Course Completion Report

National Institute of Disaster Management, New Delhi
In collaboration with
National Institute of Hydrology, Roorkee, Uttarakhand.

Training Programme on "Flood & Drought Risk Management"

Dates & Venue : 21-25 January 2019 at NIH, Roorkee

Course Team : Dr. A.D Kaushik and Dr. Anil K. Gupta, NIDM, New Delhi
Dr. Rakesh Kumar and Dr. R P Pandey, NIH, Roorkee

Eligibility of Participants : The course was designed for Middle to Senior Level Officers from SDMA, Revenue, Agriculture, Horticulture, Irrigation, Police, Civil Defence, Sericulture, PWD, Health Departments and Academicians and Researchers from related organizations.

No. of Nominations : 42

Course Fee : No Registration Fee. Boarding & lodging arrangements were made by NIH Roorkee.

No. Participants : 42

Objectives:
- To provide the concepts of disaster management and an overview on approaches & pathways of climate resilient development in flood & drought scenario of India.
- To enhance understanding concerning the nature, extent of the threats and the value of counter measures to combat the adverse impact of floods and droughts.
- To give an overview on planning & practices of various structural and non- structural measures for preparedness and mitigation during flood & drought.
- To provide an overview on the role of weather information and forecasts, early warning systems and criteria for flood & drought in coastal region.
- To develop administrative capabilities to plan and implement disaster resilience for safe national sustainable development.

GROUP PHOTOGRAPH OF PARTICIPANTS

COURSE TEAM

Dr. A.D. Kaushik and Dr. Anil K. Gupta, NIDM
Dr. Rakesh Kumar and Dr. R. P. Pandey, NIH Roorkee

LIST OF PARTICIPANTS

S.No.	Name and Address	Contact Details
1.	**Er. Vaibhav Eknath Gosavi** Scientist "B" G.B. Pant National Institute of Himalayan Environment and Sustainable Development Himachal Regional Centre Mohal- Kullu-175 126, **(Himachal Pradesh)**	Email: VAIBHAVGOSAVI8@GMAIL.COM
2.	**Dr. Sachin Bhagat** Chief Warden of Civil Defence Corps. Office of the Controller of Civil Defence & District Magistrate Vadodara **(Gujarat)**	Email: drsachbhagat@gmail.com
3.	**Sh. Naveen Kumar Joon** S.D.O., Construction Division No. 19, Rohtak **(Haryana)**	Email: naveenjoon2303@gmail.com

4.	**Sh. Rajesh Kumar Sharma** S.D.O., Construction Division No. 21 Rohtak **(Haryana)**	Email: rajesh1276kumar@gmail.com
5.	**Dr. Pravin Rangrao Patil** Assistant Professor (SWCE) Agriculture University, Jodhpur ARSS, Sumerpur – 306 902 Distt. Pali **(Rajasthan)**	Email: prpatil.auj@gmail.com
6.	**Sh. Satish Kumar Indora** A.D.O. Nahar Agriculture And Farmer Welfare Department Rewari **(Haryana)**	Email: indorasatish.ado@gmail.com
7.	**Sh. Gautam Kumar** Executive Engineer (LAC) Public Health Engineering Department Public Health Engineering Division No. 2 Yamuna Nagar **(Haryana)**	Email: er.gautamkumar21@gmail.com ee2yamunanagar@gmail.com
8.	**Sh. Adarsh Kumar** Executive Engineer (LAC) Public Health Engineering Department Public Health Engineering Division Tohana **(Haryana)**	Email: cctohana@gmail.com
9.	**Sh. M. Lakshmi Prasad Rao Maddu** Andhra Pradesh Space Applications Centre (APSAC) ITE&C Department, Government of A.P. #40-17-3/1, M.G. Road, Labbipet Vijayawada-520 010 **(Andhra Pradesh)**	Email: mlpraohydrology@gmail.com
10.	**Sh.Shamsher Singh Malik** Fire Section Officer, Sector-5 Panchkula **(Haryana)**	Email: shamshersingh000085@gmail.com
11.	**Sh. Parmod Kumar** Fire Section, Officer Yamuna Nagar**(Haryana)**	Email:HFS.YNagar@gmail.com
12.	**Sh. Rajesh Kumar** Sub Inspector, No.34/IRB Bhondsi, Gurugram **(Haryana)**	Email: rajeshnainirb@gmail.com
13.	**Sh. Sanjeev** Assistant Sub Inspector, No. 61/IRB Bhondsi, Gurugram **(Haryana)**	Email: rorsanjeev78@gmail.com
14.	**Sh. Shah Naimish Kiritbhai** Additional Assistant Engineer (CDO) Narmada Water Resources & Water Supply Department **(Gujarat)**	Email: naimish 273@gmail.com
15.	**Kum. Bhavna Hemchandra Lachake** Deputy Executive Engineer (CDO) Narmada Water Resources & Water Supply Department Gujarat, **(Gujarat)**	Email: bhlachake@gmail.com
16.	**Sh. Balbeer Singh** Pariyojna Nideshak U.P. State Rajya Aapda Prabandh Pradhikarn, **(Uttar Pradesh)**	Email: upsdma @gmail.com

17.	**Sh. Chander Kant** Project Expert Flood U.P. State Rajya Aapda Prabandh Pradhikarn, **(Uttar Pradesh)**	Email: ck8132 @gmail.com
18.	**Sh.Naveen Singhal** Adhikshan Abhiyanta Parikalp Mandal, Sinchai Parikalp Sansthan, Roorkee, **(Uttarakhand)**	Email: naveensinghal21 @gmail.com
19.	**Sh. Satyendra Singh** Assistant Director-II MOWR,CWC, **New Delhi**	Email: satyendrasingh-cwc@gov.in
20.	**Sh.Manoranjan Pattanayak** Executive Engineer Water Resources Deptt. **Odisha**	Email: manoranjan5.ee@gmail.com
21.	**Sh. N.Hari Kumar** Deputy Director Telangana State Ground Water Department **(Telangana)**	Email: tsddgwdknr@gmail.com
22.	**Sh. A. Justin** Deputy Director of Agriculture,(SS) O/o Joint Director of Agriculture Thanjavur **(Chennai)**	Email: jdatnj@gmail.com
23.	**Sh. Rajeswaran S.** Deputy Director of Agriculture,(SS) O/o Joint Director of Agriculture Trichy **(Chennai)**	Email: jdatrichy.gmail.com
24.	**Ms. Rashmi K.** Assistant Engineer Water Resources Department Government of Karnataka, **Bangalore**	Email: rashmik.krishnamurthy@gmail.com
25.	**Sh. Ranjit Kumar Pani** Executive Engineer Water Resources Deptt. **Odisha**	Email: ranjitpani639@gmail.com
26.	**Dr. Sudhir Kumar Singh** Assistant Professor K. Banerjee Centre of Atmospheric & Ocean Studies, IIDS, Nehru Science Centre, University of Allahabad Allahabad-211002, **Uttar Pradesh**	Email:sudhirinjnu@gmail.com
27.	**Dr. Shiva Kumara Naiklal H.S.** Scientific Officer Karnataka State Natural Disaster Monitoring Centre **(KSNDMC)** Banglore, **Karnataka**	Email: dmc.shivakumar@gmail.com
28.	**Sh. Surinder Sandhu** SDO Haryana Irrigation Deptt., W.S. Division, Kurukshetra, **Haryana**	Email: SANDHU705@GMAIL.COM
29.	**Sh. Rajesh Kumar Chauhan** Forester Forest Deptt. Dehradun **Uttarakhand**	

30.	**Sh. An Singh Kandle** Range officer, Roorkee **Uttarakhand**	
31.	**Sh. K.M.E. Prasad** Assistant Director Dept. of Agriculture, Govt. of. A.P. Andhra Pradesh, Guntur, **Andhra Pradesh**	Email: kmeprasad@gmail.com
32.	**Sh. Anubhav Nautiyal** Assistant Engineer Irrigation Department, Roorkee **Uttarakhand**	Email: nautiyal.anubhav@gmail.com
33.	**Sh. Ajay Kumar** Superintending Engineer Irrigation Department, Roorkee **Uttarakhand**	Email: ajayukid@gmail.com
34.	**Sh. Balwant Singh** Assistant Plant Protection Officer Deputy Director of agriculture, Rohtak, **Haryana**	Email: dda2009@gmail.com
35.	**Sh. Dalvir Singh Rana** Hydrologist Ground Water Cell Haryana Delhi Road Rohtak, **Haryana**	Email: dalvirsrana@gmail.com
36.	**Sh. Gurmail Singh, H.F.S** Add. Divisional Forest Officer, Kaithal Haryana Forest Department	Email: gsdhankhar@gmail.com
37.	**Sh. Komal Singh** A.C.F. Wild Life Warden Rajaji Tiger Reserve Haridwar **Uttarakhand**	Email: komal.s.forester@gmail.com
38.	**Surender Mehta** Naib Tehsildar D.C. Office, Sirsa, **Haryana**	Email:surendermehta04@gmail.com
39.	**Dr. Swapnali Barman** Scientist "C" National Institute of Hydrology, Roorkee, **Uttarakhand**	Email: swapnali.barman@gmail.com
40.	**Dr. Vishal Singh** Scientist "C" National Institute of Hydrology, Roorkee, **Uttarakhand**	Email: vishal18.nihr@gov.in
41.	**Sh. Neeraj Bhatnagar** Scientist "B" National Institute of Hydrology, Roorkee, **Uttarakhand**	Email: neeraj.nihr@gov.in
42.	**Sh. Jatin Malhotra** Senior Research Assistant National Institute of Hydrology, Roorkee, **Uttarakhand**	Email: jatin.malhotra29@gmail.com

