually on average about 2% of country area is affected
  - On an average about 2.5% of country population affected annually
  - About 0.03% of GDP Damage
- Major Flood Prone Basins: Ganga, Brahmaputra, Mahanadi, Godavari
- Structural & Non-structural measures adopted to manage
- Flood Forecasting & Warning is cost effective non-structural measure

Flood Forecasting in India

- Central Water Commission (Ministry of Water Resources, River Development & Ganga Rejuvenation) - Nodal department for Flood Forecasting

- Services based on hydro-meteorological data from its network, reservoir release data received from project authorities, Rainfall forecast from India Meteorological Department

  ✓ Estimation of river WL or inflow into reservoirs in advance to alert concerned

Role of Institutions

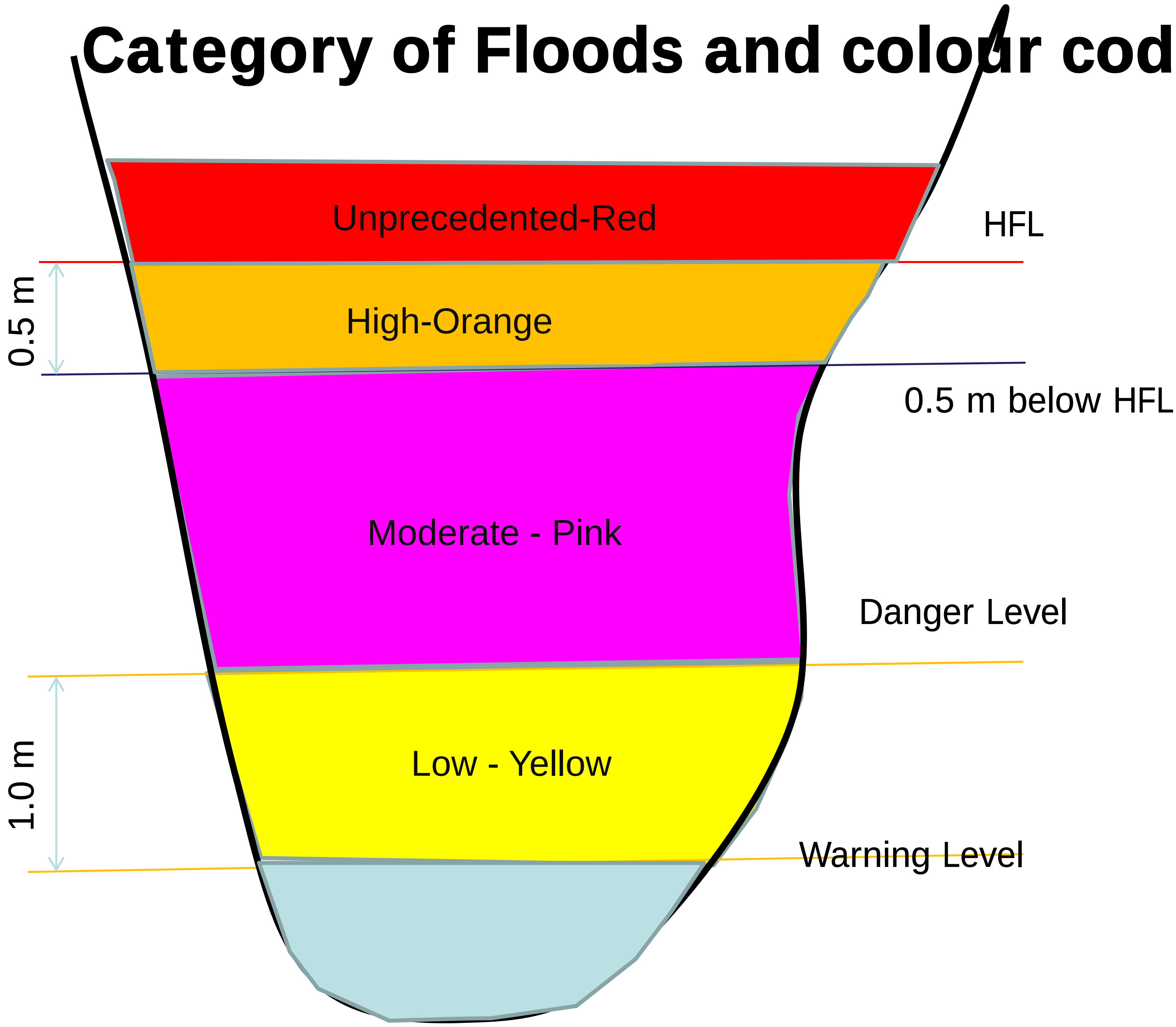
- **India Meteorological Department (Ministry of Earth Sciences)**
  - **Weather Monitoring & Forecast**
- **National Remote Sensing Centre (Department of Space)**
  - **Satellite observations and monitoring**
- **Central Water Commission (Ministry of Water Resources, River Development & Ganga Rejuvenation)**
  - **River Monitoring & Flood Forecasting**
- **State Governments**
  - **Warning and mitigation**
- **National Disaster Management Authority**
  - **Policy and Guidelines**
- **Ministry of Home Affairs**
  - **Overall inter agency coordination**

Flood Monitoring Period

Sl. No.	Basin	Modified Period
1.	Brahmaputra Basin	1st May to 31st Oct
2.	All other Basins upto Krishna Basin	1st June to 31st Oct
3.	Basins South of Krishna Basin (Pennar, Cauvery and Southern Rivers)	1st June to 31st Dec

- In case of floods beyond designated period due to unexpected rain/releases from dams or other reasons, FF activity shall be resumed by concerned organisation/division till water level falls below threshold limit & necessary bulletins shall be disseminated.

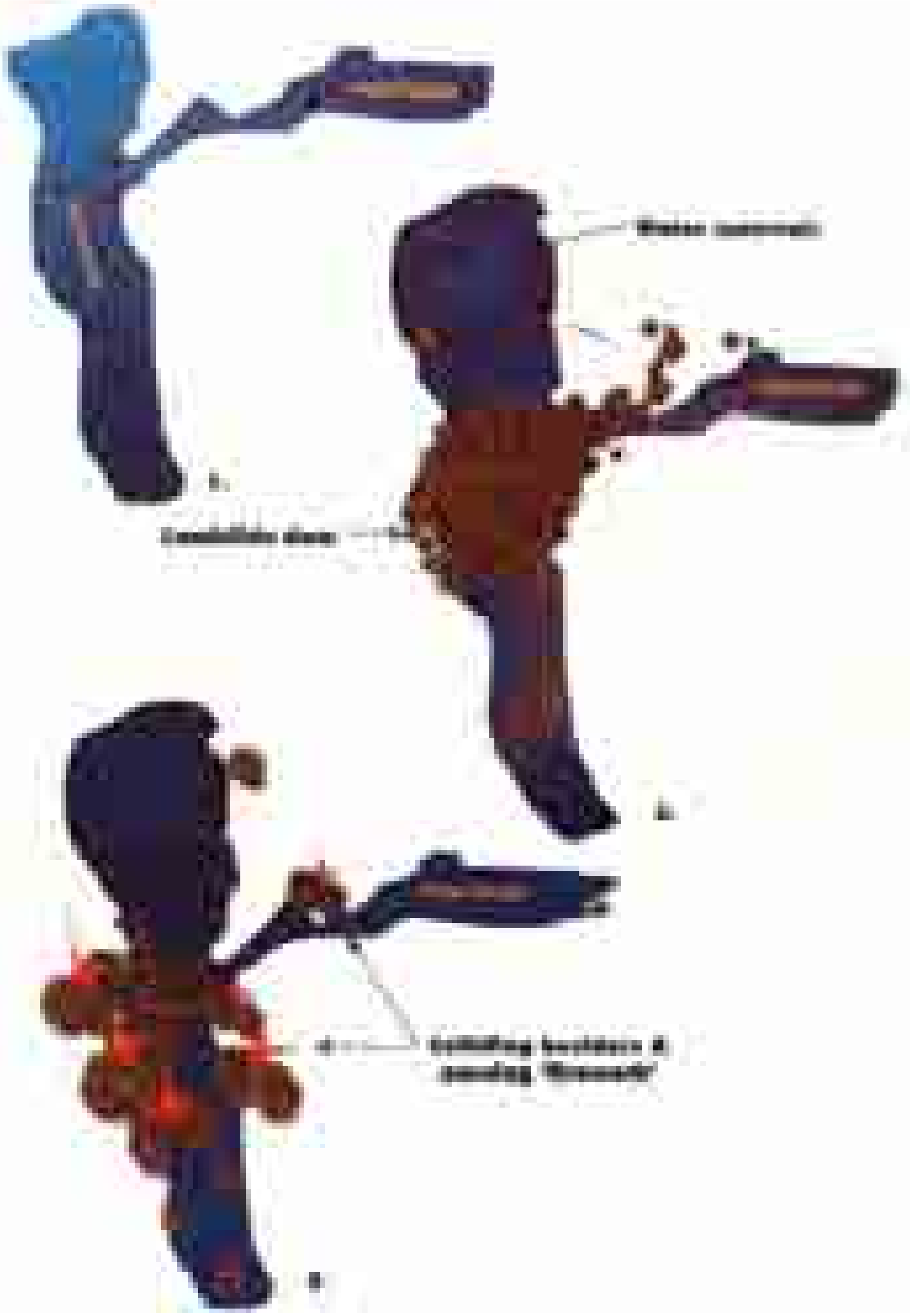
Category of Floods and colour code



Some Significant Flood Events

Alaknanda Tragedy

Belakuchi immediately after 1970's flood



A rare Catastrophe in Himalayan Region
20 August 1970

PARECHU LAKE FORMED BY LANDSLIDE POSED STRATEGIC, SOCIO-ECONOMIC & ENVIRONMENTAL RISKS;

AFTER BURSTING LEAD TO LOSS OF ABOUT 2000 CRORES OF RUPEES AND DAMAGES TO SEVERAL PROJECTS, STRUCTURES & INFRA-STRUCTURES

Typical example of Toe erosion by the 2005 Flash flood


H-T FLOOD 26 JUNE 2005

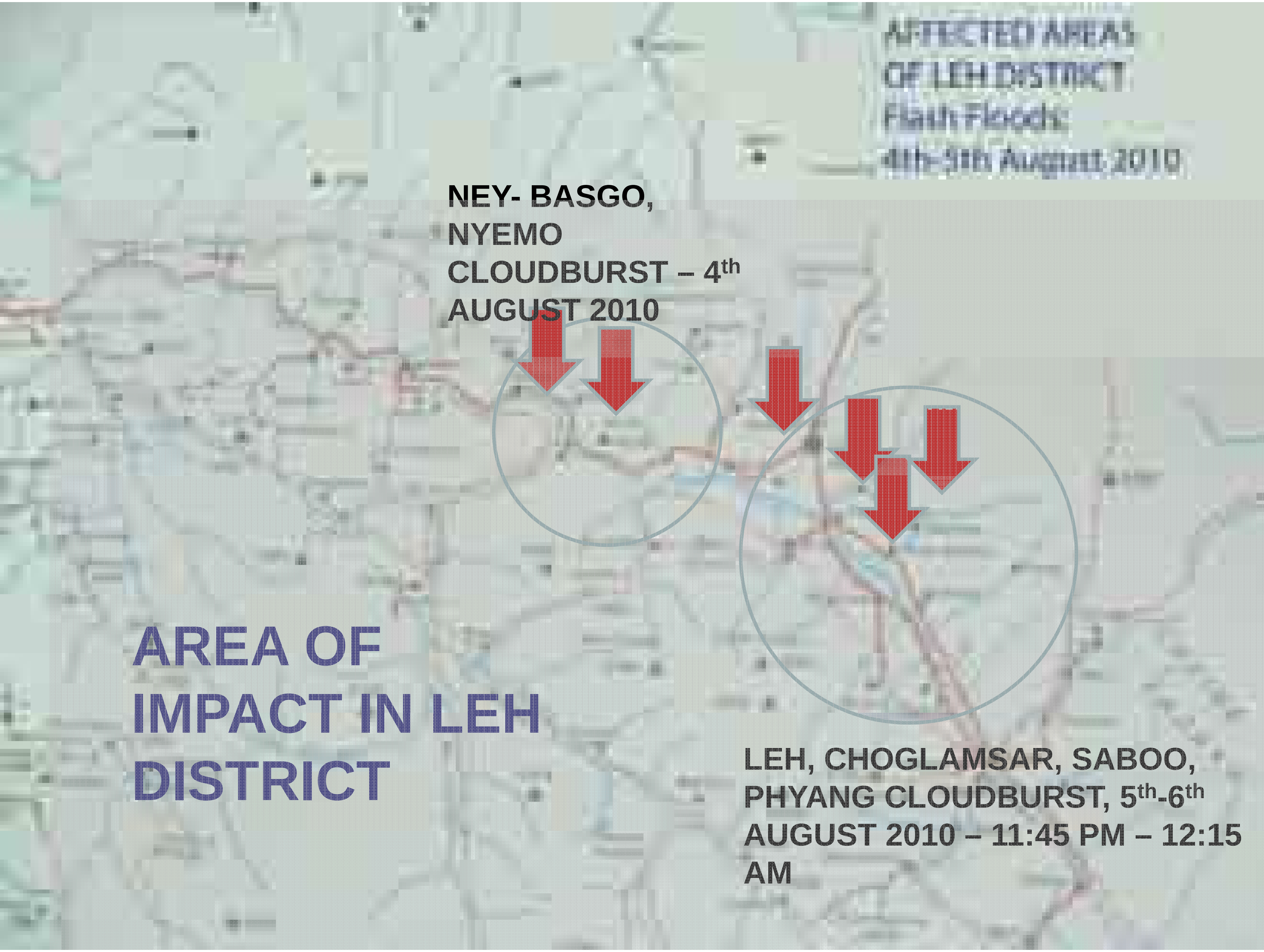
360 FT BSB AKPA BRIDGE HANGING ON ROPE

BADRINATH LANDSLIDE (2005) THAT TRAPPED >5000 PILGRIMS

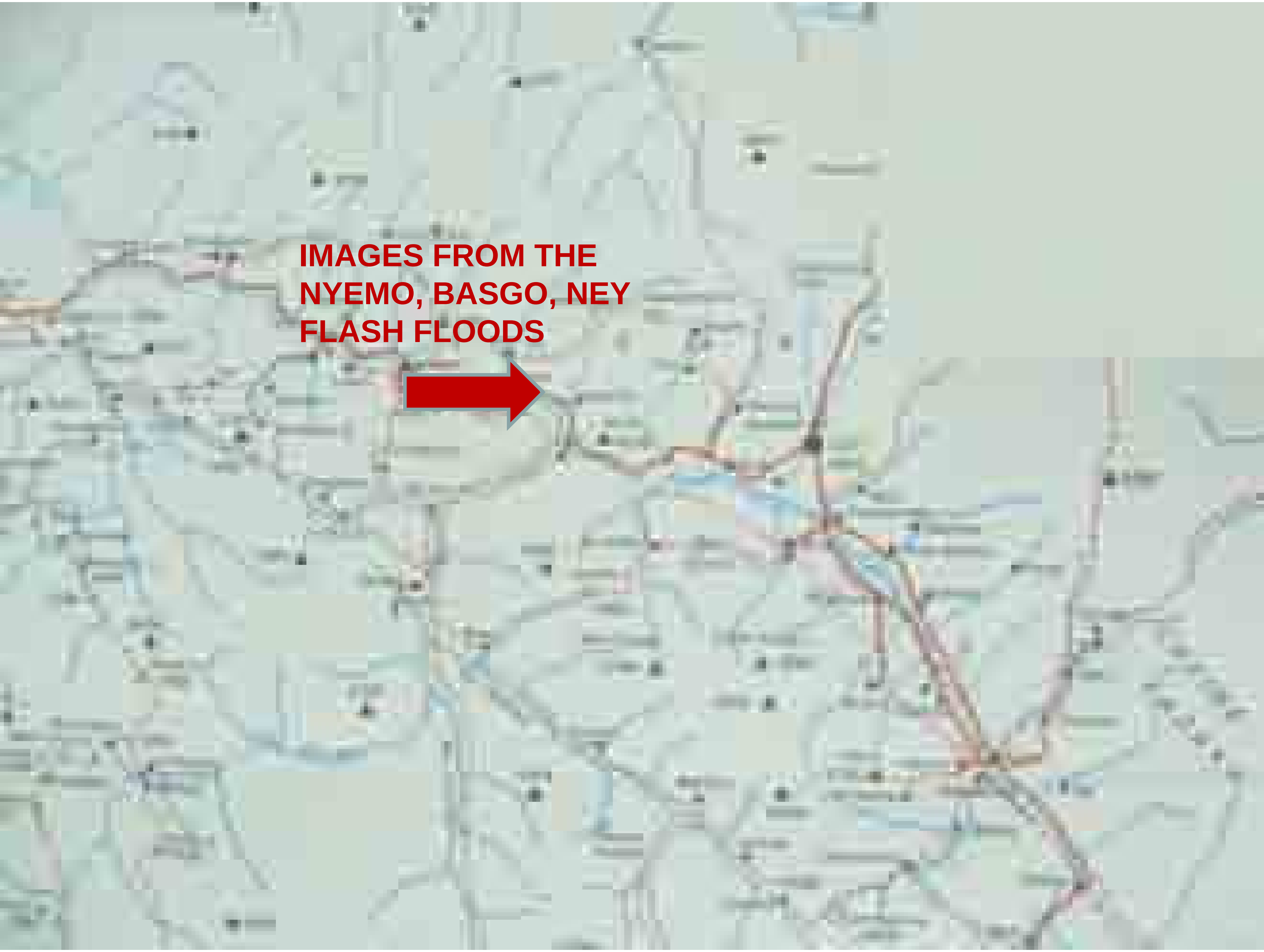
Khanera


Debris Blocked Kali River
Chautuldhar, Dharchula


Lake formed in Kali River due to the
Blockage by Landslide



AFFECTED AREAS OF LEH DISTRICT
Flash Floods:
4th-9th August 2010
NEY- BASGO, NYEMO CLOUDBURST – 4th AUGUST 2010
AREA OF IMPACT IN LEH DISTRICT
LEH, CHOGLAMSAR, SABOO, PHYANG CLOUDBURST, 5th-6th AUGUST 2010 – 11:45 PM – 12:15 AM


IMAGES FROM THE
NYEMO, BASGO, NEY
FLASH FLOODS


National
Highway to
Srinagar

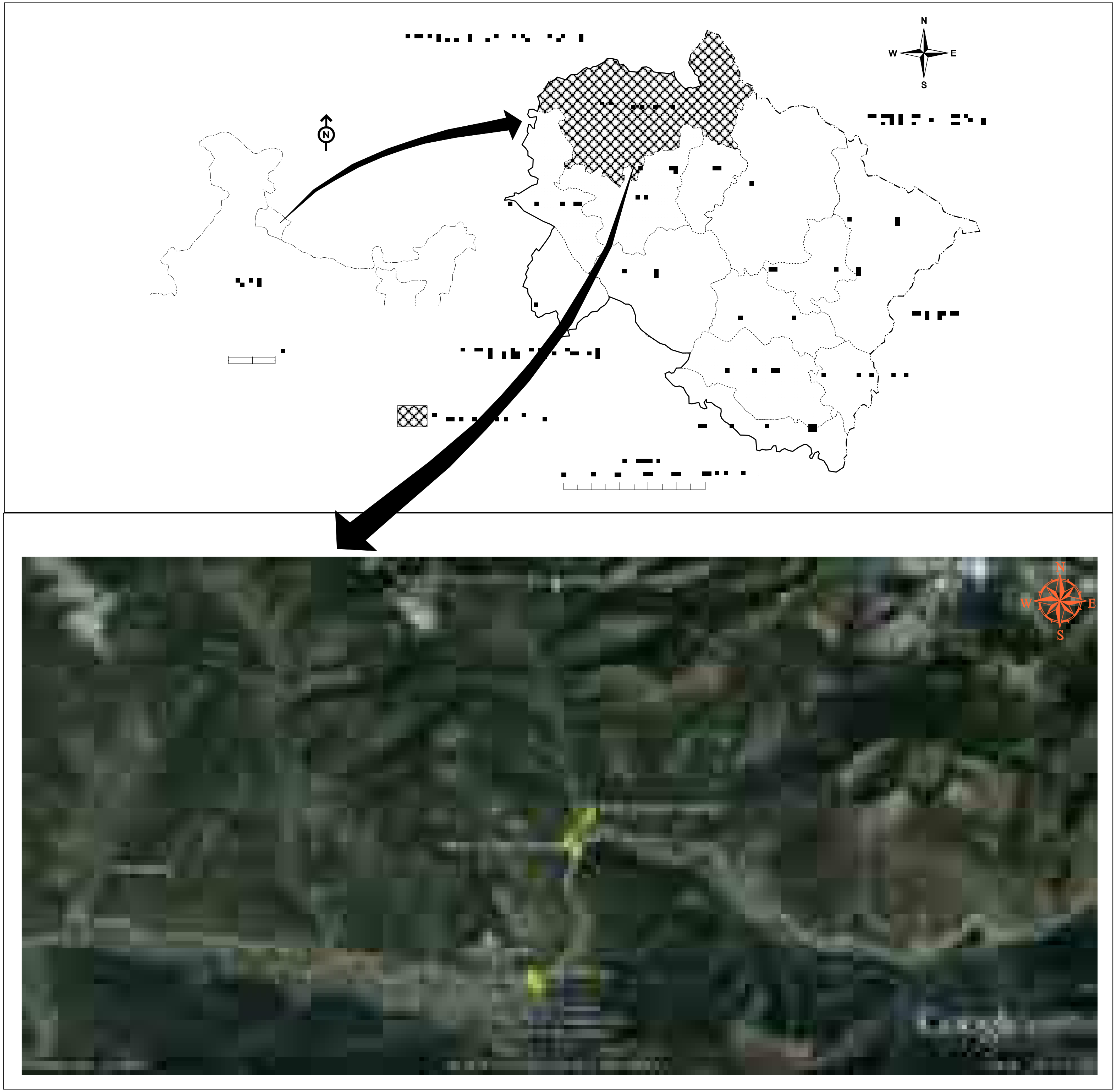

N
W
E
S

Figure 1.2: Access Route Map from New Delhi to Uttarkashi

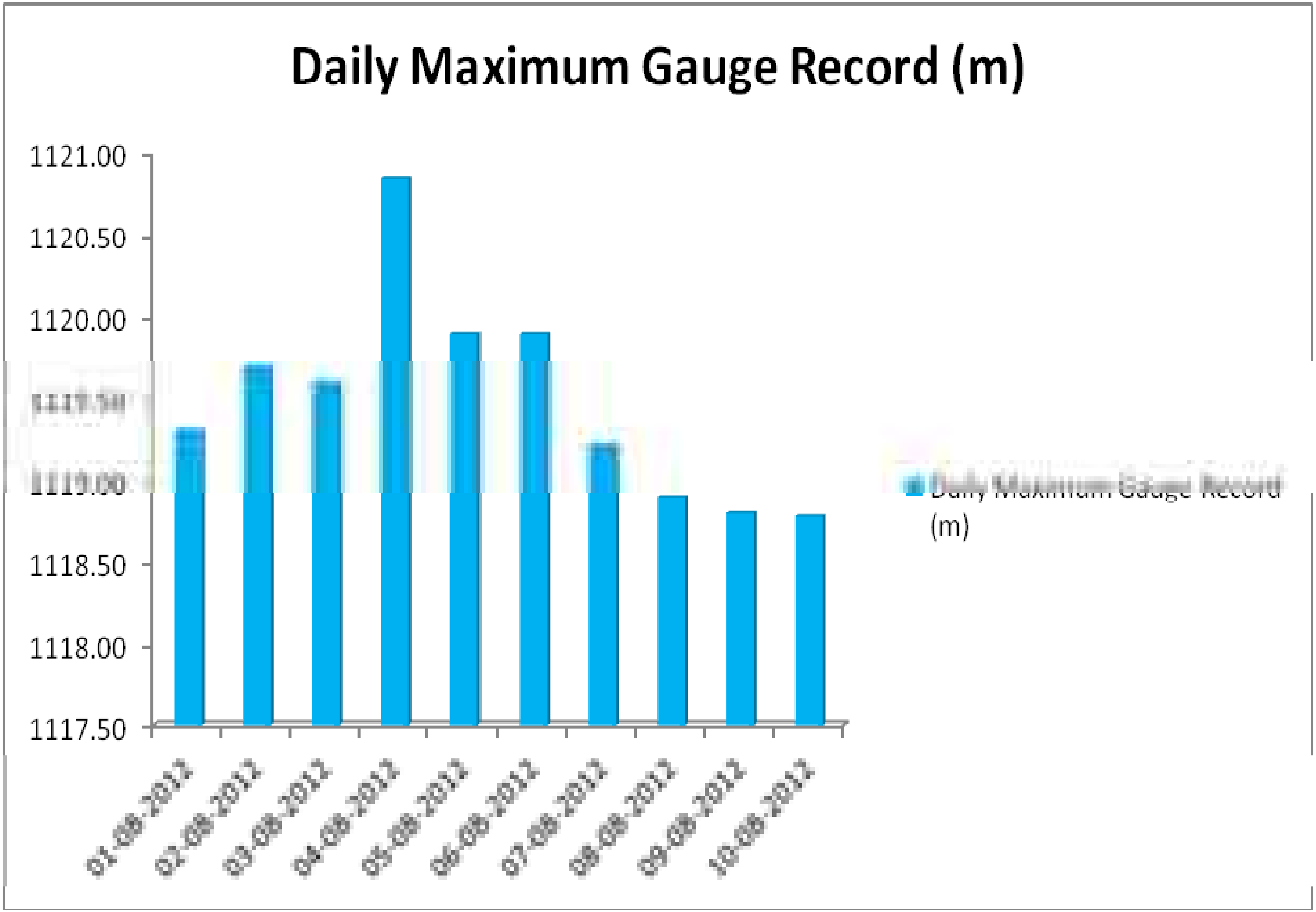


Fig. 1.5: Daily Gauge Records indicating maximum water level in the Bhagirathi river durng 1-10 August 2012

Automated Weather Station for recording rainfall, temperature and pressure at DGBR office, Tekhla