Training Programme on

Flood and Drought Risk Management
21 - 25 January, 2019
NIH, Roorkee

Day I: 21st January, 2019

Session	Topic	Faculty
0930 – 1000	Registration	
1000 – 1030	Inauguration and Introduction	NIH & NIDM (AKG & ADK)
Tea Break		
Basics of Disaster Management and vulnerability of India		
1100– 1200	Basic concepts of flood disaster risk reduction and management	NIDM (ADK)-NIH (RK)
1200 – 1300	Basic concepts of drought disaster risk reduction and disaster management	NIDM(AKG)-NIH (RPP)
Lunch Break		
1400 – 1500	Processing and analysis of precipitation data for flood and drought studies	NIH (MA)
Tea Break		
1530 – 1630	Processing and analysis of stream flow and other hydrological data for flood and drought studies	NIH (SK)
1630 – 1730	Geoinformatics applications in flood, drought and disaster risk management	NIH (PM)-NIDM

Day II: 22nd January, 2019   Preparedness, Mitigation &DRR

Session	Topic	Faculty
0930 – 1030	Design flood estimation using deterministic approach	NIH (JPP)
Tea Break		
1100 – 1200	Design flood estimation using probabilistic approach	NIH (RK)
1200 – 1300	Flood mitigation measures and disaster risk reduction (DRR) structural measures	NIH (PM)
Lunch Break		
1400 – 1500	Flood forecasting, early warning and disaster risk management	NIH (AKL)
Tea Break		
1530 – 1630	Regional drought indices, monitoring and mitigation	NIH(RPP)-NIDM (ADK)
1630 – 1730	Assessment of frequency and severity of drought in different climatic regions	NIH(RPP)/NIDM (AKG)

Day III: 23rd January, 2019   Response & DRR

Session	Topic	Faculty
0930-1030	Regional methods of design flood estimation	NIH (RK)
Tea Break		
1100-1200	Search and rescue operation in flood risk management	SDRF/NDRF
1200-1300	Integrated assessment of vulnerability to drought	NIH (RPP)
Lunch Break		
1400-1530	Drought preparedness and early warning	NIH (RPP)-NIDM (ADK)
Tea Break		
1545 - 1715	Resilient agriculture system for flood and drought w.r.t. Drought Manual 2016 and DRR	NIDM (AKG)

Day IV: 24th January, 2019   Field Visit & Experience Sharing

Session	Topic	Faculty
0930 – 1300	Group Exercise (based on case studies on floods, droughts & Films) Resilient agriculture system for flood and drought w.r.t. Drought Manual 2016 and DRR	NIDM (ADK)
Lunch Break		
1400 – 1800	Field Visit to flood and drought affected areas near to Roorkee	NIDM (ADK & AKG)-NIH (JPP/TRS)

Day V: 25th January, 2019 Cross Cutting Issues & lessons learnt

Session	Topic	Faculty
0930 – 1030	Health aspects during flood & drought	NIH (CKJ)
Tea Break		
1100 – 1200	Role of Community in DRR w.r.t. National Guidelines on flood and drought	NIH (RPP-AS)
1200 – 1300	Role of stakeholders in mainstreaming flood and drought resilience	NIDM (AKG)
Lunch Break		
1400 – 1500	Group Exercise (based on case studies on floods & droughts)	NIDM (ADK & AKG)
1500 – 1600	Group Presentation and Discussion	NIH-NIDM(ADK& AKG)
1600 – 1700	Feedback and Valediction	NIH-NIDM(ADK& AKG)

NIH Faculty:

RK: Rakesh Kumar, CKJ: C. K. Jain, AKL: A. K. Lohani, RPP: R. P. Pandey, SK: Sanjay Kumar, PM: Pankaj Mani, AS: Archana Sarkar, MA: Manohar Arora, JPP: J. P. Patra, TRS: T. R. Sapra

NIDM Faculty:

AKG: Anil Kumar Gupta, ADK: AD Kaushik

Photo-gallery

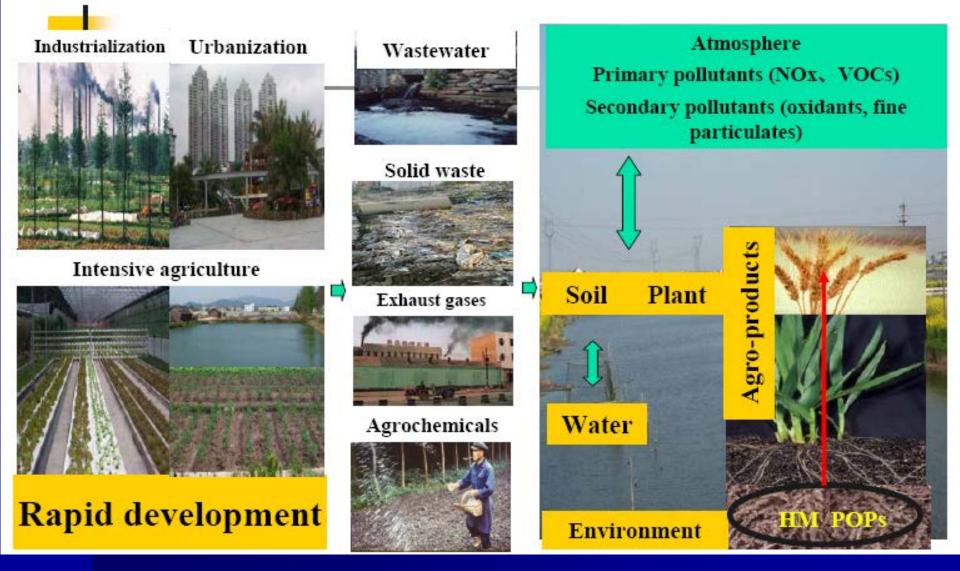# Water Quality Monitoring Planning

Dr. C. K. Jain

ckj_1959@yahoo.co.in

**National Institute of Hydrology
Roorkee – 247 667**

Water – A National Resource

- The planning of water as a national resource is not merely a question of ensuring the availability of water in right quantity, but also to ensure right quality for the use in view.

- For any proper river basin planning, whether long range or short term, before going into alternative plans for development, it is very essential to combine it with water quality problems and hydrological analysis.

Water Quality Problems

- **Natural hydrology of the river basin**

- **Development and use of land and water resources by human beings**

- **Therefore each river basin is unique and it must be subjected to individual and intensive water quality assessment**

- The United Nations also identified water quality as one of the key concerns in Asia in the 21st century.

- This concern is based on the fact that water quality degradation is so severe in many Asian countries that it is placing serious constraints on:

    - Economic Growth
    - Public Health
    - Biodiversity
    - Environmental Quality

Monitoring planning

- **Why ?**
- **Where ?**
- **What ?**
- **When ?**
- **How often ?**

- **Results obtained from such monitoring should be regularly reviewed to decide if any changes in the programme are necessary**

Stages of the monitoring process

- **Sample taking**
- **Transportation to the laboratory**
- **Sample pretreatment**
- **Analysis proper**
- **Data storage and communication**

- ❑ **The data that comes out of the sequence of operations must still be related to the initial quality of water**

Philosophy

- **Keep it simple**

- **Think first, sample later**

- **Samples can be obtained fairly easily, what comes next is much more difficult**

- **Often data are buried in computers, never to be used again**

- **Try to set up a conceptual model first**

Philosophy …

- Map the area with the main sources of pollution

- Sample, monitor, investigate

- Communicate data to the decision makers

Two approaches

- **Fixed networks (WQ Protocol)**

- **Synoptic studies**

Water Quality Protocol

Ministry of Environment and Forests
Notification S.O. 2151, New Delhi, the 17th June 2005.

- **"Protocol" means a system of uniform water quality monitoring mechanism developed by the Water Quality Assessment Authority constituted under sub-sections (1) and (3) of section 3 of the Environment (Protection) Act, 1986.**

Protocol - Definitions

- "Monitoring" means standardized measurement of identified parameters in order to define status and trends of water quality

Different Stations

- **"Baseline stations" means the monitoring location where there is no influence of human activity on water quality**

- **"Trend station" means the monitoring location designed to show how a particular point on a watercourse varies over time due, normally, to the influence of man's activities**

Stations …

- "Flux stations or Impact stations" means the location for measuring the mass of particular pollutant on main river stem for measuring the extent of pollution due to human interference or geological feature at any point of time and is necessary for measuring impact of pollution control measures adopted.

Disciplines involved

- **Geography**
- **Chemistry**
- **(micro)biology**
- **Statistics**
- **Hydrology – conditions of flow are more important to understand the quality of water**

Why monitoring ?

- **Process control**
- **Curiosity**
- **Compliance with the standards**
- **Detection of trends**
- **Modelling**
- **Early warning – fish monitors**

Objectives of GEMS/WATER

1. Assess the impact of activities by man upon the quality of water and its suitability for intended use

2. Determine the quality of water, in its natural state, which might be available to meet future needs

3. Keep under observation the sources and pathways of specified substances

4. Determine the trend of water quality at representative stations

GEMS/WATER …

- **Impact Stations (1) – situated in water bodies where there is at least one major use of water or which are greatly affected by man's activities.**

- **Baseline Stations (2) – located in an area where no direct diffuse or point sources of pollution are likely to be found.**

- **Impact or baseline station (3) – depending upon whether the hazardous substance is of artificial or natural origin.**

- **Trend Stations (4) – set up specially to assess the trends of water quality.**
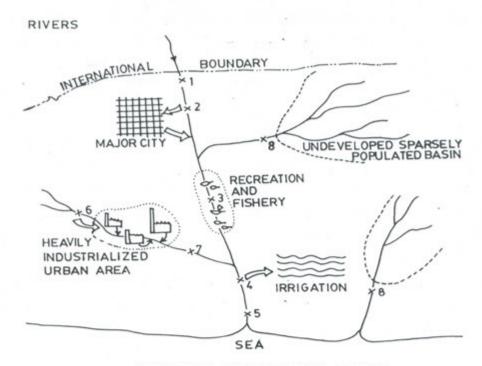
Where ?