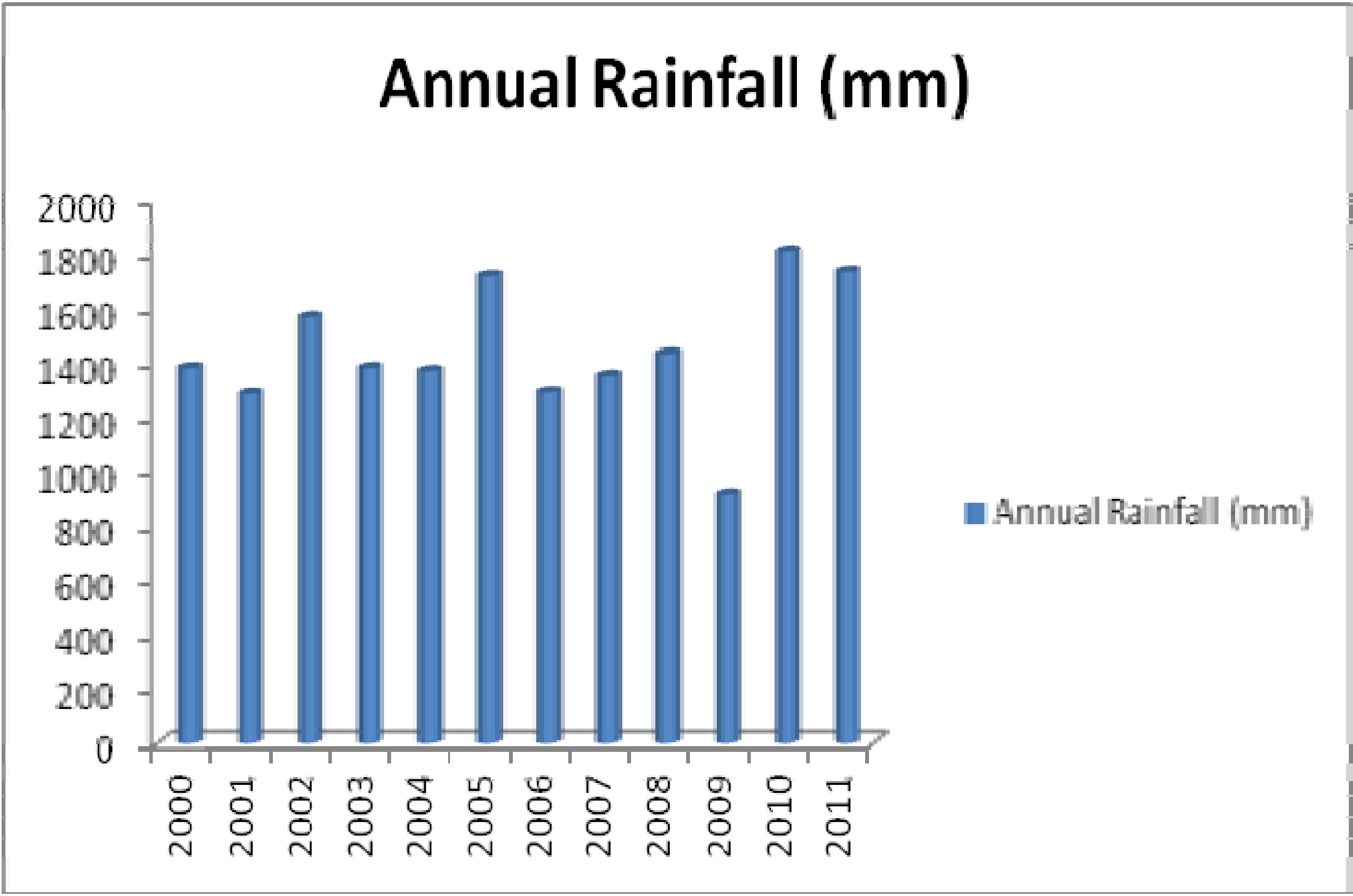


Fig. 1.67: Average Cumulative Annual Rainfall in the Uttarkashi district during the period between the years 2000 and 2012

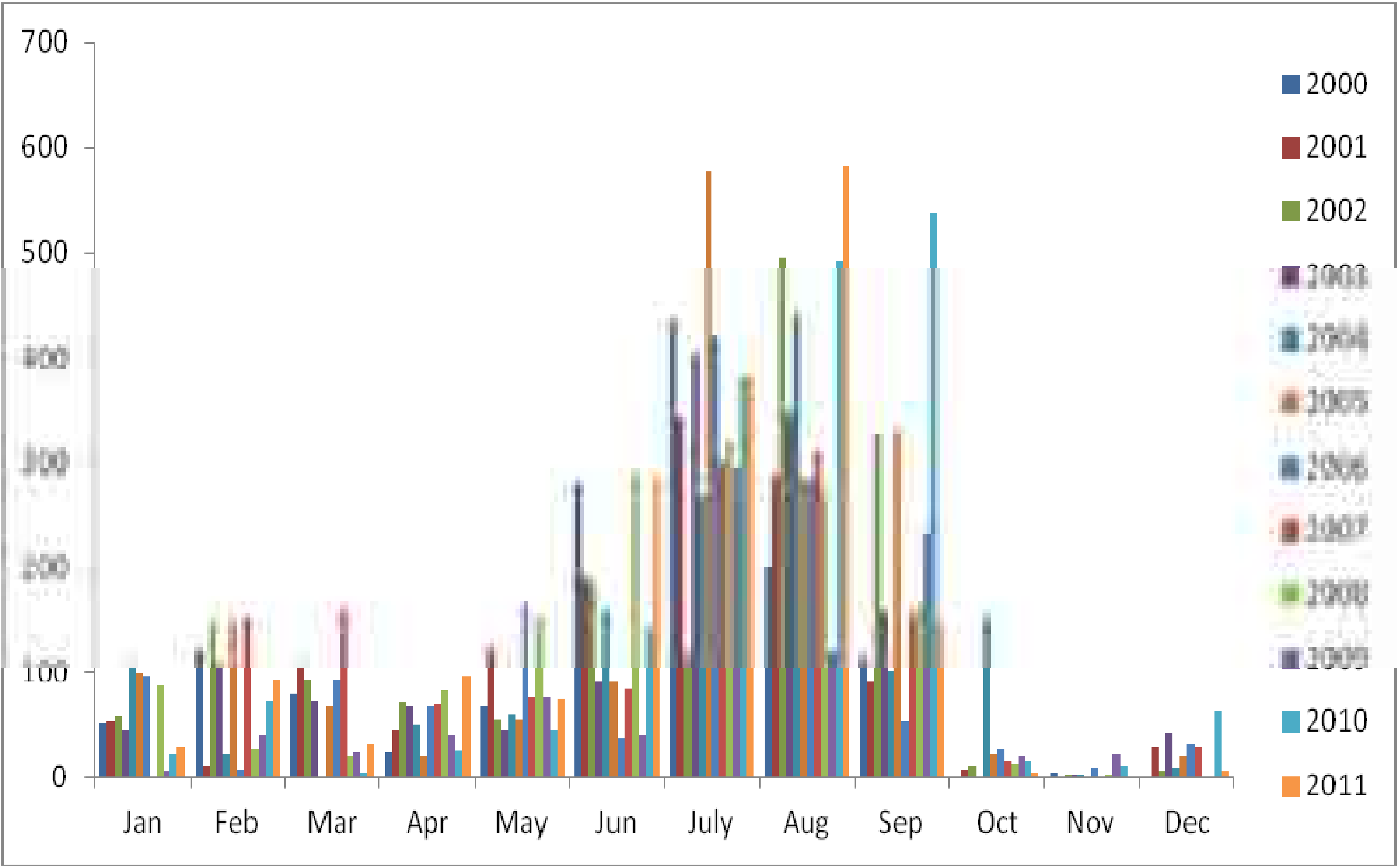


Fig. 1.65: Average Monthly Cumulative Rainfall in the Uttarkashi district during the period between the years 2000 and 2011

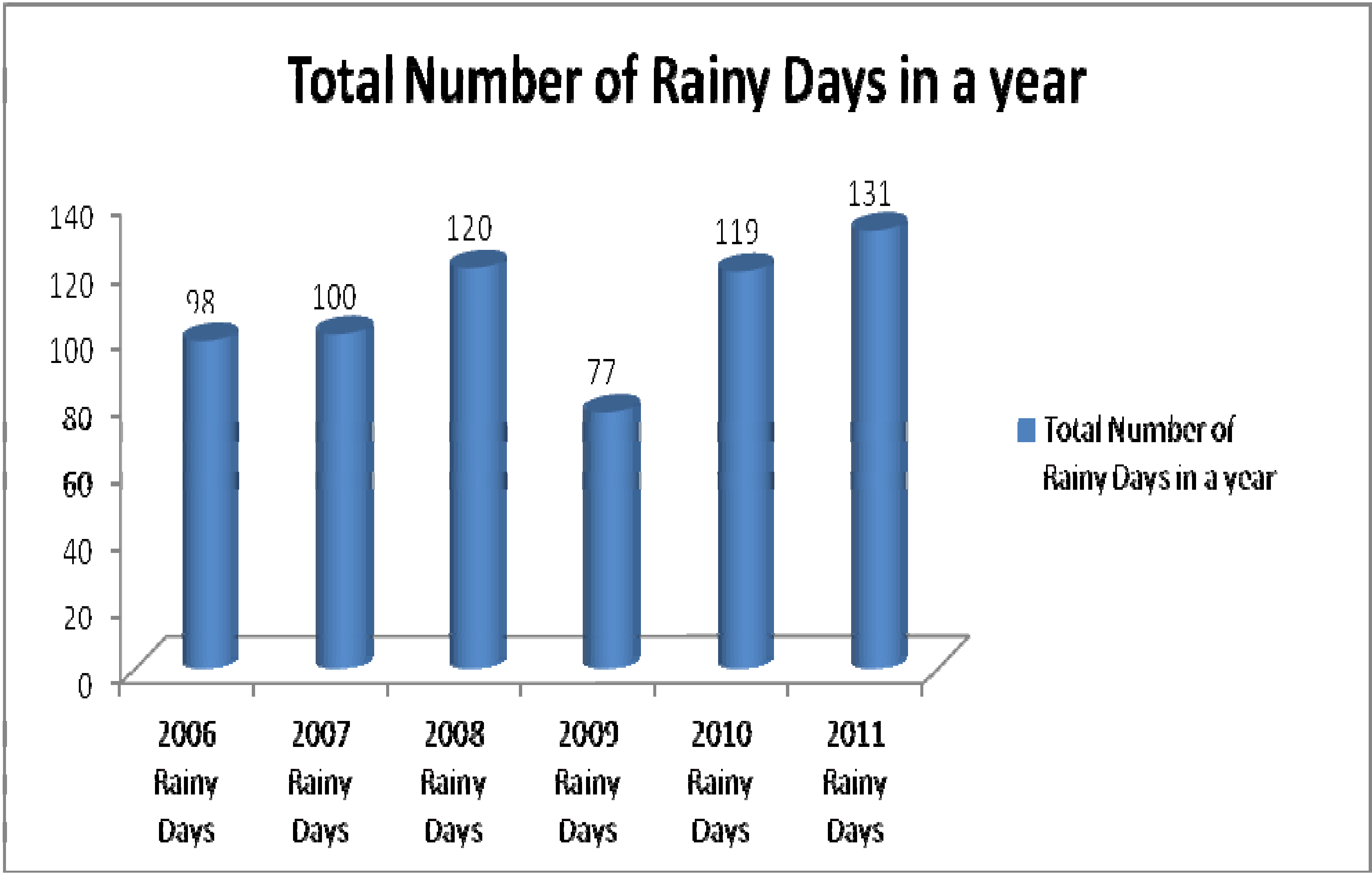


Fig. 1.68: Cumulative Number of Rainy Days per year in the study area during the period between the years 2006 and 2011

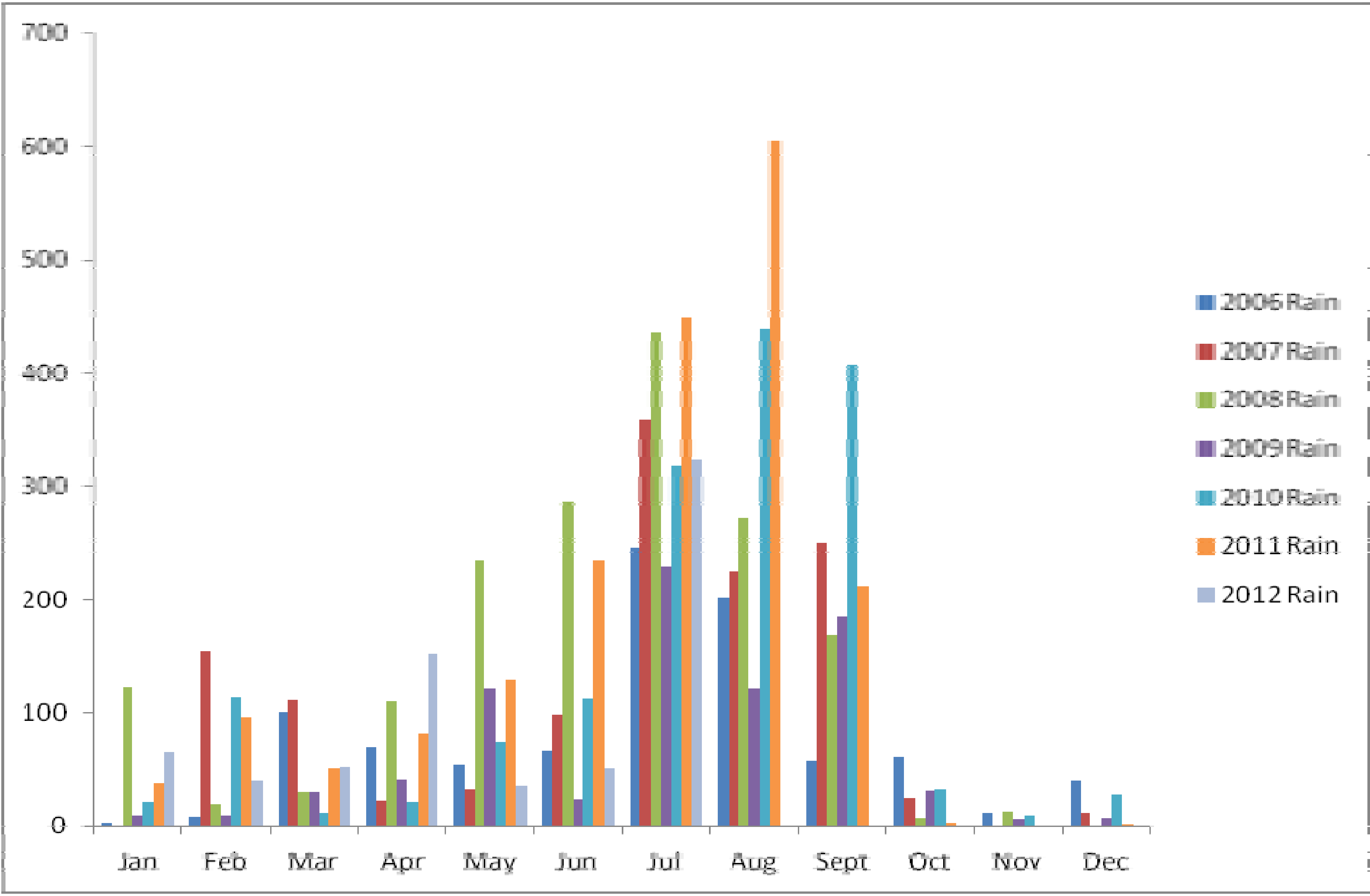
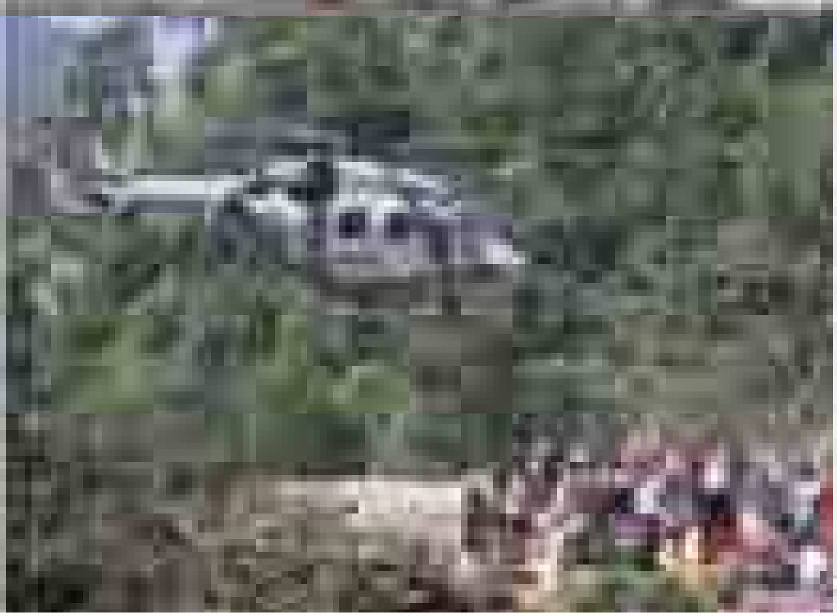
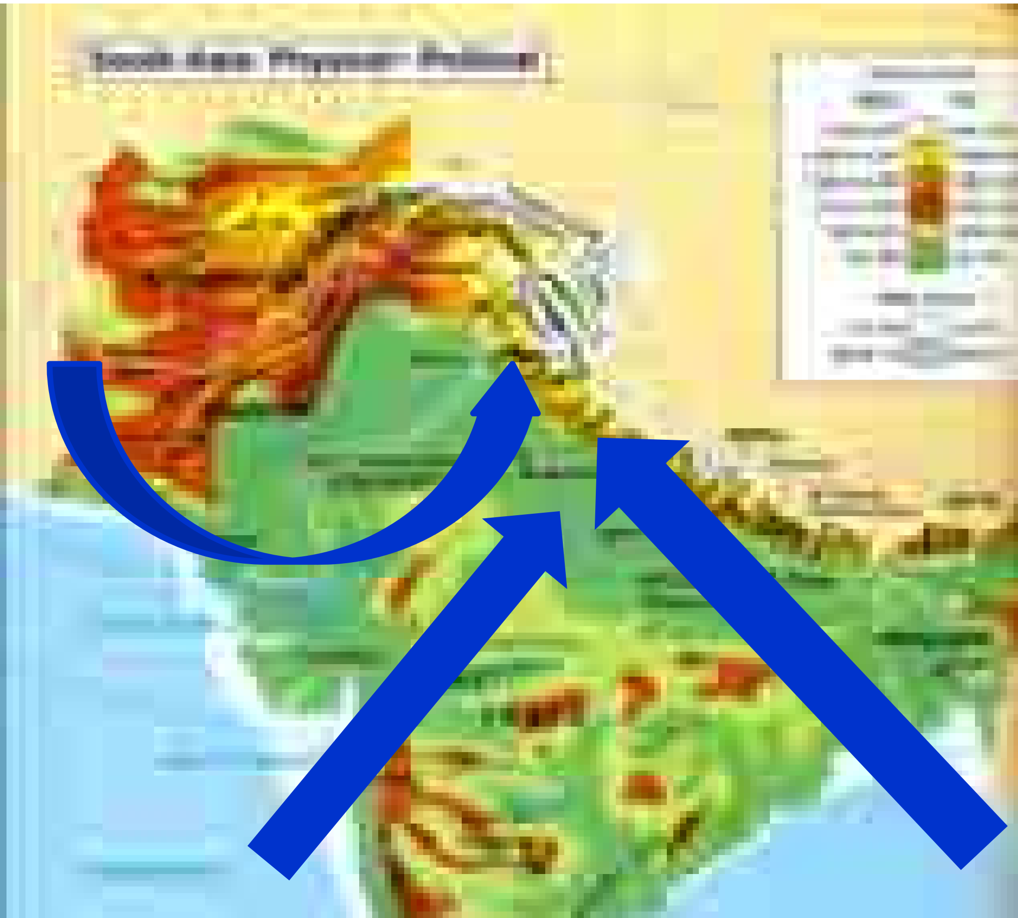


Fig. 1.64: Average Monthly Cumulative Rainfall in the study area during the period between the years 2006 and 2012

UTTARAKHAND FLASH FLOOD 2013



Probable causes of the disaster



The excessive rainfall probably caused by fusion of **westerlies** and **monsoon clouds**

State was hit by ‘**heavy**’ (64.5-124.4 mm) to ‘**very heavy**’ (124.5-244.4 mm) rainfall

Breaching of **Chorabari lake** near **Kedarnath temple**

- Rivers carrying higher amounts of water due to continued widespread rains for previous 3-4 days

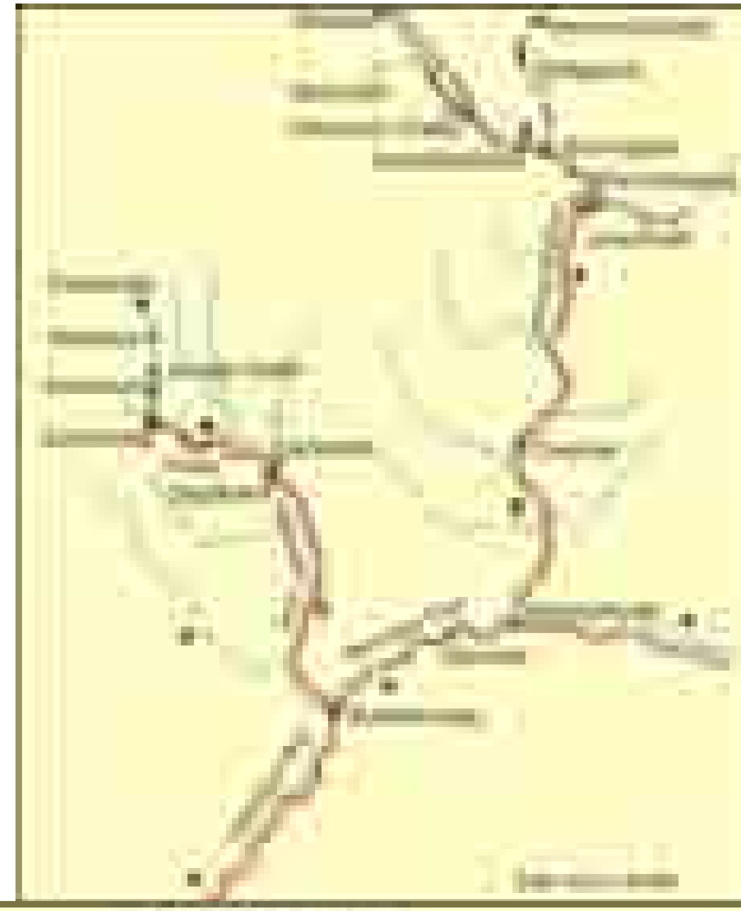
✓ Disaster Vulnerability increased by heavy influx of Pilgrims

✓ Increase in snowmelt due to warm monsoon rains added to increased runoff.

✓ A possible Lake burst added to the impact.

Impact of the Disaster

The districts of **Bageshwar**, **Chamoli**, **Pithoragarh**, **Rudraprayag** and **Uttarkashi** were the most affected.



The worst impact of the disaster events of June 2013 on human settlements was in the Kedarnath shrine area (Gaurikund to Kedarnath), the Mandakini valley, the Alaknanda valley (at Gobindghat and upstream), the Pindar valley, and along the banks of the river Kali in Dharchula area.

Development issues

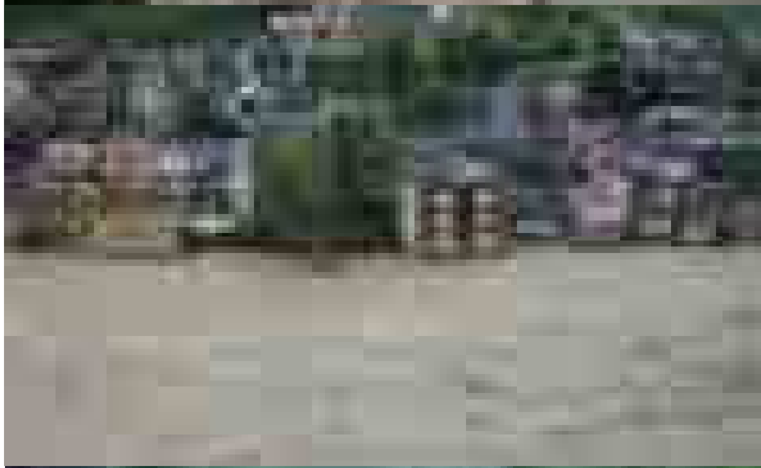
- Inappropriate hill area development including *unscientific construction of road and buildings, infrastructures, hydro-projects, utility services*
- Illegal *encroachment* taking place along the rivers (Since 2002 there has been a ban on building within 100 meters of the river bed which is often violated)
- *Human activities* like deforestation, river bed mining, quarrying, blasting, drainage disruption, slope modification etc
- Greater emphasis on *commercial / tourism / infrastructural development* since the formation of Uttarakhand
- *Dissonance/imbalance in the environment/ecosystems*

Land use Planning

Implementation of "*Flood Plain Zoning*" regulating construction within the flood plain of a river

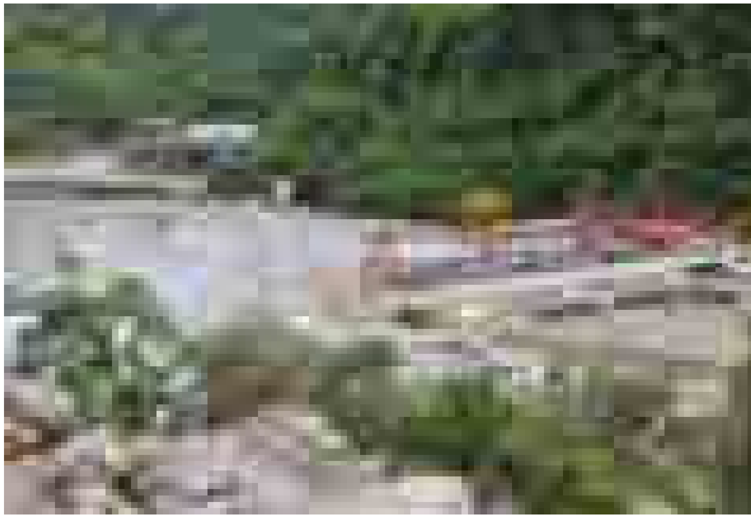
Legal *framework needs to be developed to avoid construction on unstable or steep slopes* and ensure land use planning based on Hazard, Risk and Vulnerability studies

Encroachment in riverbeds must be strictly prohibited and all past encroachments must be immediately removed



Hydro-power projects

- Along with the **Environmental Impact Assessment** (EIA), hydropower projects in ecological sensitive regions like Uttarakhand must have comprehensive Disaster Impact Assessment (DIA) mandatory for project clearance.
- **Hydroelectric projects** must have a **muck disposal plan**, with proper site for muck disposal, and plans for transportation of muck to the designated sites well above the high flood levels.
- **Alternative energy** options like solar / wind / bio energy need to be further explored in the Himalayan region



River Bed Mining

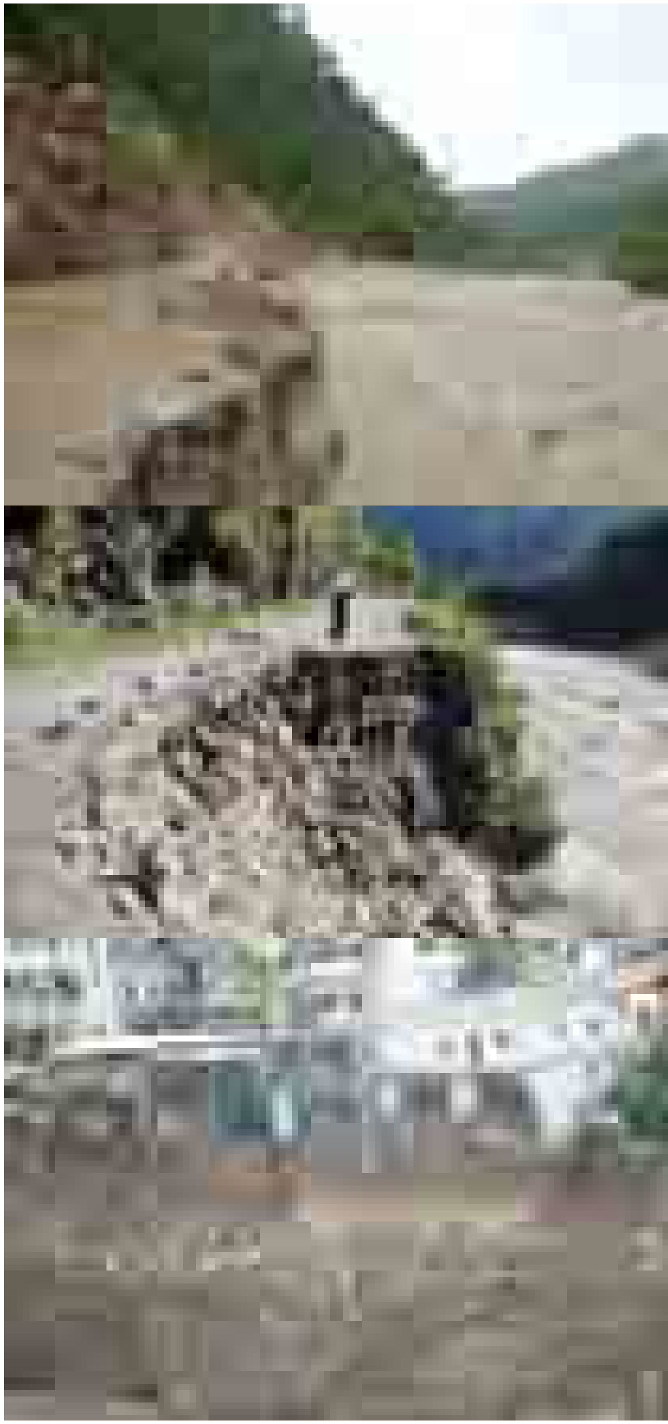
River Bed Mining related issues are to be tackled systematically, based on the scientific investigations, taking care of ecological aspects.