- **Where changes are occurring**

- **Depends on the goal:**

  - **Trends > well mixed**
  - **Compliance > at intake or in effluent**
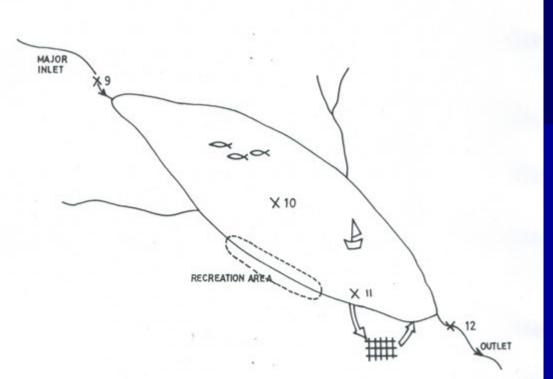
- **Not necessarily at bridges – bridges are ideal for traffic but not for sampling, although convenient**

Mixing length

$$Lm = 2.6\, u\, \frac{B^2}{H} \quad \text{(for side)}$$

$$Lm = 1.3\, u\, \frac{B^2}{H} \quad \text{(for mid-stream)}$$

u = Average velocity (m/s)

B = Width of river (m)

H = Depth of river (m)

MONITORING SITE SELECTION - RIVERS

Station	Type	Criteria
1	Impact	Immediately downstream of an International (or baseline) boundary
2	Impact	Abstraction for public supply of large town
3	Impact	Important fishing, recreation and amenity zone
4	Impact	Abstraction for large scale agricultural area
5	Trend	Fresh water tidal limit of major river
6	Impact	Abstraction for large industrial activity
7	Impact	Downstream of industrial effluent discharge & important tributary influencing main river
8	Baseline	Station where water is in a natural state (no direct or indirect pollution, no water use)
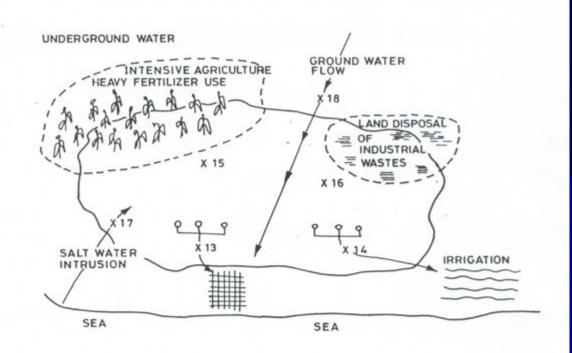
MONITORING SITE SELECTION—LAKES

Station	Type	Criteria
9	Impact (or baseline)	Principal feeder tributary
10	Impact (or baseline)	General water quality of lake
11	Impact	Water supply of major city
12	Impact (or baseline)	Water leaving lake

MONITORING SITE SELECTION – UNDERGROUND WATER

Station	Type	Criteria
13	Impact	Water supply to large town threatened by fertilizer residues and saline intrusion
14	Impact	Water for large scale irrigation threatened by leachate from waste tips
15 } 16 } 17 }	Impact	Water supply of major city
18	Baseline	No human activities in the ground water recharge area

Sample Containers

- **Chemically neutral plastic – Polyethylene or glass containers should be used, non-breakable plastic containers being more desirable than glass**

- **Sterilized equipment and apparatus for bacteriological analysis. Autoclave can be used for sterilization. Polypropylene sample containers should be used**

Water Sampling

- **Manual sampling**
  - Sample water holder
  - Meyer's sampler
  - Dussart sampler
  - Kemmerer sampler

- **Automatic sampling**
  - Vaccuum type
  - Pressure type
  - Pump operated
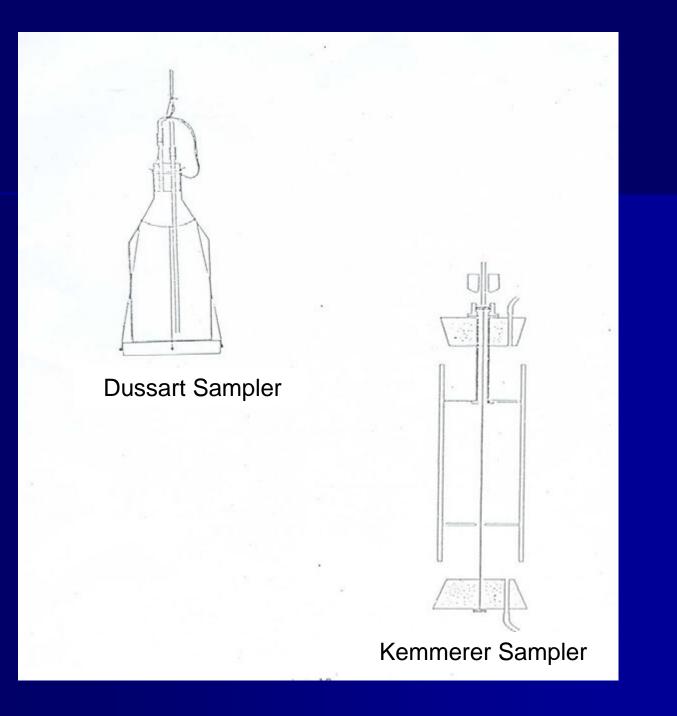
- **Sediment sampling**
  - Eckman dredge (15x15; 24x24; 30x30 cm)
  - Peterson dredge (quite heavier; > 30 kg)
  - Surber dredge
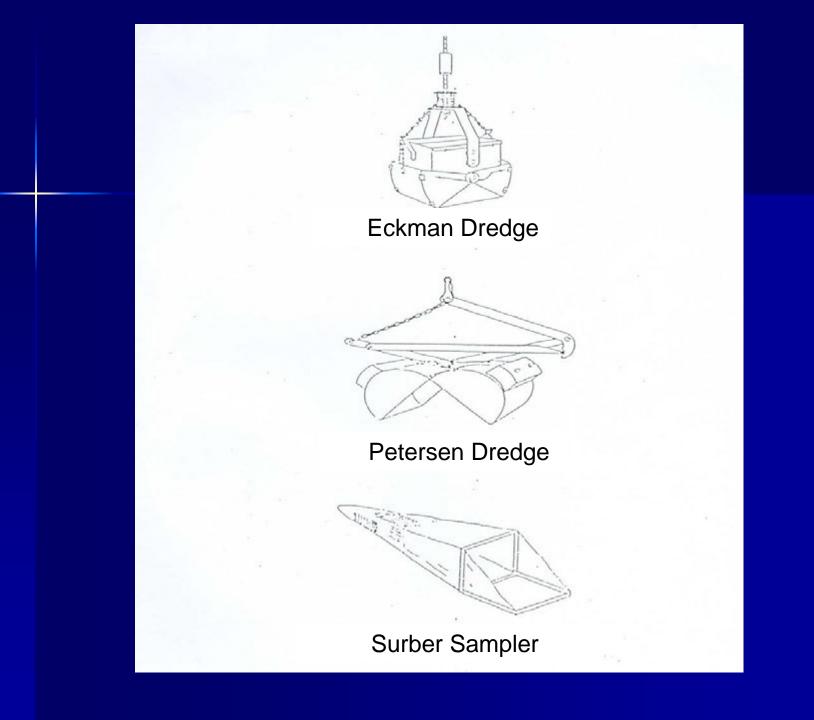
Sample Bottle Holder

Meyer's Sampling Bottle

Dussart Sampler

Kemmerer Sampler

Eckman Dredge

Petersen Dredge

Surber Sampler

Frequency and Parameters

Station	Frequency	Parameters
Baseline	**Perennial rivers and lakes:** Four times a year (seasonal) **Seasonal rivers:** 3-4 times (at equal spacing) during flow period **Lakes:** 4 times a year (seasonal**)**	**(A) Pre-monsoon:** Once a year Analyse 25 parameters as listed below: **a) General:** Colour, Odour, Temp., pH, EC, DO, Turbidity, TDS **b) Nutrients:** NH4-N, NO2 + NO3, TP **c) Demand parameters:** BOD and COD **d) Major ions:** Na, K, Ca, Mg, CO3, HCO3, Cl, SO4 **e) Other inorganic:** F and B and other location specific parameter, if any **f) Microbiological:** TC and FC

Frequency and Parameters

Station	Frequency	Parameters
Baseline	**Perennial rivers and lakes:** Four times a year (seasonal) **Seasonal rivers:** 3-4 times (at equal spacing) during flow period **Lakes:** 4 times a year (seasona**)**	**(B) Rest of the year** (after the pre-monsoon sampling) at every three months interval Analyse 10 parameters: Colour, Odour, Temperature, pH, EC, DO, $NO_2 + NO_3$, BOD, Total coliform and Faecal Coliform

Station	Frequency	Parameters
Trend or impact or flux	Once every month starting April-May (pre-monsoon) i.e. 12 times a year	**A. Pre-monsoon:** Analyse 25 parameters as listed for baseline monitoring **B. Other months:** Analyse 15 parameters as listed below **(a) General :** Colour, Odour, Temp, pH, EC, DO and Turbidity **(b) Nutrients :** NH3 - N, NO2 + NO3 , TP **(c) Organic Matter :** BOD, COD **(d) Major ions :** Cl **(e) Microbiological:** TC & FC **C. Micropollutants:** Once in a year/pre monsoon. **a) Pesticides –** Alpha BHC, Beta BHC, Gama BHC (Lindane), OP-DDT, PP-DDT, Alpha Endosulphan, Beta Endosulphan, Aldrin, Dieldrin, Carbaryl (Carbamate), Malathian, Methyl Parathian, Anilophos, Chloropyriphos **b) Toxic Metals:-** As, Cd, Hg, Zn, Cr, Pb, Ni, Fe (The parameters may be selected based on local need)

What ?

- **Speciation**
- **Operational definition of analyte/determinant**
- **Priorities**
- **Analytical capabilities**
- **Money**
- **Objectives (see 'why ?')**

- ❑ **Know the business of the area of interest. Do not search for the substances that can't be there.**

Water Quality Characterization Domestic Water Supply

1. Colour, odour, taste
2. Organic content: COD, BOD, TOC, Phenols, hydrocarbons
3. Carcinogens and toxic compounds, insecticides, pesticides, detergents
4. Turbidity, salinity
5. Alkalinity, pH
6. Total hardness, Ca, Mg, Fe, Si., etc.
7. Pathogenic organisms, total bacterial count (37^oC), E. coli count, plankton count

Water Quality Characterization Agricultural Irrigation

1. Salinity
2. SAR (Na-Ca-Mg content)
3. RSC (CO_3-HCO_3-Ca-Mg content)
4. Boron
5. Alkalinity, pH
6. Pesticides, growth regulators, etc.
7. Persistent synthetic chemicals (e.g., polyethylene derivatives, asphalt sprays, etc.)
8. Pathogenic organisms

Water Quality Characterization
Fish, shellfish, wildlife and recreation

1. Colour, odour
2. Toxic compounds
3. Turbidity, floating matter, sludge deposits, salinity
4. Temperature
5. Dissolved oxygen, BOD
6. Alkalinity, pH
7. Pathogenic organisms, plankton count
8. Nitrogen, phosphorous, etc. (inorganic nutrients which support algae blooms and other undesirable aquatic growth)

Water Quality Characterization Watering of livestock

1. Salinity
2. Toxic compounds
3. Pathogenic organisms
4. Plankton count

Industrial Characterization

Industry	Quality Parameters
Pulp and Paper Mill	Colour Suspended solids Chromium BOD Phenols COD Solids pH Total coliform

Industrial Characterization …

Industry	Quality Parameters
Steel Rolling Mill	Suspended solids NH_4-N Phosphorous Cyanide Nickel Iron Zinc Phenols pH

Industrial Characterization …

Industry	Quality Parameters
Sugar Mill	Colour Suspended solids BOD NH_4-N Solids Alkalinity pH Total coliform

When ?

- **Depends on the variability**:

  - Systematic
  - Random

- **Examples**:

  - Colis in swimming pool (in morning hours no colis but evening hours much colis)

When …

- **Examples:**

  - Diurnal variations of oxygen (if algae is present we may measure 120% oxygen in day time and only about 70% in night)

  - Industries starts producing sewage in day

  - People produces more sewage in day than night

When …

- **Examples**:

  - Water quality problems are more critical in dry season because of low flows

  - Because of dilution water quality problems are not pronounced in wet season

  - Wet seasons are important for erosion studies

How often ?

- The precision increases with $\sqrt{n}$

  n is the number of samples

Compare

- Rivers
- Lakes
- Groundwater

❑ The quality of water in various water bodies is rarely if ever constant in time but subject to change. Variations are caused by changes in the quantity of any of the input to the water body

Results

Result = Average + Noise

(Systematic + Random)

Results …

- **Relationships**

- **Correlation/association**

  - Scatter plots
  - Correlation coefficients (r = 0.01-0.99)

- **Regression (line)**

- **Transformations**

Current Water Policy and Management Issues

- **Equitable and sustainable allocation**

- **Environment and human health**

- **Food security**

- **Climate and land use variability and change**
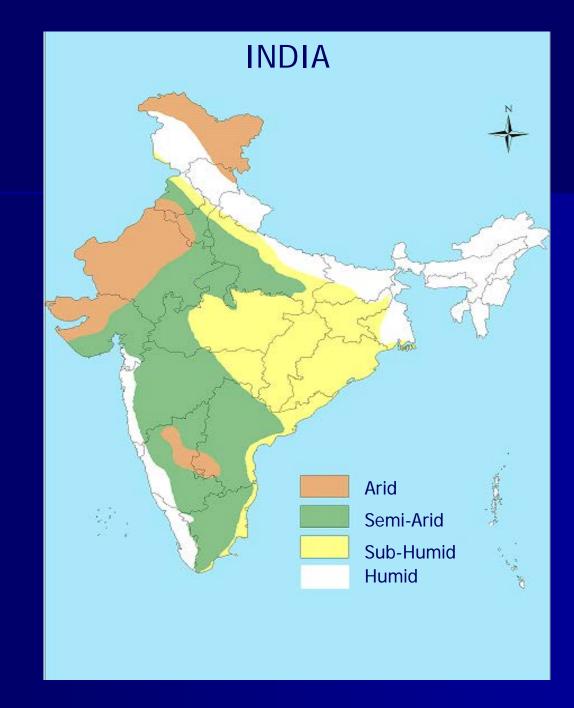
Water Quality Issues

- **Water Scarcity**
- **Oxygen Depletion**
- **Pollution due to Urbanization**
- **Non-Point Source Pollution**
- **Eutrophication**
- **Salinity**
- **Natural contaminants**
- **Pathogenic Pollution**
- **Ecological Health**

Water Scarcity

- Un-even distribution of rainfall

- Increasing demand of water for agricultural, industrial and domestic activities

INDIA

Arid
Semi-Arid
Sub-Humid
Humid

Precipitation Facts

- Being 'monsoon country', India gets most of its precipitation as a heavy downpour for just about 100 h out of the total 8760 h in a year

- Rainwater/snowmelt must be stored properly and used sensibly during the 8660 h without precipitation

Oxygen Depletion

- Oxidation of organic matter in water by microbial activities

- Survival of aquatic life becomes difficult

Pollution due to Urbanization

- Migration of people from villages to urban areas

- Water supply, waste water generation and its collection, treatment and disposal

Non Point Source Pollution

- Agricultural activities (nutrients, pesticides etc.)

- Open defecation in fields

- Bathing and Washing activities

Eutrophication

- Discharge of domestic waste water

- Agricultural runoff

- Industrial effluents

Salinity

- Leaching of salts build-up in agricultural areas under intense irrigation

- Industrial effluents with high dissolved solids

- Increased use of chemicals in agriculture

Natural Contaminants

- **Fluoride**

- **Arsenic, Selinium**

- **Nitrate**

- **Iron**

Fluorosis

- **More than 60 million people in 22 States are affected with dental, skeletal and/or non-skeletal fluorosis in India**

- **Extent of fluoride contamination: 1.0 - 48.0 mg/L.**

- **The control of the fluoride contamination in ground water is difficult**

- **However, some artificial recharge and/or rainwater harvesting techniques improve the quality of groundwater by dilution**

States endemic to fluorosis

- Andhra Pradesh
- Assam
- Bihar
- Delhi
- Gujarat
- Haryana
- J & K
- Karnataka
- Kerala

- Madhya Pradesh
- Maharashtra
- Orissa
- Punjab
- Rajasthan
- Tamil Nadu
- Uttar Pradesh
- West Bengal
- ...
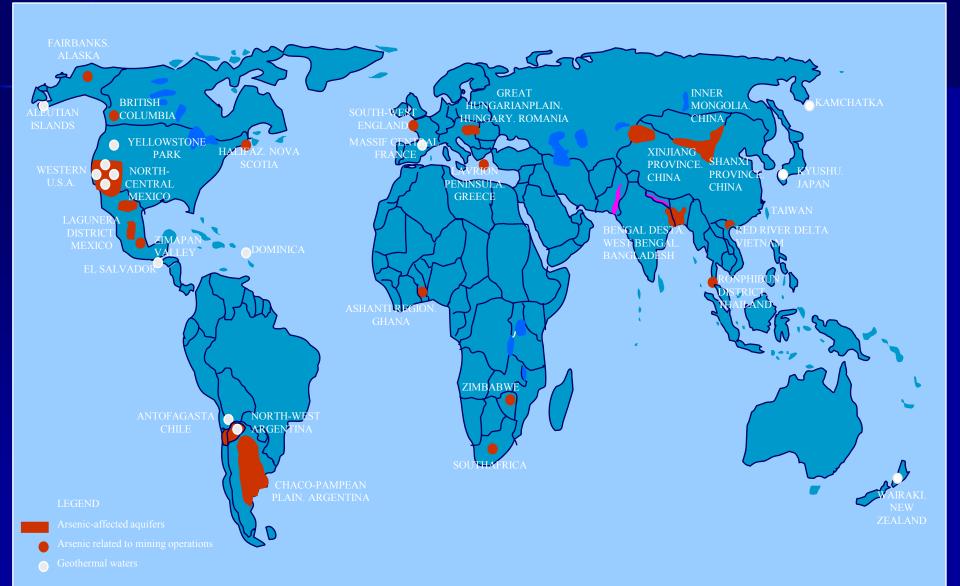
Arsenic

- As as As(V), As(III), As(0) and As (-III)
- Sb as Sb(V), Sb(III), Sb(0), and Sb(-III)
- Se as Se(VI), Se(IV), Se(0) and Se(-II)

- Cr as Cr(III) and Cr(VI)

All are members of the same family.

Pathogenic Pollution

- Water borne diseases are the most important water quality issues in India

- Inadequate arrangement for transport and treatment of wastewater

Ecological Health

- Large area in our aquatic environment support rare species and ecologically very sensitive

Ground Water Contaminants

- Nitrate – Blue baby disease
- Pathogens – Bacteria and virus causes water borne diseases such as typhoid, cholera, dysentery, polio and hepatitis
- Toxic Metals – Arsenic, selenium, lead, mercury, cadmium, copper, chromium, nickel, etc.
- Organic compounds – Pesticides, Phenols, Hydrocarbons, PCBs, etc.