The issue needs an area specific approach before giving **lease for River Bed Mining**.

Unsustainable mining of the riverbeds must not be allowed and illegal mining must be stopped immediately

Landslide management

- **Landslide risk micro-zonation** using ground truth of landscape, geology, ecology, vegetation, soil characteristics, human settlements, landslide and flood history of the site.
- **Appropriate guidelines**, regulations and codes for landslides risk assessment and mitigation through an integrated approach, involving State agencies/departments and local administration.
- **Blasting** for **developmental activities** must be avoided because frequent blasting may destabilize the weak rocks of the region, which may result in landslides and rock falls



Road Construction

- Review the **alignments of existing roads** in consultation with scientific agencies.

- In view of the importance of roads connecting pilgrimage centres and sensitive border areas, a **Programme for construction of new roads**, and **widening** and **renovation** of existing roads should be undertaken in a **scientific manner**.

- **Separate evacuation routes/roads** to be constructed from major pilgrim centres, even if they are for short stretches.

Jammu & Kashmir Flood 2014

Date of event	6 & 7 September 2014
Duration	several days
Location	I Jammu and Kashmir in India as well as in Pakistan area
Deaths	**Total** : 557 deaths 277 in India 280 in Pakistan
Property damage	2,550 villages affected 80,000 people evacuated

This image of the northern Indian subcontinent captured by NASA on 4 September 2014 shows that heavy clouds over Jammu and Kashmir.

Rainfall over J&K

- Jammu & Kashmir experienced the worst floods in the past 60 years during first week of September 2014

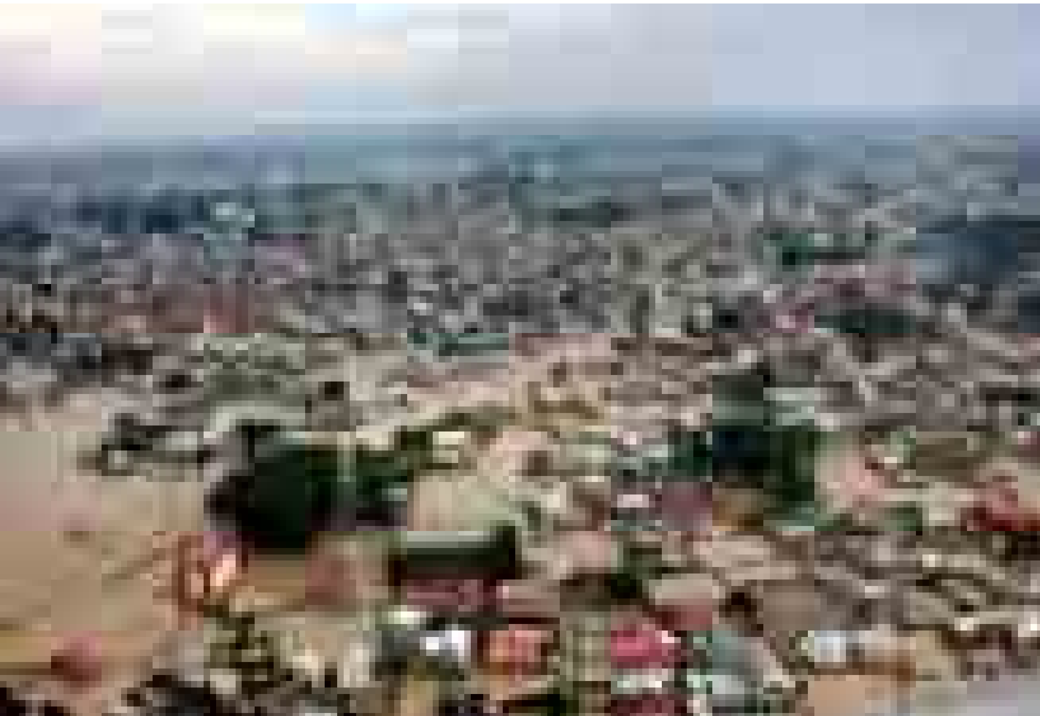
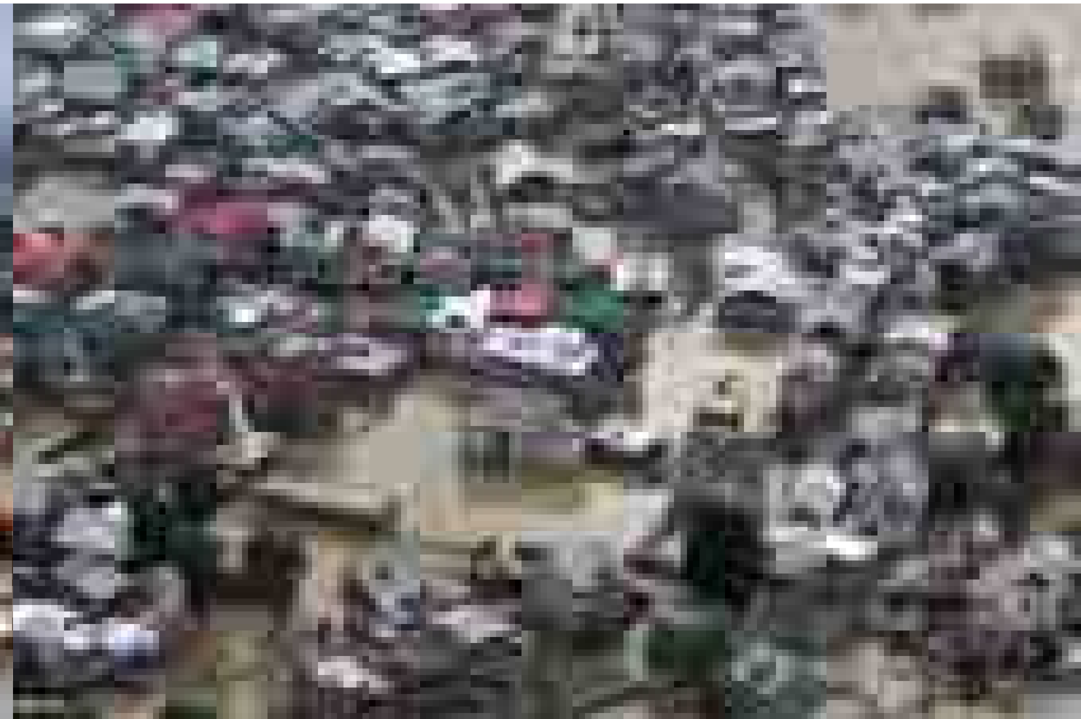
- The Jammu and Kashmir state experienced catastrophic rainfall from **1**st to **6**th of September

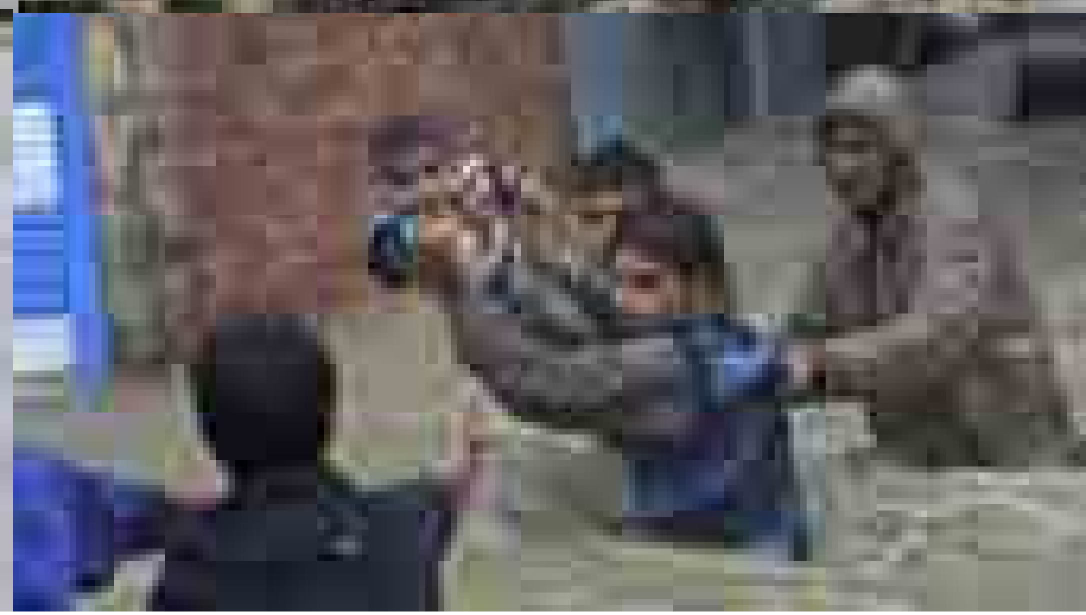
- On September 4th, 2014 J&K experienced 30 hr long rainfall that has broken the record of many decades

- Some parts of the state experienced more than 650 mm of rainfall in 3 days

Source: Department of Ecology, Environment and Remote Sensing, J&K Govt.

Affected areas



Affected areas

- Several thousand villages across the state had been hit and 390 villages had been completely submerged

- Many parts of Srinagar, including the Border Security Force (BSF) HQ in Sanant Nagar & Army cantonment in Badam Bagh, were inundated, and vital roads were submerged, by the floods

- On **September 8**, in many parts of Srinagar's neighbourhood, the water was about 12 feet (3.7 m) deep, submerging entire houses

- The death toll was 277 in India and areas affected by the floods were mostly districts in South Kashmir

POSSIBLE CAUSES

Impact of Climate Change

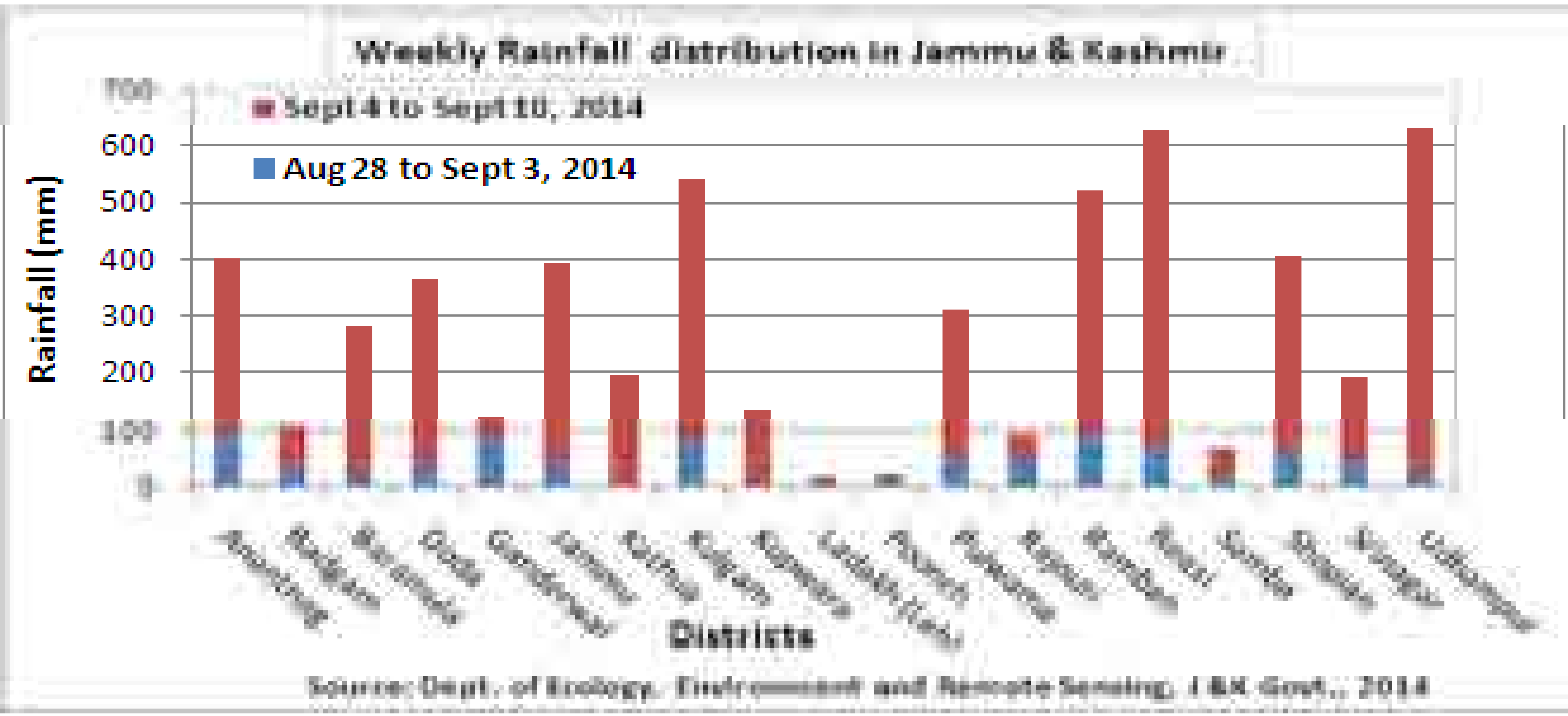
As per IPCC 5th Assessment Report there will be 30% increase in the incidence of extreme rainfall in Asia

Occurrences of floods outside the traditional States of Bihar, Assam, Eastern UP and Orissa have increased due to higher frequency of extremely high intensity rainfall storms

POSSIBLE CAUSES

Impact of Climate Change

Highly anomalous rainfall storms and **shifting** of their distribution is now an internationally admitted manifestation of climate change induced by indiscriminate **industrialization**, **urbanization**, **consumerism** and **other factors**.



POSSIBLE CAUSES (Contd.)