Main parameters of WQ

- Related to impact on human health
  - pathogens indicated by most probable number
  - heavy metals, especially, mercury, arsenic, lead, cadmium, etc.
  - other dissolved matter, e.g. fluorides and iron
- Related to environment and ecology
  - sodium, which can affect fertility of soil
  - boron, which can affect crops
  - selenium, which can affect cattle
  - dissolved oxygen, which can affect all aquatic life
  - diversity index and saprobicity index, which defines the well being of the water body
- Of economic and social significance
  - high or low pH, which can damage property and machinery
  - temperature and dissolved solids, which can affect fisheries

Threats to Water Quality

- Discharge of sewage
- Discharge of trade effluent
- Non-point sources of pollution
  - Runoff from agricultural fields
  - Leachate from wastes dumped in catchment
- Reduction in flow/assimilative capacity
- Sudden increase in rate of flow or sediment load due to operation of spillway, bottom sluice or even dam failure

Vision for counteracting threats

- No sewage, treated or untreated, should be

Some corollaries of the vision

- Waste and wastage be minimised at every place
- Adopt decentralised sewage treatment
- For flushing of toilets, landscaping and centralised air conditioning, only treated sewage be used
- Water tariff for industrial use be so revised that industry finds treating sewage cheaper than drawing water
- Incentives be given for use of bio-fertilisers and bio-pesticides
- Joint body for stream flow regulation

Two points to ponder

- Why every demand is attempted to be met only with fresh water – even flushing the water closet?

- Are human needs more important than the ecological needs?
  - humans are one of the species, biodiversity comprises far too many species
  - human survival itself is linked to biodiversity

Legal Consideration

- Water (Prevention and Control) Act, 1974: To maintain and restore the wholesomeness of the national aquatic resources, each one has got a very specific waste load receiving capacity

- This implies the need for prescribing different effluent standards based on assimilative capacity

Minimum National Standards (MINAS)

- MINAS was evolved by CPCB whereby minimum effluent limits were prescribed for each category of discharge, regardless of receiving water requirements

Water Quality Management

- The Water (Prevention and control of Pollution) Act, 1974 reflects the national concern for water quality management

- The objective of the Act is to maintain and restore the wholesomeness of water through prevention and control of pollution

The Water Act, 1974

- The act does not define the level of wholesomeness to be maintained or restored in different water bodies

- For defining these levels, the CPCB had initially taken use of water as a base for identification of water quality objectives for different water bodies

- CPCB has identified primary water quality criteria for different uses of water as a yardstick for the preparation of different pollution control programmes

Use Based Classification

Designated best use	Quality class	Criteria
Drinking water source without conventional treatment but with chlorination	A	pH: 6.5 to 8.5 DO: 6 mg/L or more BOD: 2 mg/L or less Total coliform MPN/100 ml: 50

Use Based Classification…

Designated best use	Quality class	Criteria
Outdoor bathing (organized)	B	pH:6.5 to 8.5 DO: 5 mg/L or more BOD: 3 mg/L or less Total coliform MPN/100 ml: 500

Use Based Classification…

Designated best use	Quality class	Criteria
Drinking water source with conventional treatment	C	pH: 6.5 to 8.5 DO: 4 mg/L or more BOD: 3 mg/L or less Total coliform MPN/100 ml: 5000

Use Based Classification…

Designated best use	Quality class	Criteria
Propagation of wildlife and fisheries	D	pH: 6.5 to 8.5 DO: 4 mg/L or more Free ammonia: 1.2 mg/L

Use Based Classification…

Designated best use	Quality class	Criteria
Irrigation, industrial cooling, and controlled waste disposal	E	pH: 6.5 to 8.5 EC: 2250 mS/cm SAR (max): 26 B: 2 mg/L

Revised approach

- All water bodies where the existing water quality is below the acceptable level should be identified on priority basis for taking remedial measures to restore their quality to the acceptable level within a stipulated period of time

- 351 river stretches have been identified as Polluted Stretches

Analytical techniques to measure WQ

Thank You

ckj-1959@yahoo.co.in

Basic concepts of drought disaster risk reduction and disaster management
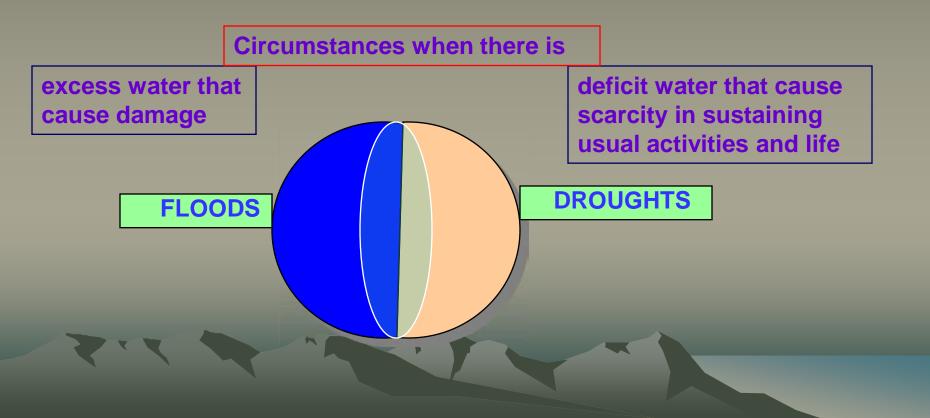
Dr. Rajendra Prasad Pandey,

Scientist G

National Institute of Hydrology, Roorkee-247667, India &

Member-Secretary INCCC, MoWR RD &GR, Govt. of India

21st January 2019

HYDROLOGIC EXTREMES

Two opposite faces of same coin

Circumstances when there is

excess water that cause damage

deficit water that cause scarcity in sustaining usual activities and life

FLOODS

DROUGHTS

DROUGHT

** A least understood natural climatic phenomenon.
** Quantification of severity & impacts are highly complex

Philosophically :

"Any calamity/hazard which can be measured"

certainly "that can be better managed"

Topics to be covered

1. Basic Concept and Definitions, & Causes of Drought
2. Drought indicators and time units $\qquad$ Ist
3. Drought Indices &Truncation level/thresholds
4. Climatic regions & Drought characteristics $\qquad$ IInd
5. Integrated assessment of vulnerability to drought. $\qquad$ IIIrd
6. Drought Risk management -
7. Tutorial $\qquad$ IVth
8. Critical Issues $\qquad$ Vth

Drought : The Facts

- Unlike cyclone, flood and earthquake, droughts do not create sense of sudden panic or fear among the masses.

- Drought **ranks first** among the natural disasters in terms of number of persons directly affected, geographical area affected and **economic losses** *(Hewitt,1997),* .

- Drought affects virtually all climatic regions *(Wilhite, 2000)* and more than one half of the earth is susceptible to droughts every year *(Gol'tsberg 1972).*

- Drought is a creeping phenomenon, slow onset, difficult to recognize its onset in time.

DROUGHT : The facts

- Drought characteristics vary across the climatic regions.

- **Drought Characteristics** are driven by regional climatic parameter.

- Assessment of severity & impacts of drought is complex because it depend on multiple indicators.

- We lack with suitable methodology for identification of onset and progression of drought and quantification of drought severity.

- Approach of drought Response actions is largely steered towards relief measures/crisis management or recovery from drought **rather than proactive mitigation**.

- **RESULT**, **Slow scientific advancement of drought early-warning & preparedness systems.**

population affected from droughts in India 1900-2010
(Source: Samra, 2004. Working Paper No 84, IWMI)

Date	State, region or district	Population Affected (#)	Loss/ Deaths (Rs.)
July 2002	13 states	300 million	41000 million
May 2001	4 states	--	**20 deaths**
Nov. 2000	5 districts in Chattisgarh	--	--
April 2000	6 states	90 million	26500 million
March 1996	Rajasthan	-	-
March 1993	8 states	1.2 million	--
July 1987	Orissa	--	**110 deaths**
1987	6 States + 4 UT	300 million	**300 deaths**
April/1983	3 states	100 million	--
1973	Central India	100 million	2500 million
1972	Central India	100 million	2500 million
Aug. 1964	Mysore	166 million	--
1964	Rajasthan, Central India	0.5 million	--
1942	Kolkata, Bengal region	-	**15 lakh deaths**
1900	Bengal	-	**13 lakh deaths**

DROUGHT, ARIDITY AND WATER SCARCITY

Drought should not be confused with Aridity or water scarcity

Drought	Aridity	Water Scarcity:
Drought is defined as a relative deficit in a given area compared to its average or usual water availability, either in the form of rainfall, river flow, surface/ ground water storages or due to combination of these for certain period of time. Thus drought is a temporary phenomenon.	Aridity refers to persistently short supply of water even in normal circumstances. It is a climatic attribute of the region. It applies to the persistently dry regions like arid areas & deserts, where, water is always in short supply. It is a permanent climatic feature of the region	The water scarcity refers to long-term unsustainable use of water resources, which water managers can influence. Or in other words, it is associated to over exploitation of water resources when demand for water is more than its availability. Thus water scarcity is a human induced phenomenon.

Climatic Variability & Climate Change

Climatic Variability	Climate Change
The year-to-year fluctuation of climate above or below long-term average value (the climate normal i.e. average of 30-or more year of records of climatic variable.

Climate varies over seasons & years instead of day to day like weather. | Climate Change is long-term continuous change (increase or decrease) to average weather conditions (e.g. average temperature OR the range of weather elements (e.g. more frequent and severe extreme events).

Climate Change is slow and gradual unlike year-to-year variability |

Regions with greater inter-annual variability of precipitation are more susceptible to frequent and severe drought.

Drought definition

Drought: no universally accepted definition

- **There exists a variety of methods and indices to identify Onset & Termination and to quantify Severity of drought but none is acceptable to all.**

- **The definition of drought vary from region to region and also very with subject of interest.**

- Nature /type of Drought
  - Meteorological
  - Agricultural
  - Hydrological
  - Socio-economic
  - Environmental

- Impact: sector specific; region specific

Diversity in Drought Definition

Author Ref.	Definition
Cole (1933) UK	A period of atleast 15 days without rain
Hoyt (1936)USA	When annual rainfall is less than 85% of normal.
U.S Weather Bureau (Havens, 1954)	Lack of rains so great and long continued as to affect injuriously plant and animal life in regions where it is sufficient for such purposes
Ramdas (1960)	When rainfall is deficient by twice of mean deviation
Hudson & Hazen (1964)	LIBYA- Drought is recognized only after two years without rain Egypt- any year the Nile does not flood is drought
Palmer (1965)	Month/year during which the actual moisture supply consistently falls short of the climatically expected supply.
Konstantinov 1968	When difference of PET and AET exceeds a given value
IMD-India	When seasonal/yearly rainfall received at a meteo. station is less than 75% of normal
Dracup et al 1980	When rainfall/runoff in a month/year is below truncation level

Global water distribution

Seas / oceans	96%	4000 yrs
Ice / snow	2%	10-10,000 yrs
Groundwater	1.5%	<10,000 yrs
Hydrological cycle*	**0.5%**	**1 day - 10 yrs**
Atmosphere	**0.001%**	**1 day - 10 yrs**
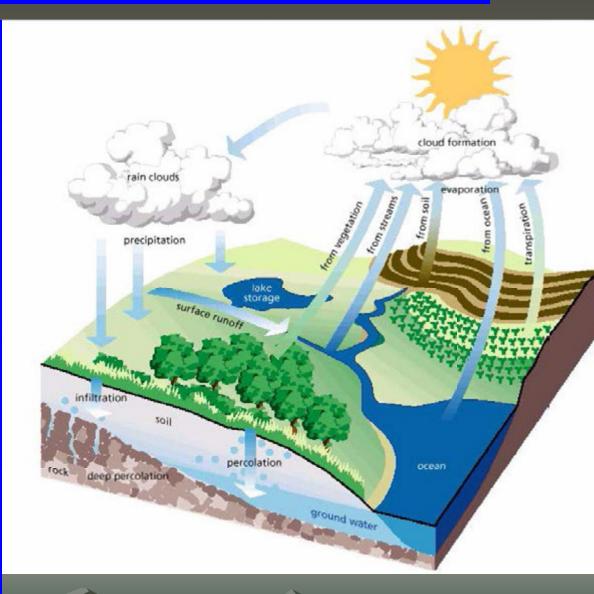
* soil moisture, lakes, rivers, atmosphere

HYDROLOGIC CYCLE

- Moisture is constantly circulating between the land, the ocean and the atmosphere.---Hydrologic Cycle

- Involves complex and interdependent processes
  - Precipitation
  - runoff
  - Infiltration
  - groundwater flow
  - Evaporation
  - transpiration etc…..

- During the hydrologic processes –soil acts as a reservoir and water is always in transitory storage in soil.

- Considerable time may elapse before this stored water flows either underground to a stream or returned to the atmosphere by evapotranspiration

During the process of precipitation and transitory soil water storages an opportunity exists to take advantage of hydrologic cycle in rainfed agriculture.

PRECIPITATION FACTS

- **Being 'monsoon country', India gets most of its precipitation as a heavy downpour for just about 100 h out of the total 8760 h in a year**

- **Rainwater / snowmelt must be stored properly and used sensibly during the 8660 h without precipitation**

Causes of droughts

1. Deficient rainfall
   - Over seeding of clouds by dust particles from earth surface
   - Increase in albedo
   - Decrease in biogenetic nuclei in rain drop formation
   - Reduced plant cover
   - Oceanic circulation (current & Heat storages)

2. El Nino phase of the Southern Oscillation (ENSO)

3. Greenhouse effect and rise in temperature

4. Unabated deforestation

5. Poor water resources management

Cure is easy if cause is known

Primary cause of drought--deficient rainfall.

In India, a drought may occur due to any one or more of following causes

- Less than expected amount of rain in space and time
- Late arrival (or onset) of monsoon.
- Prolonged dry days during monsoon
- Early withdrawal of monsoon

Example: Agricultural Drought

- Kharif season: (July –Sept.)
  - Delay in onset of monsoon > two week
  - Daily rainfall - Consecutive dry days > 12 Alert (Agril)
  - month rainfall < 50% of month's mean
  - Seasonal rainfall < 75%

Aridity Measuring Models

De Martonne's Aridity Index

De Martonne (1926) proposed a method for calculating aridity index (AI) of an area using following equation:

$$AI = [P/(T+10) + 12p/(t+10)]/2$$

Where:

P is the mean annual precipitation in mm,

T is the mean annual temperature in °C,

p the precipitation of the driest month in mm, and

t the mean temperature of the driest month in °C.

AI Value	Climate Class
≤ 5	Arid
5 − 12	Semi-arid
12 − 20	Dry sub-humid
20 − 30	Moist sub-humid
30 − 60	Humid
≥ 60	Wet

Thornthwaite's Precipitation Effectiveness

Thornthwaite (1931) classified the climatic regions into different classes based on the precipitation effectiveness index (PE), using monthly values of precipitation and temperature.

$$PE\ Index\ =\ \sum_{1}^{n=12} 115*(P/(T-10))^{10/9}$$

where, P = monthly precipitation in inches;

T = temperature in °F; and

n = months = 12.

PE Index	Climate Class
Greater than 128	Wet
100 - 127	Humid
64 - 99	Moist sub-humid
32 - 63	Dry sub-humid
16 – 31	Semi-arid
Less than 16	Arid

UNESCO aridity index

The UNESCO (1979) proposed a method for aridity mapping from the ratio of precipitation (P) to potential evapotranspiration (PET),

$$AI = P/PET$$

AI Value	Climate Class
≤ 0.03	Hyper Arid
0.03 – 0.2	Arid
0.2 – 0.5	Semi-arid
0.5 – 0.65	Dry sub-humid
> 0.65	Humid

Precipitation

- Atmospheric Circulation
  - Shape of the earth
  - Rotation of the earth
  - Differential heating
- Essential conditions for precipitation
  - Sufficient moisture in the air mass
  - Colloidal instability in air mass
  - Presence of nuclei

Precipitation

- **Varies greatly over the earth surface**

  [precipitation averaged over the entire earth surface amounts to about 1000 mm *(Trewartha and Horn 1980)]*

  Among the terrestrial regions, some deserts receive very little rainfall (< 100 mm) while a few places receive even more than 10000 mm of annual rainfall *(Critchfield, 1983).*

- **Precipitation over a region/place is governed by the zonal pattern of presence of precipitable water in the atmosphere *(Trewartha and Horn 1980).***

  – The precipitable water is a measure of water vapour content of the atmosphere in terms of equivalent liquid content. It is expressed in terms of water depths (mm/cm).

  – Since the saturation vapour pressure of air increase with increase in temperature, the warm air can hold more moisture (water vapour) than the cold air. Therefore, the moisture content in air is highest near the equator and lowest in high latitudes (polar region).

Climatic Classification

- Initially attempted in 1850s, considering plant/vegetation characteristics- Biologists.

- Koppen's Ist classification based on Temp. & Precipitation)- 1900. (viz. dry, tropical rainy, temperate rainy, cold snowy forest & polar climate. (Revisions 1931, Koppen & Geiger1930-39)

- Thornthwait (1943, 1948)- Based on moisture adequacy index $I_m = 100[(P/PE)-1]$

Sl No.	Climate Class	Class code	Moisture adequacy index, I_m
1	Perhumid	A	100 and above
2	Humid	B_4	80 to 99.9
3	Humid	B_3	60 to 79 9
4	Humid	B_2	40 to 59.9
5	Humid	B_1	20 to 39.9
6	Moist subhumid	C_2	0 to 19.9
7	Dry subhumid	C_1	- 19.9 to 0
8	Semiarid	D	- 39.9 to - 20
9	Arid	E	- 60 to - 40

These classification however does not describe appropriately the climatic condition of midlatitudinal regions (Ponce *et al.,* 2000), where drought impacts are more adverse (Karl, 1983).

CLIMATIC CLASSIFICATION (contd…)

The global terrestrial mean annual precipitation (P_g)

(i) Average moisture in the atmosphere ranges:

  * 2 - 50 mm in the terrestrial regions *(UNESCO, 1978; L'vovich, 1979*

(2- 15 mm over polar and arid regions;

45-50 mm over humid regions*)*

 * mean global terrestrial value -- 25 mm *(Ponce et al.2000; others*)

(ii) Atmospheric moisture recycles every 11 days - (33 annual Cycles)

(iii) **Global terrestrial mean annual precipitation P_g = 825 mm**

CLIMATIC CLASSIFICATION (contd…)

(iii) **Global terrestrial mean annual precipitation** P_g = 825 mm

Comparison :

L'vovich, 1979--

P_g = 910 mm for exorheic drainages (78.4 % of total terrestrial area) and 238 mm for endorheic drainages (21.6 %).

@ This gives Weighted value of P_g= 765 mm.