Glacial melt and heavy rainfall

The glaciers and hard rocks produced lot of run-off, the soil of the region was already saturated and incessant high rainfall for four days generated unprecedented floods, which raised the flood level of Jehlum at Sangam to about 34.70 ft (danger level 21) breaking all the previous records.

This resulted in the abrupt increase in the flood level at Ram Munshi Bagh which touched around 29.50ft (danger level 18). This was boosted by the heavy rains in Sindh basin (105mm) resulting in heavy discharge in Sindh Nallah which joins the Jehlum at Shadipora causing an upward rush and limiting the free flow of Jehlum water into the Wullar Lake

POSSIBLE CAUSES (Contd.)

Breaches of protection structure

Due to high speed of Jhelam river water, embankment along the river gets breaches at many locations such as Kandizal, Chursu, Lelhar, Marwal, Khadermoh causing wide spread flood in the region.

Ecological Aspects of Floods

Vast network of wetlands and waterways locally called “Dembs” acted as sponges during the floods and shared the Jhelum waters, but during the last few decades due to rapid urbanization, these wetlands and water ways were converted in to built-up areas

Wetlands in Kashmir valley have lost their water absorption capacity due to excessive siltation and encroachments, thus decreasing the chances to provide assistance during floods

A view of the growing lake formed behind the landslide, seen from the ruins of Attabad village, Pakistan on February 1, 2010

Phuktal River Blockade 2014

- **Around 31 Dec 2014, a major landslide caused a blockade of River Phuktal, a major tributary of River Zanskar, thereby creating an artificial reservoir**

- **The location is about 90 kms from Padum. However the road terminates at Zordang which is still 43 kms from Padum**


BLOCKAGE LENGTH


BLOCKAGE WIDTH


50 MTR HIGHT FROM
RIVER BED

Kosi Flood 2008

On 18th August, embankment of river Kosi suffered a breach at Kusaha, 10 kilometers inside Nepal bordering Supaul district of Bihar

After the breach the **river effectively changed course -** on the day of the highest discharge the flow in new course was 191800 cusecs and only 25744 cusecs in the old course.

Spread of water in the new course 150 km long and 15 to 20 km wide.

More than 33 lakh people and their houses spread in 110258 ha land fell in the path of the new course.

North Karnataka Floods (Karwar) October 2009

A Calamity of Unprecedented Proportions: Heavy Rains and Flood Havoc caused by Low Pressure System (28/9 – 5/10/2009)

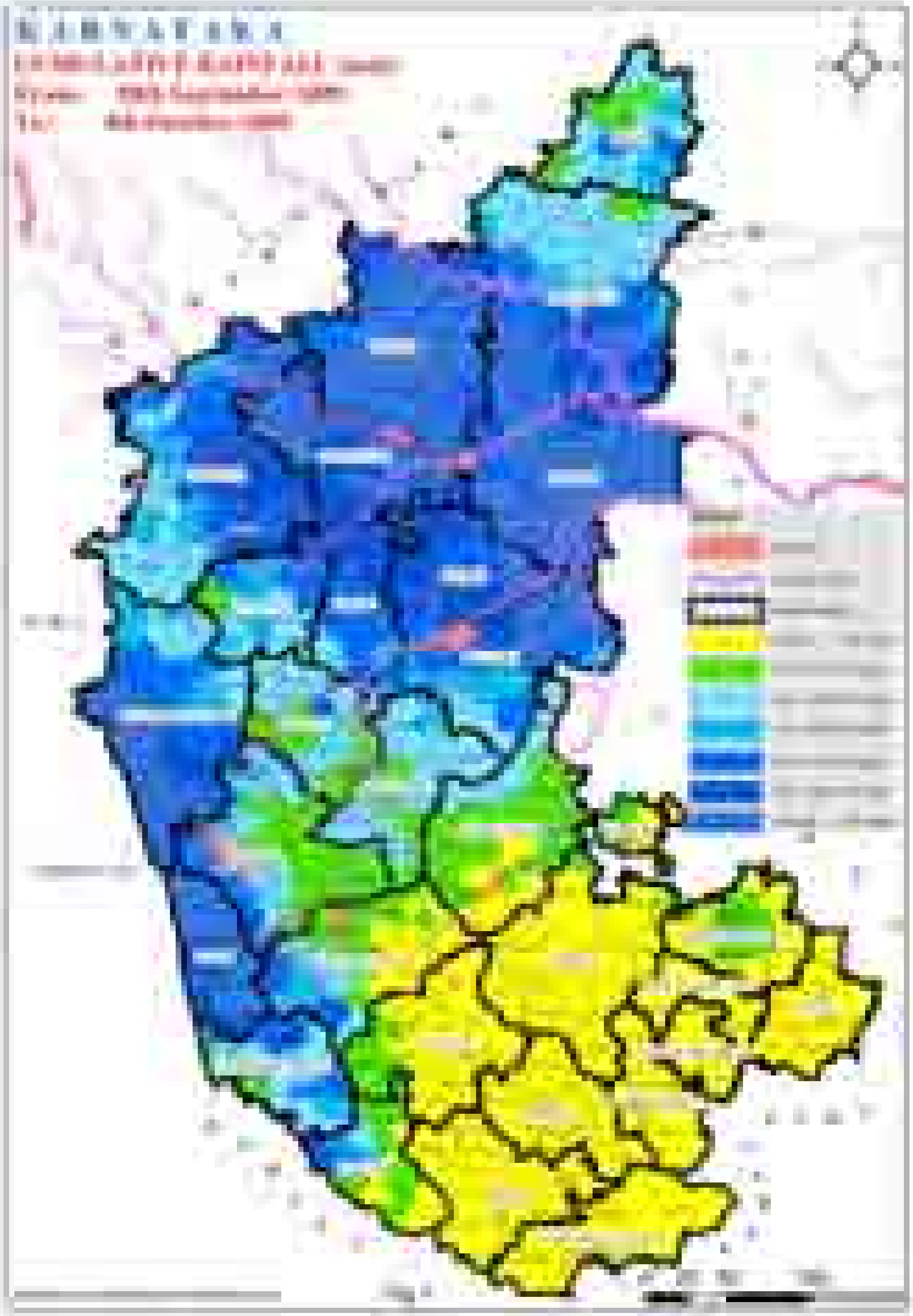
Area and Population Affected:

15 Districts, 84 Taluks

63% of the State's area

18 Million Population

4,292 villages



Rainfall (mm)

29th Sep- 4th Oct 2009

377 mm in 24 hrs

Highest in 100 years

70% of Annual Normal Rainfall in Five Days

177% - 924% excess

in 15 Districts

Human Lives Lost

Sl.No	Districts	Human Lives Lost
1	BIJAPUR	34
2	RIACHUR	34
3	BAGALKOTE	33
4	GULBARA	23
5	UTTARA KANNADA	23
6	KOPPAL	22
7	BELGAUM	17
8	BELLARY	17
9	GADAG	12
10	DAVANAGERE	4
11	CHITRADURGA	4
12	BIDAR	3
13	DHARWAD	3
TOTAL		229

Loss of Livestock

Sl.No	Districts	Livestock Lost
1	Gulbarga	1,568
2	Raichur	1,420
3	Bagalkote	1,378
4	Belgaum	842
5	Koppal	685
6	Bellary	558
7	Gadag	389
8	Bijapur	281
9	Chitradurga	223
10	Uttara kannada	163
11	Dharwad	125
12	Bidar	113
13	Davanagere	77
14	Haveri	60
Total		7,882

Agriculture Crop Loss – Kharif Season

Sl.No	Districts	Kharif Crop Area Damaged (Ha)
1	Gulbarga	3,06,447
2	Belgaum	2,84,089
3	Raichur	2,02,442
4	Bijapur	2,01,630
5	Haveri	1,99,425
6	Koppal	1,66,962
7	Davanagere	1,49,052
8	Gadag	1,16,028
9	Dharwad	1,15,525
10	Bagalkote	1,11,505
11	Bellary	39,447
12	Chitradurga	1,909
13	U.Kannada	1,019
Kharif Crop Area Damaged		18,95,480

Agriculture Crop Loss – Rabi 2009

Sl.No	Districts	Rabi Crop Area Damaged (Ha)
1	**Bijapur**	**2,95,500**
2	**Gulbarga**	**1,009**
3	**Bellary**	**803**
Rabi Crop Area Damaged		**2,97,312**

Damaged Agriculture Crops

- Maize: 4,37,689 Ha
- Redgram: 2,88,409 Ha
- Bajra: 2,12,047 Ha
- Sunflower: 2,79,376 Ha
- Jowar: 2,12,604 Ha
- Groundnut: 1,88,190 Ha
- Paddy: 1,85,141 Ha
- Cotton: 1,51,050 Ha
- Soyabean: 85,242 Ha
- Sugarcane: 66,022 Ha
- Bengalgram: 56,009 Ha
- Other Crops: 31,013 Ha

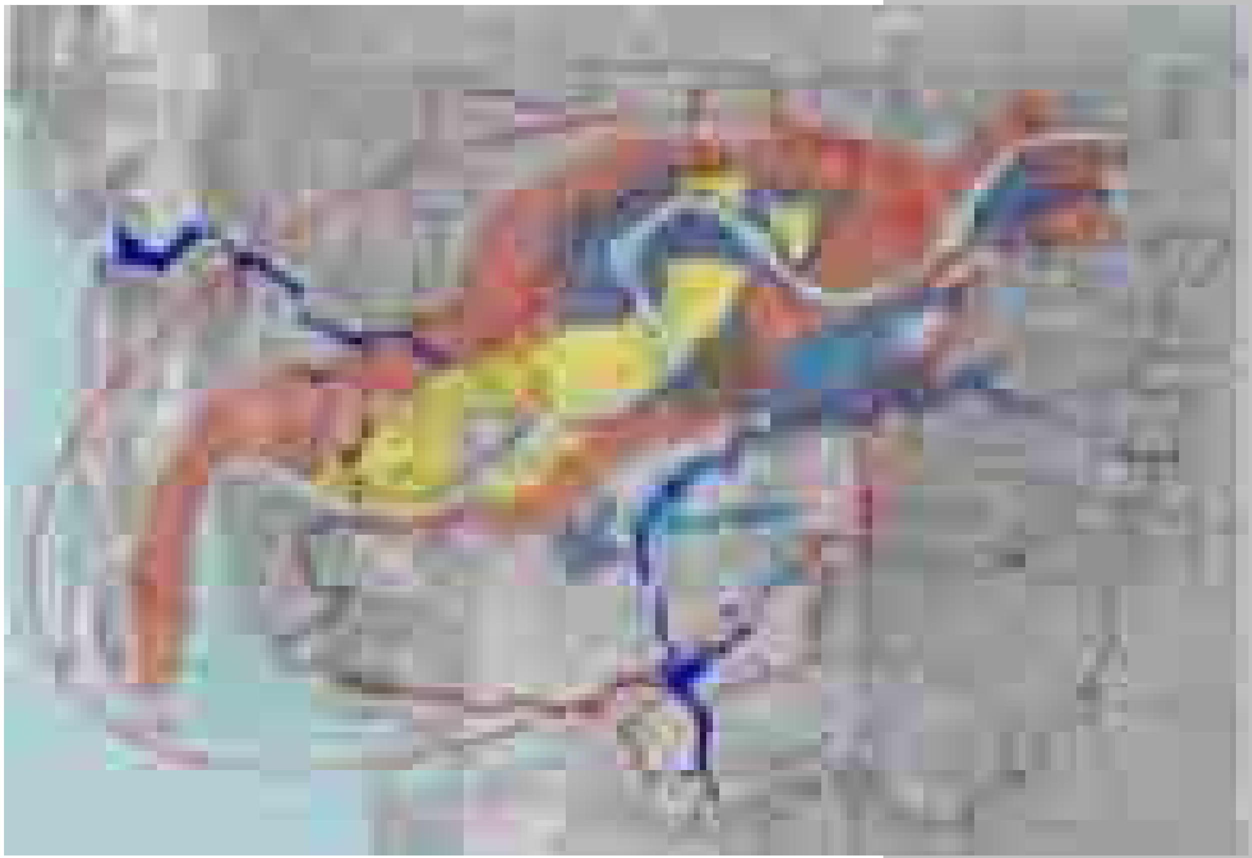
- **URBAN FLOODING**

- Severity of disasters is increasing. Too much rain in less time and space.
- Urban flooding now a serious concern
- One city after other – latest to join this club Hyderabad, Bengaluru.

Mumbai 2005

SURAT FLOODS 2006

In the perspective of post 2006 floods – saving Ecology makes tremendous Economical Sence. Rs.20,000 Crores is the predicted loss – the budget for Surat Municipal Corporation last year was Rs.1000 crore.



City growth, planning practices and urban governance will benefit tremendously from informed and concerned individuals and their continued efforts towards sustainability.

Perspective of a planner…

City , history and Growth

When the dam , embankment , dredging have only limited feasibility towards safeguarding the city. The only way flooding in future can be mitigated is,

by way of spreading it.

By

Adding width to the River Corridor

Adding width to the creek corridor

reconnecting traditional flood routes

By preserving wetlands

Adding Soft lands

By retention ponds

Bypass Channels

Profile of the Surat City

- Surat is located on banks of river Tapi:
- **It has Witnessed floods 30 times in 100 years.**
- **The city has witnessed Consecutive floods in the years as follows.**
- **1822 .1838 .1837**
- **1872 .73.76.79.82.83.84.94**
- **1914.30.31.31.37.38 to 45**
- **1949.50.54.59**
- **1968 - the height flood, 16 Lacs cusec.**
- **69.70.78.79.90.94.98**
- **2002.03.06**

City grows – vulnerability increases.