(Chosen for simplicity)

Middle of the climatic spectrum -- P_a/P_g = 1

* Regions with P_a/P_g< 1 -- less than average moisture

* Regions with P_a/P_g> 1 -- more than average moisture

COMMON CLIMATIC FACTORS

PRECIPITATION (P_a)

Depends on:-

- – **Latitude**
- – **Season**
- – **Orographic factors**
- – **Proximity to Ocean**
- – **Character of the earth surface**
- – **Atmospheric pressure & circulation pattern etc.**

POTENTIAL EVAPOTRANSPIRATION (E_p)

Depends on:-

- – **Net solar radiation**
- – **Vapor pressure deficit**
- – **Surface roughness and**
- – **leaf area index**

Climatic Parameter

$$\frac{P_a}{P_g} \; Ratio$$

$$\frac{E_p}{P_a} \; Ratio$$

Length of Wet Period
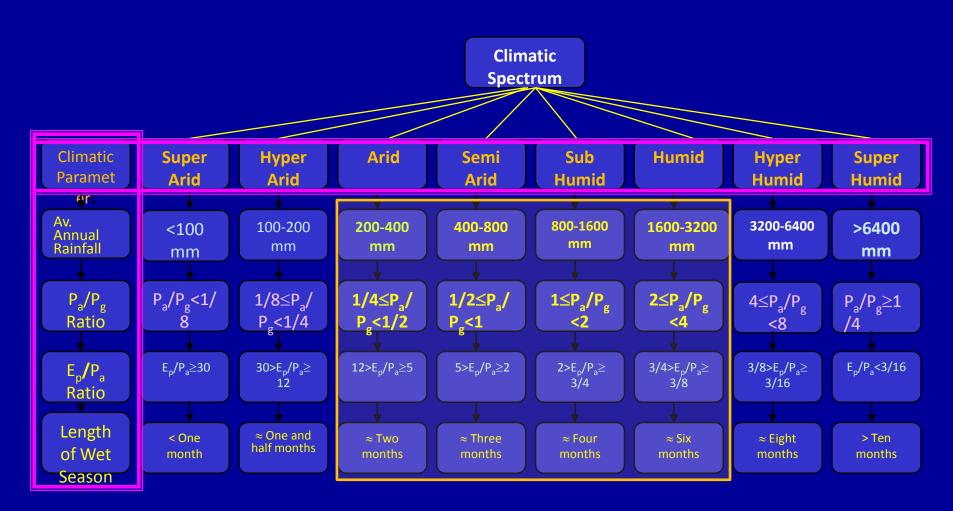
CLIMATIC CLASSIFICATION

Climatic spectrum may be defined using readily available climatic parameters :

(1) Ratio of mean annual precipitation (P_a) to terrestrial mean annual precipitation (P_g)--i.e., $\mathbf{P_a/P_g}$
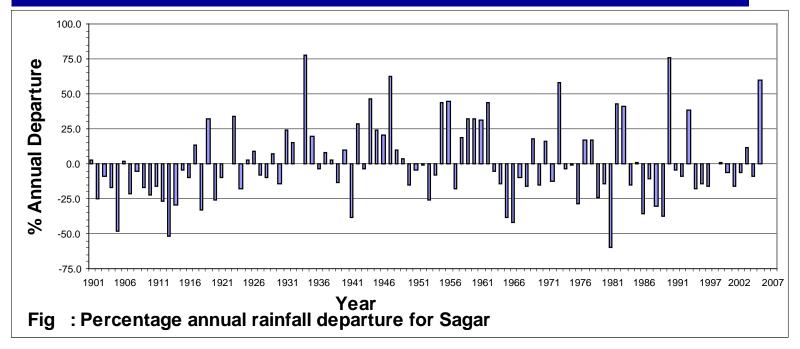
(2) Ratio of mean annual potential evapotranspiration (E_p) to mean annual precipitation (P_a) --i.e., $\mathbf{E_p/P_a}$

Climatic Classification

Climatic Parameters	Super Arid	Hyper Arid	Arid	Semi Arid	Sub Humid	Humid	Hyper Humid	Super Humid
Av. Annual Rainfall	<100 mm	100-200 mm	200-400 mm	400-800 mm	800-1600 mm	1600-3200 mm	3200-6400 mm	>6400 mm
P_a/P_g Ratio	$P_a/P_g<1/8$	$1/8\leq P_a/P_g<1/4$	$1/4\leq P_a/P_g<1/2$	$1/2\leq P_a/P_g<1$	$1\leq P_a/P_g<2$	$2\leq P_a/P_g<4$	$4\leq P_a/P_g<8$	$P_a/P_g\geq1/4$
E_p/P_a Ratio	$E_p/P_a\geq30$	$30>E_p/P_a\geq12$	$12>E_p/P_a\geq5$	$5>E_p/P_a\geq2$	$2>E_p/P_a\geq3/4$	$3/4>E_p/P_a\geq3/8$	$3/8>E_p/P_a\geq3/16$	$E_p/P_a<3/16$
Length of Wet Season	< One month	≈ One and half months	≈ Two months	≈ Three months	≈ Four months	≈ Six months	≈ Eight months	> Ten months

Climatic Spectrum

Ponce and Pandey 2000 ; Pandey and Ramasastri 2001, 2003
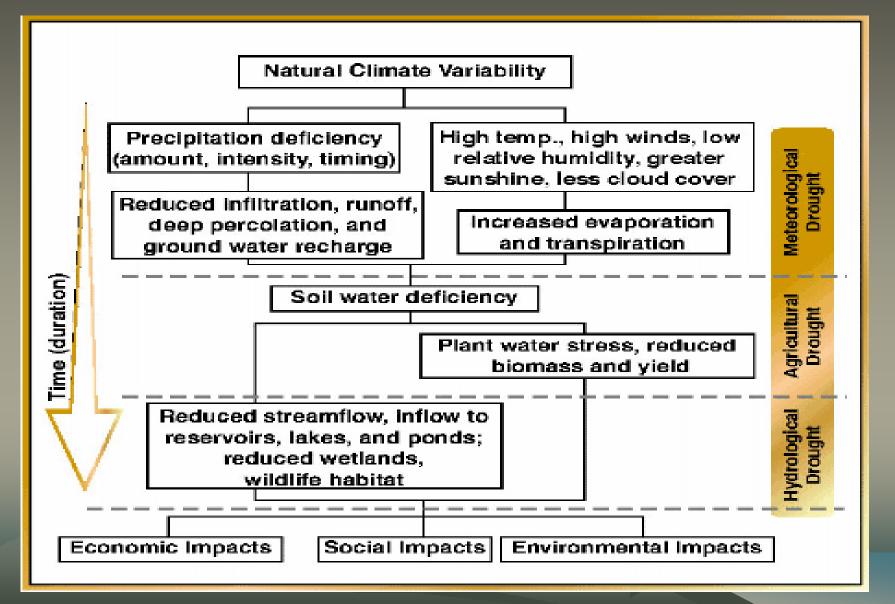
Identification of Drought events/years 1901-2008

Fig : Percentage annual rainfall departure for Sagar

Fig : Percentage annual rainfall departure for Damoh

Sequence of drought impact

Harvest Rainwater for
More Crop, Income & Resilience
Per Drop of Water

Thank You All

Thanks *for your*

kind attention!

"Drought can be measured and better managed"

Dr. Rajendra Prasad Pandey

rppanndey@gmail.com

Climate Resilience –
Disasters and Development

Dr. Anil K Gupta

Head - Division of Environment, Climate & Disaster Risk Management

National Institute of Disaster Management, New Delhi

Expert Team Member – WMO Climate Statement

Core Group Member - IUCN – CEM South Asia

PRIME MINISTER'S AGENDA 10:
India's Disaster Risk Management Readmap to Climate Resilient and Sustainable Development
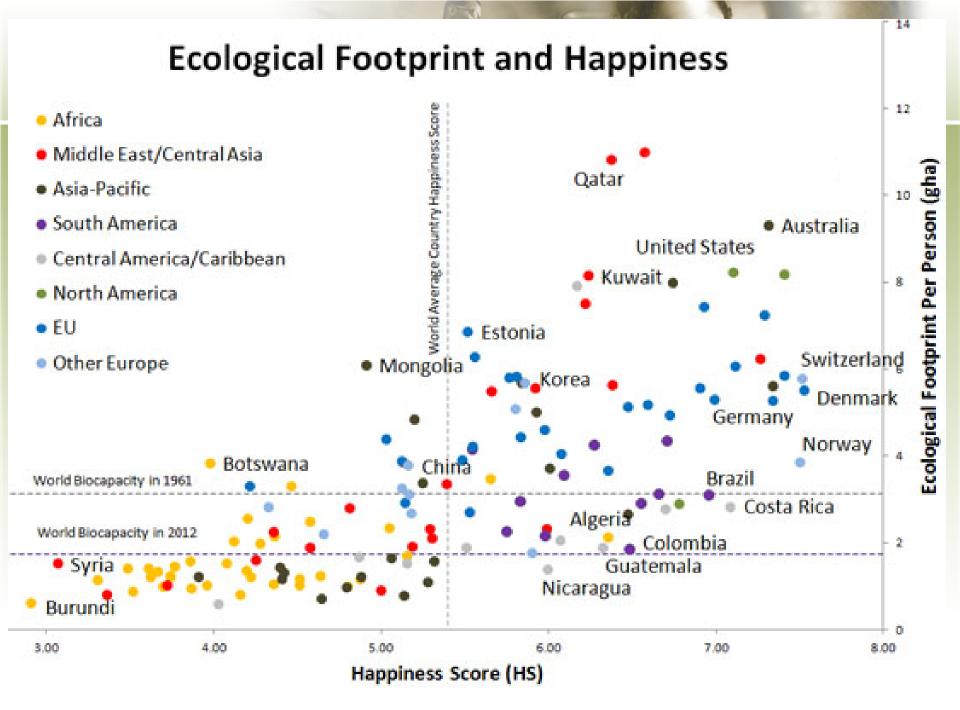
Key words