Compare the Flood in 1968 to the floods in 2006. Water level is almost the same,

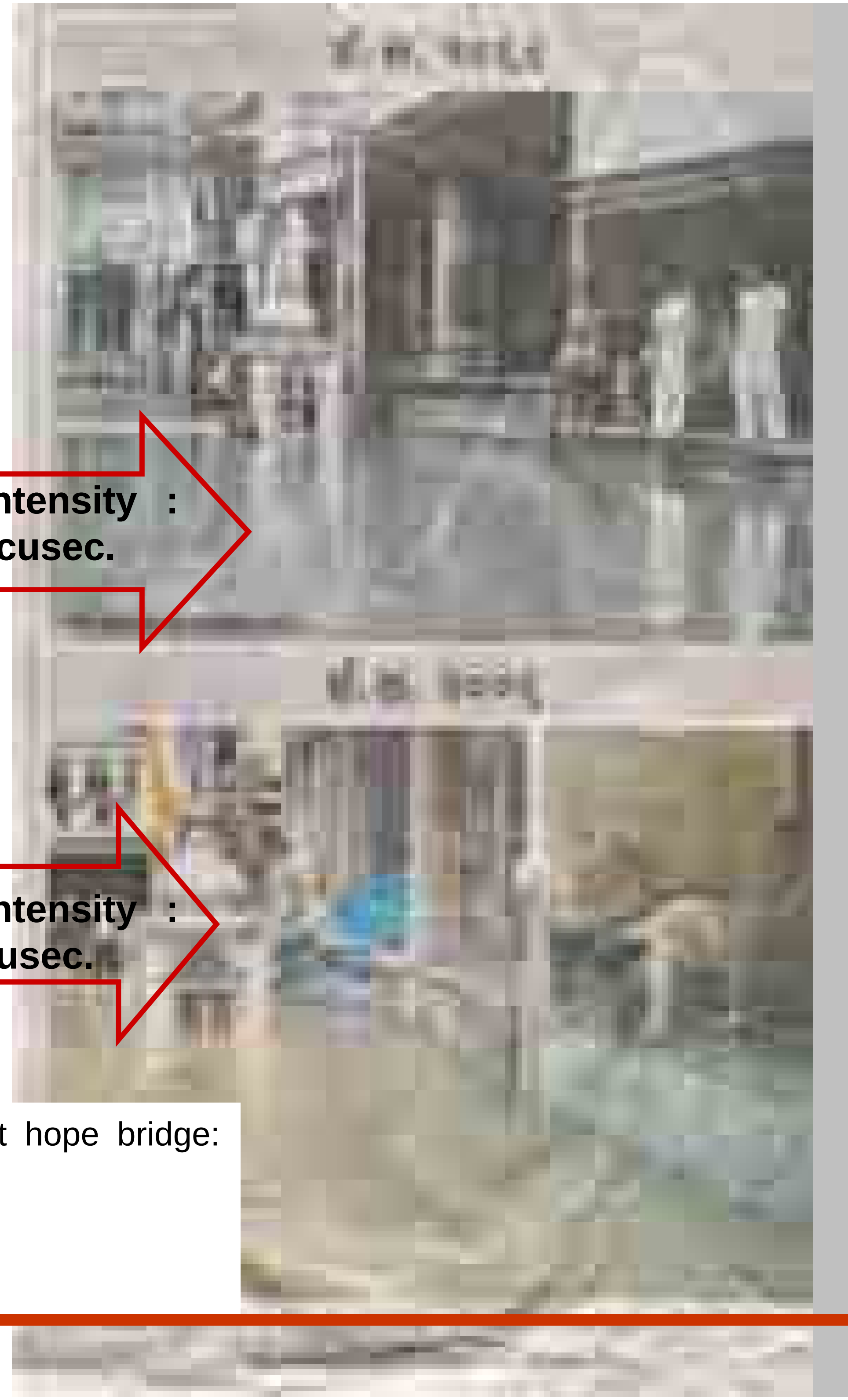
"This gave rise to media cry: 2006 flood is biggest flood ever…

when the city was smaller- with water had more area to spread. 1968 was a bigger flood for water to have risen to the same level as today's flood.

The fact that this flood was perceived as a larger disaster was because the area in which the flood could spread has shrunk. Multiple actions have contributed to this fact. Either one can link it to all the way to global warming , term it a natural phenomena , hang a minister or two and sit back or Review the fact that we have all contributed to the increase in the vulnerability of the region – since long…

Flood intensity : 15.5 lac cusec.

Flood intensity : 9,1 lac cusec.



- 1968 – the flood flow was 15.5 lac cusec.The level at hope bridge: 103.50 feet
- 1994 – 3.5 lac cusec : the level at hope bridge: 97.64 feet
- 1998 – 7.5 lac cusec : the level at hope bridge : 101.30
- 2006 –10 lac cusec. The level at hope bridge: 105.00 feet

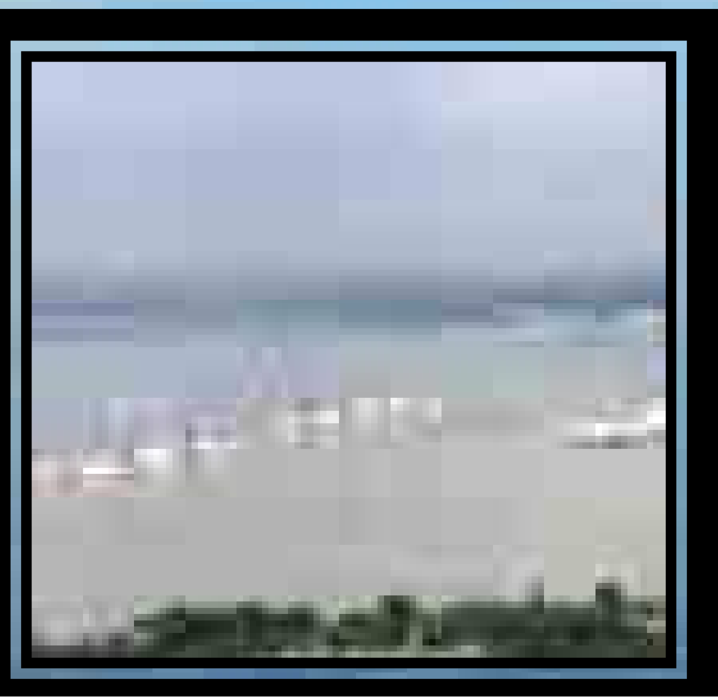
Kolkata 2007

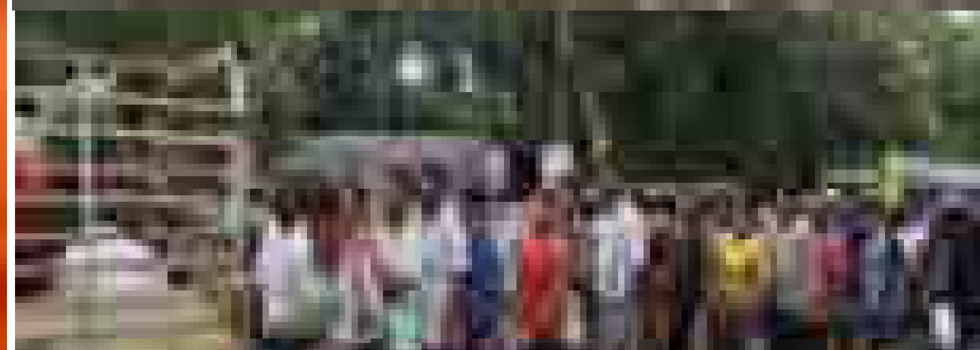
Jaipur 2012

Chennai Flood in 2015

- 1,049 mm (41.3 in) of rainfall in November, the highest recorded since November 1918 when 1,088 mm (42.8 in)

- Worst in a century



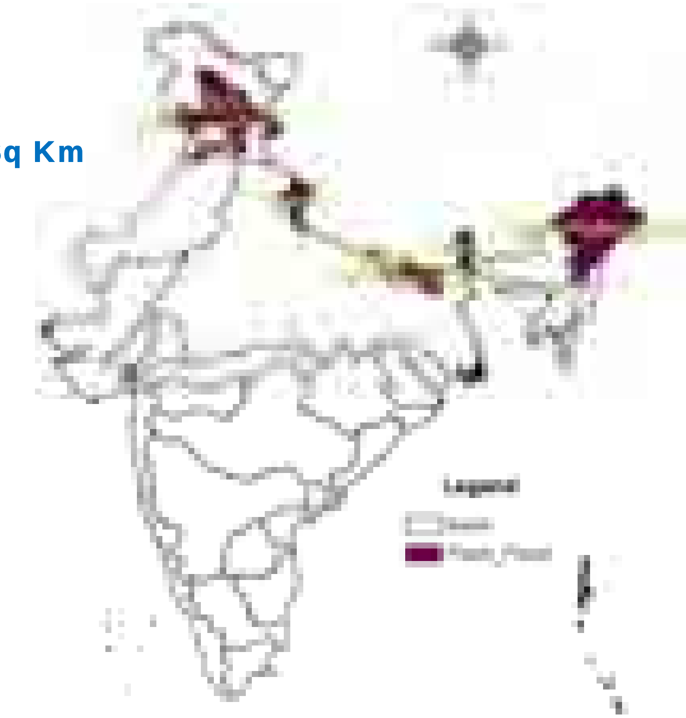


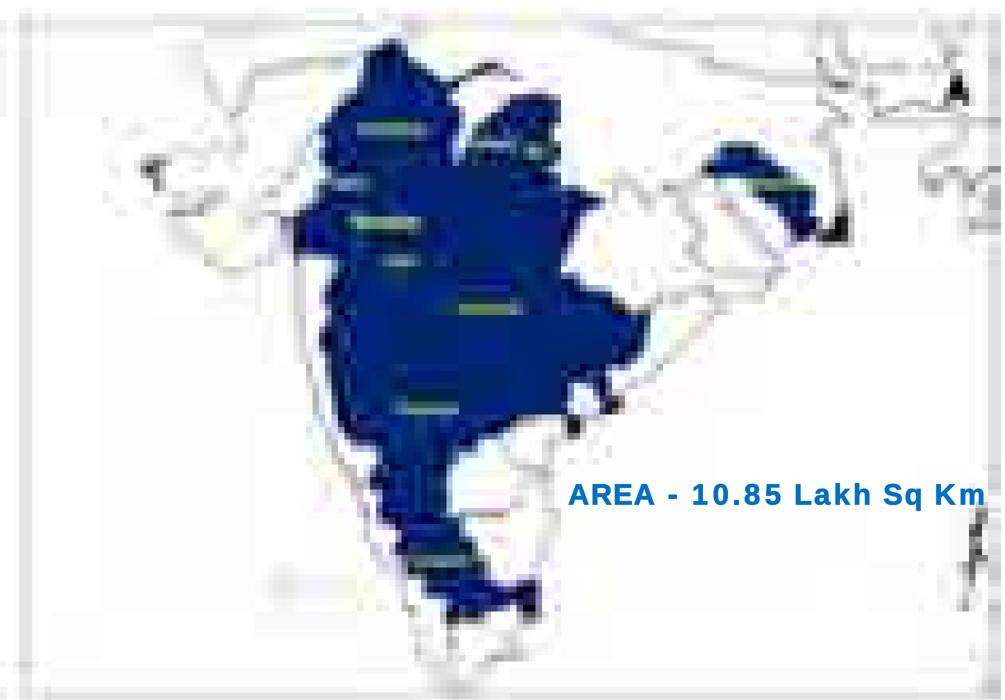
Gurgaon 2016

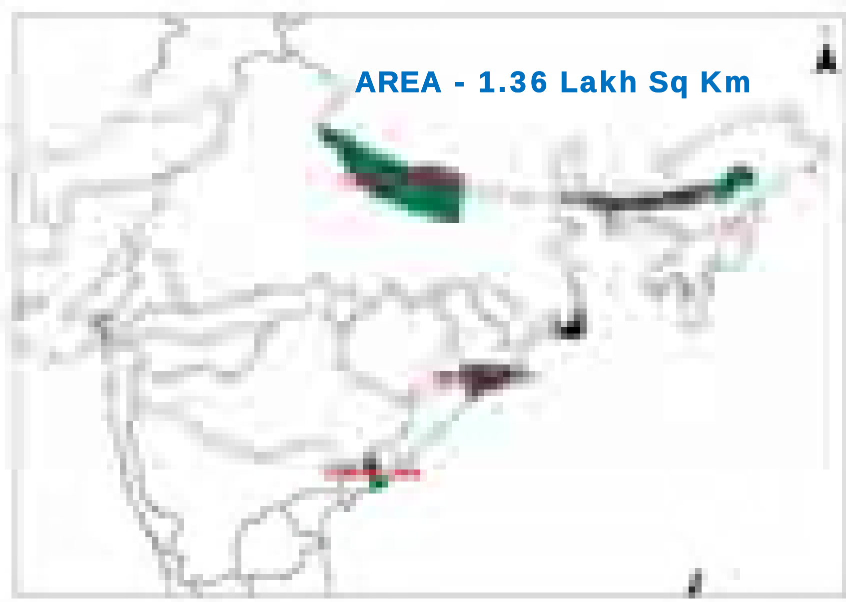
Bengaluru 2016

Future Plan

- **Flash flood guidance coupled with weather forecast**
- **Inundation modeling including cyclone related floods in delta regions**
- **Basin-wise Extended Hydrologic Prediction model along with DSS (yield forecasting) for medium & long term forecast**







River Morphology

- **Morphology (of river) is a field of science which deals with the change of river plan form and cross sections due to sedimentation and erosion.**

- **Dynamics of flow and sediment transport are the principal elements.**

Importance of Morphological studies

- **The Morphological Studies play an important role in knowing the Nature of rivers which helps in planning, designing and maintaining of Flood Protection/ river training Works and water resources projects.**
- **The morphological studies help in finding the vulnerable spots for**
  - **(a) Bank Erosion**
  - **(b) Deposition**
  - **(c) River Bed Aggradation**
  - **(d) River Bed Degradation**

Technique

- Remote sensing Techniques are capable of providing large information about river migration, changes in river course, land use changes etc with time

The main objective is to study the shifting of river course and also changes in its Plan form @ 10 years from the base year 1970 till 2010 using Remote sensing technology

Risk Management

Preventive Measures

Strengthening of embankments of potential damage centers such as

- human inhabitations along the river side
- sites of bridges,
- low lying roads
- and important installations along the river sides so as to impact of huge water mass

Physical Methods for Slope Stabilization and Erosion Control

These include measures to reduce runoff (terracing, diversions, grassed waterways, conservation ponds), methods to stabilize slopes and reduce erosion (retaining walls, drop structures, sabo dams) and integrated methods to address specific problems (gully control, trail improvement) etc.

Terracing

It is technique of converting slope into a series of horizontal step-like structures to

- Control the flow of surface runoff by guiding runoff across the slope and conveying it to a suitable outlet at a non-erosive velocity
- Reduce soil erosion by trapping the soil on the terrace
- Create flat land suitable for cultivation

Terracing prevents formation of rills, improves soil fertility through reduced erosion and help water conservation. The 3 main types of terracing are bench terraces, Contour or level terraces and parallel or channel terraces

Diversions

Diversions are ridges of soil or channels with a supporting ridge on the lower side. They are built across the slope to intercept runoff and dispose it at a selected location. They are used to break up long slopes, to direct water away from active erosion sites, to direct water around agricultural fields or other sites, and to channel surface runoff to suitable outlet locations. Safe passage of the runoff to prevent slope failures can be achieved by drainage ditches or by cross drainage work for road structures.

Slope drainage – open ditch/drains, side drain, culvert, pipe drains (The most common type of drain are stone or gravel filled drain with or without pipes)

Grassed Waterways

are natural or artificially constructed water courses shaped or graded to the required dimensions and planted with suitable vegetation. The channel helps water to flow without causing erosion.

Grassed waterways are used as

- Outlets for diversions and emergency spillways
- To safely convey runoff from contour and graded bunds and bench terraces
- As outlets for surface and sub-surface drainage systems on sloping lands
- To carry runoff from natural drains and prevent formation of rills/gullies
- To dispose water collected in road ditches through culverts

Conservation Ponds / Farm ponds, Dugout ponds, Embankment type ponds are small reservoirs constructed for the purpose of collecting and storing water from runoff, to reduce peak flow and erosion, and thus, probability of FF. It also help ground water recharge.

Mitigation Measures

NSM include risk assessment, planning measures to reduce exposure and vulnerability, raising awareness and preparedness, education, training, monitoring, warning and evacuation

SM aim to reduce the volume of water as well as the hydrostatic pressure on the dam. The 4 main approaches are i) controlled breaching/blasting of the moraine dam, ii) construction of an outlet control structure / construction of spillway or open channel, iii) pumping or siphoning the water from lake and iv) drilling and tunneling under the moraine or ice dam

Non-structural Measures (NSM)

Any measure that does not involve physical construction but instead uses awareness, knowledge, education, training, practices, policies, laws, and/or agreements etc. to reduce the impacts.

NSM measures can be cost effective and sustainable alternative to traditional engineering solutions. NSM are only efficient with participation of a responsive population and an organized institutional work

Structural Measures (SM)

Any physical construction designed to intervene, control or mitigate the potential impacts.

SM for FF can be grouped in 4 groups based on overall focus; i) Activities in the whole catchment area, ii) Activities in shape retention, iii) regulating rivers and streams, iv) river conservation

Bioengineering Measures

Bioengg is the application of engineering design and technology to living systems. It refers to the combination of biological, mechanical and ecological concepts to reduce or control erosion, protect soil, and stabilize slopes using vegetation or a combination of vegetation and construction materials.

BM used in combination with civil and social engineering offers environmentally friendly, economical and efficient solution to minimize the FF & their impacts

Retaining Walls

are artificial structures that hold back soil, rock, or water from a building, structure or area. RW prevents downslope movement and soil erosion, and provide support for vertical or near-vertical changes in gradient. The walls are generally made from timber, masonry, stone, brick, concrete, vinyl steel, or a combination of these. RW act to support lateral pressure which may cause slope failure.

Drop Structures / Grade Control Structures
are the structures placed at intervals along a channel to change a continuous steep slope into a series of gentle slopes and vertical (or steep and roughened) drops, like a series of steps. They control erosion and degradation by reducing the slope of the channel and prevent development of high erosive flow velocities, and allow water to drop safely without gouging out gullies.

Drop structures include sills, weirs, chute spillways, drop pipes, and check dams.

Drop structures can be made of concrete, timber, sloping riprap sills, and soil-cement or gabions. Drop structures made from timber or logs are more appropriate in small streams and gullies.

Physical Methods for River Training

FF mitigation in the u/s part is aimed at reducing the occurrence of FF and focuses on reducing slope instability, reducing amount and velocity of runoff, preventing erosion. The morphology of river is a strong determinant of flow, and can thus serve to intensify or mitigate flood waves and torrents. When the river becomes meandered or braided, it leads to excessive bank cutting and causes damages to agricultural fields and human settlements.

River training refers to structural measures which are taken to improve a river and its banks, for prevention, mitigation and control of FF.

River training structures are classified in 2 categories: i) Transversal protection structures ii) Longitudinal Protection Structures

Transversal Protection Structures

- Check Dams
- Spurs
- Sills
- Screen dams and Beam dams
- Porcupines

Longitudinal Protection Structures

- Levees or Earth Fill Embankments
- Guide banks and other approach embankments
- Concrete Embankments
- Revetments and rock riprap
- Porcupines used as embankment protection

Other Protection Structures

- Sandbagging
- Channel Lining
- Bamboo Piles

Preparedness

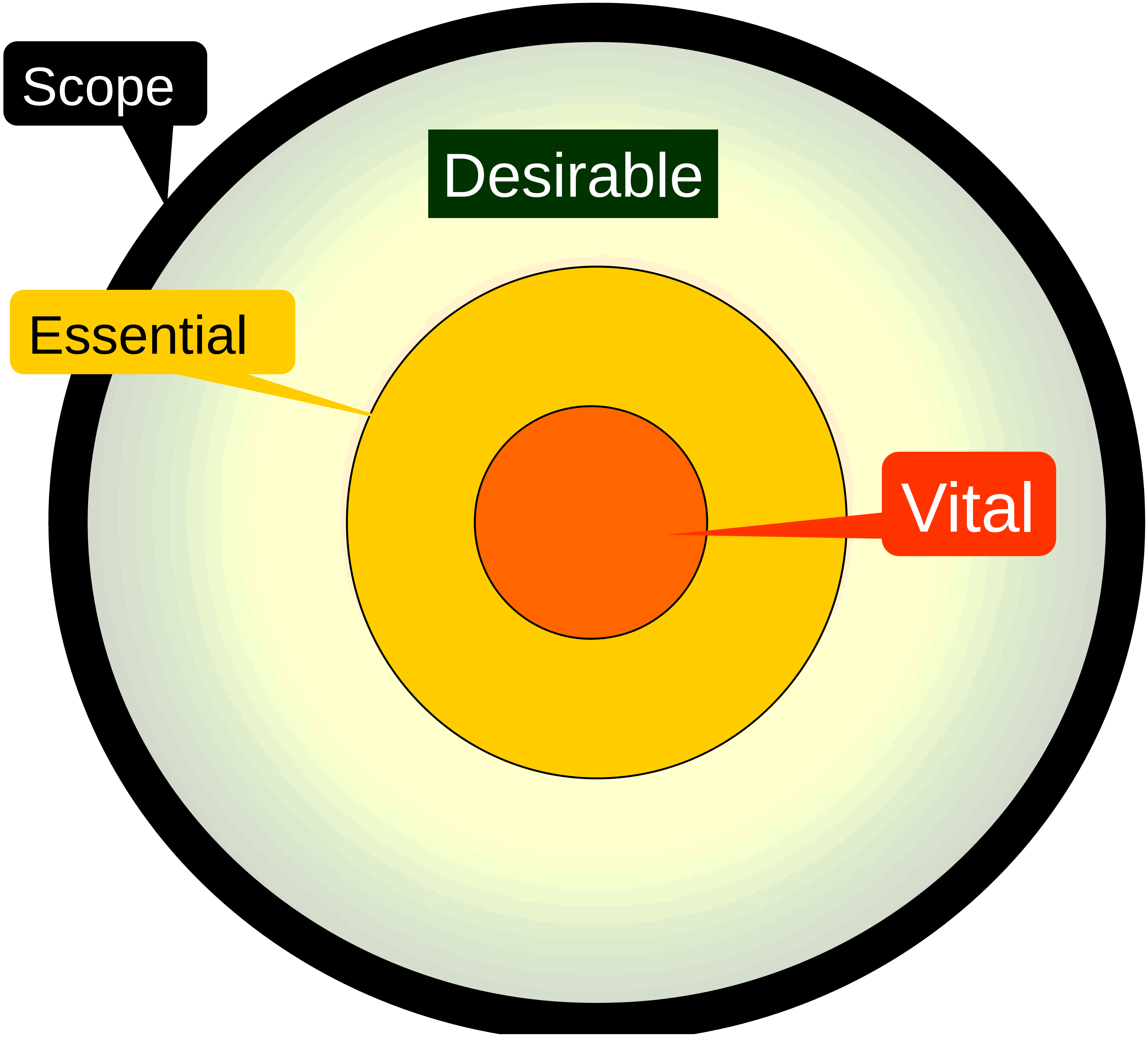
- Forecasting/ Warning to the extent possible
- Setting up control room at district headquarter, District collector as Incident Commander
- Identification of area of damage i.e. Low lying roads, Human Settlements, Army installations and important bridges
- Sectoral division of entire river basin prone to flash flood
- Sector wise storage of food grains LPG, kerosene , petrol, firewood & life saving drugs.
- Army, BRO & paramilitary forces sounded for taking of rescue and relief operation
- Identification of buildings for setting of relief camps.
- Establishing an alert system for affected community

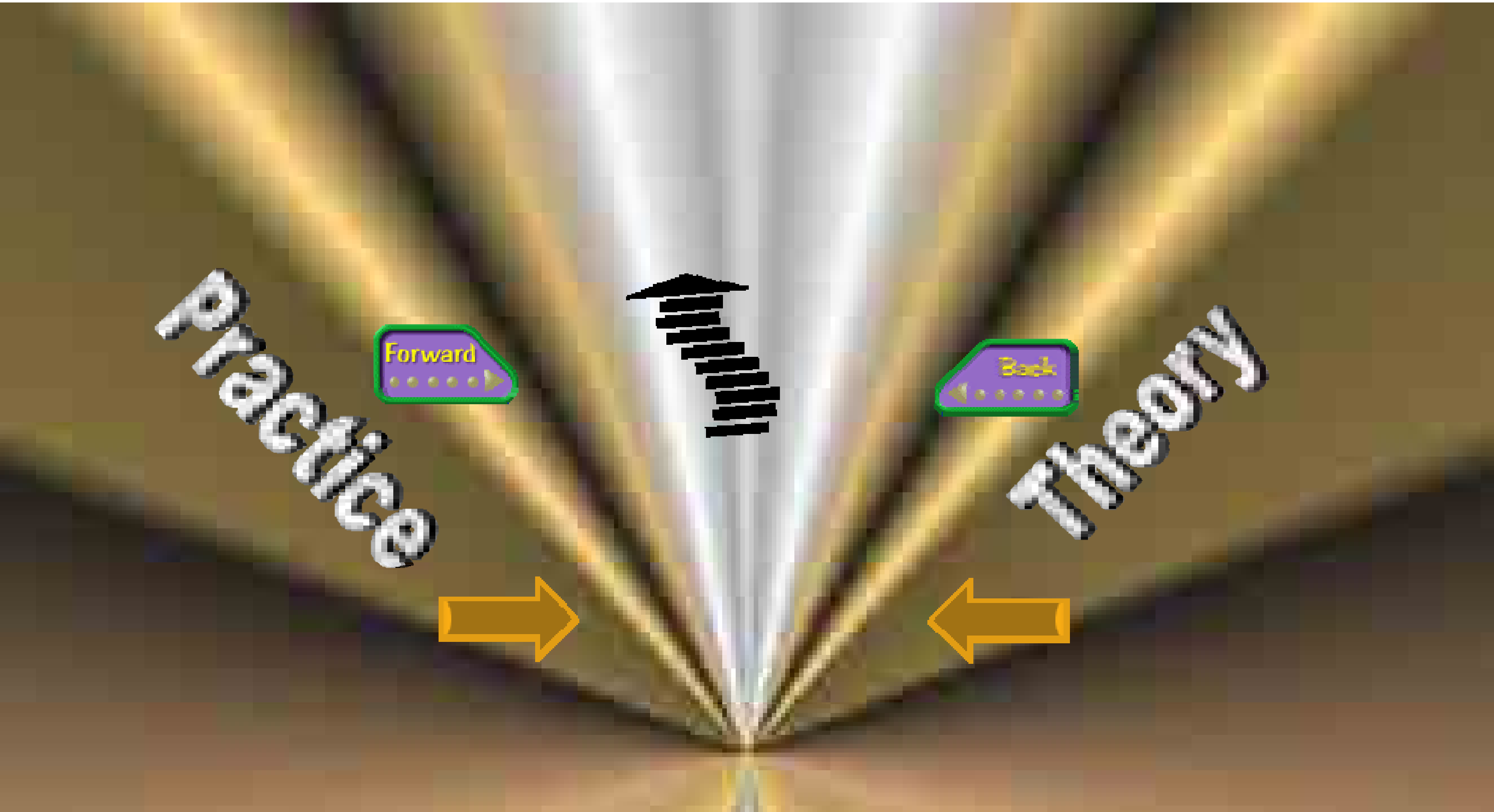
Response Preparedness

- Evacuation of inhabitants from the villages under potential risk of damage
- Deployment of rescue teams & restoration machinery at critical points in different sectors
- Delaunching of all Bailey Bridges
- Erection of safety walls along strategic & important installations
- Alternative routes of transportation
- Realignment & construction of roads at a reasonable distance from river belt

Response

- Quick reporting and assessment of losses in sector wise manner
- Provision of adequate shelter, food, clothing, firewood, medicine and school to the displaced families
- Provision of relief to the farmers and orchidst and restoration means of transportation of their produce
- Reconstruction of damage roads stretches and relaying of bridges
- Identification of land for building alternative house at safer places


Scope
Desirable
Essential
Vital



Close Gap between
scientific & operating tempers


BUILD
PARTNERSHIP
DO NOT
HANDLE IT
ALONE

Our dream is to build a disaster free INDIA

suryanidm@gmail.com
Call: +919868915226

Thanks.....