- Hazards
- *Vs* Disaster
- Risk
- Vulnerability
- Capacity
- Accident
- Emergency
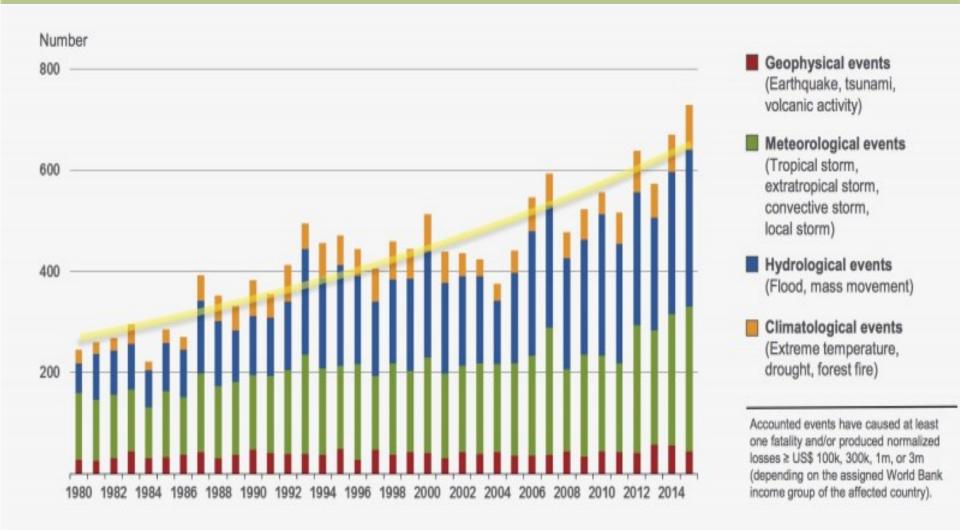
The 17 United Nations Sustainable Development Goals (SDGs)

Ecological Footprint and Happiness

Africa
Middle East/Central Asia
Asia-Pacific
South America
Central America/Caribbean
North America
EU
Other Europe

World Average Country Happiness Score

Ecological Footprint Per Person (gha)

Qatar
Australia
United States
Kuwait
Estonia
Mongolia
Korea
Switzerland
Denmark
Germany
Norway
Botswana
China
Brazil
World Biocapacity in 1961
Algeria
Costa Rica
World Biocapacity in 2012
Colombia
Syria
Guatemala
Nicaragua
Burundi

Happiness Score (HS)

Disasters: more people affected and increasing Economic Damage

Number

- **Geophysical events** (Earthquake, tsunami, volcanic activity)
- **Meteorological events** (Tropical storm, extratropical storm, convective storm, local storm)
- **Hydrological events** (Flood, mass movement)
- **Climatological events** (Extreme temperature, drought, forest fire)

Accounted events have caused at least one fatality and/or produced normalized losses ≥ US$ 100k, 300k, 1m, or 3m (depending on the assigned World Bank income group of the affected country).

© 2016 Münchener Rückversicherungs-Gesellschaft, Geo Risks Research, NatCatSERVICE – As at March 2016
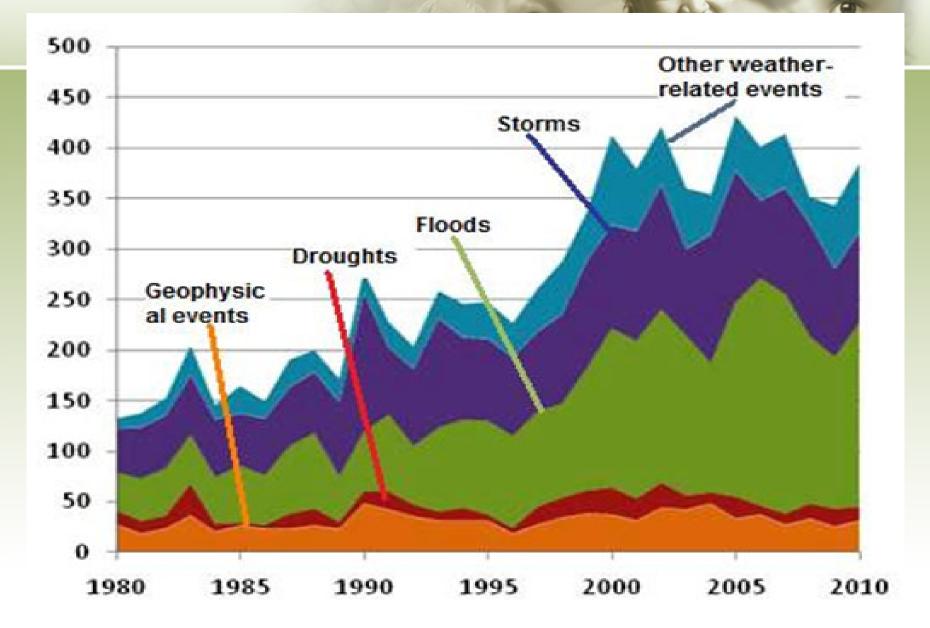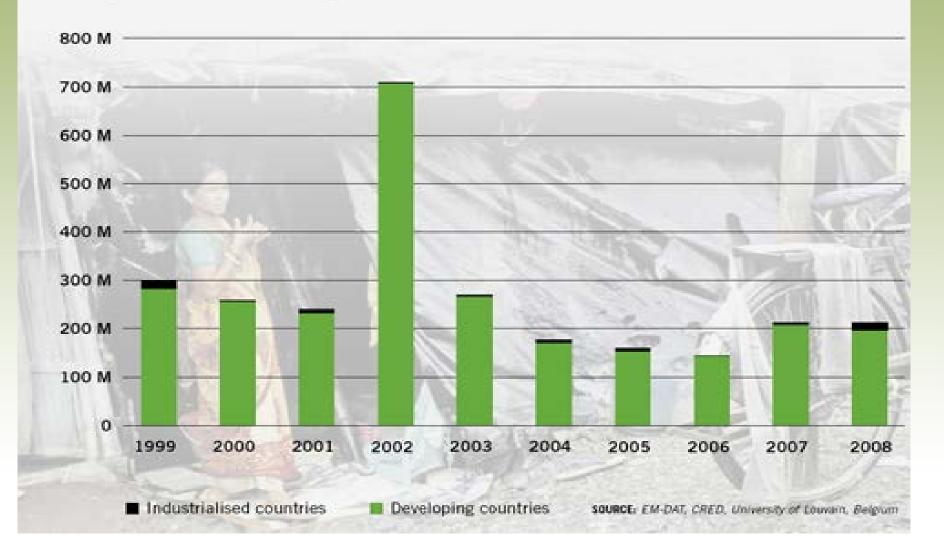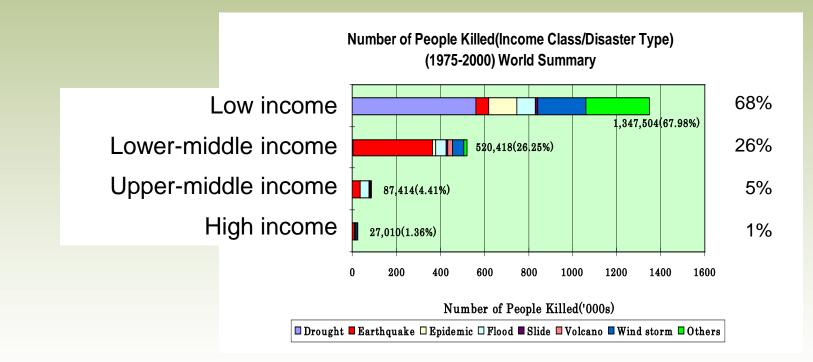
Figure 1 – Trends in number of reported natural disasters

People affected by natural disasters

Source: EM-DAT, CRED, University of Louvain, Belgium

Who is Most Affected by Disasters?

The poor: most vulnerable to current hazards and to expected climate change impacts

Number of People Killed(Income Class/Disaster Type)
(1975-2000) World Summary

Income Class		Percent
Low income	1,347,504(67.98%)	68%
Lower-middle income	520,418(26.25%)	26%
Upper-middle income	87,414(4.41%)	5%
High income	27,010(1.36%)	1%

Number of People Killed('000s)

Legend: Drought · Earthquake · Epidemic · Flood · Slide · Volcano · Wind storm · Others

Source: ADRC, OFDA/CRED

Guiding ...

- Risk sensitive LUP

- Carrying capacity based planning

- Livelihood and food security

- Sustainable / resilient infrastructure

- SDGs

- Paris Climate Agreement

- Sendai Framework for DRR

- 7th AMCDRR

Sendai Framework for Disaster Risk Reduction 2015-2030

Promote the mainstreaming of disaster risk assessments into land-use policy development and implementation, including urban planning, land degradation assessments and informal and non-permanent housing, and the use of guidelines and follow-up tools informed by anticipated demographic and environmental changes

Emerging Issues

- Environmental change as risk driver - climate change, land-use, natural resource degradation

- Vulnerabilities – governed by environmental, technological and behavioural factors

Addressing underlying causes of vulnerability (HFA Priority 4) / SFDRR (Priority 1,3)
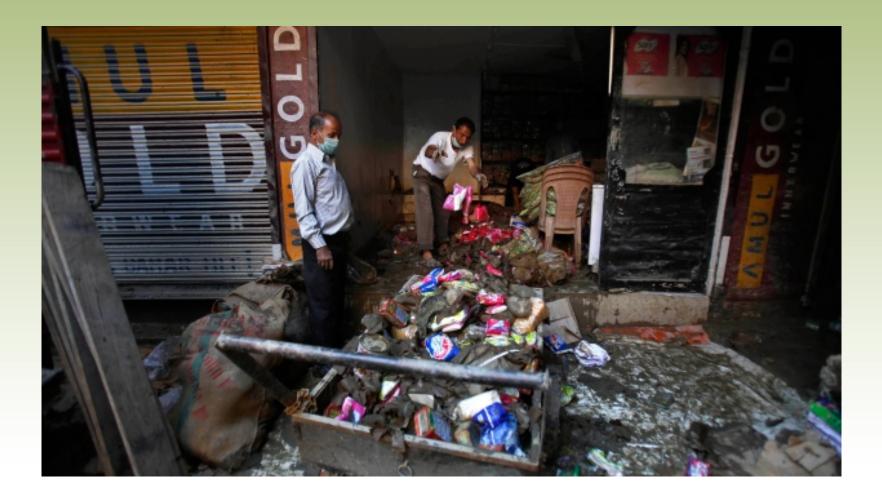
- Integrating climate change adaptation and DRR

- Mainstreaming across sectors of development

- Tools of planning and implementation

J&K

Overview

© EPA

J&K
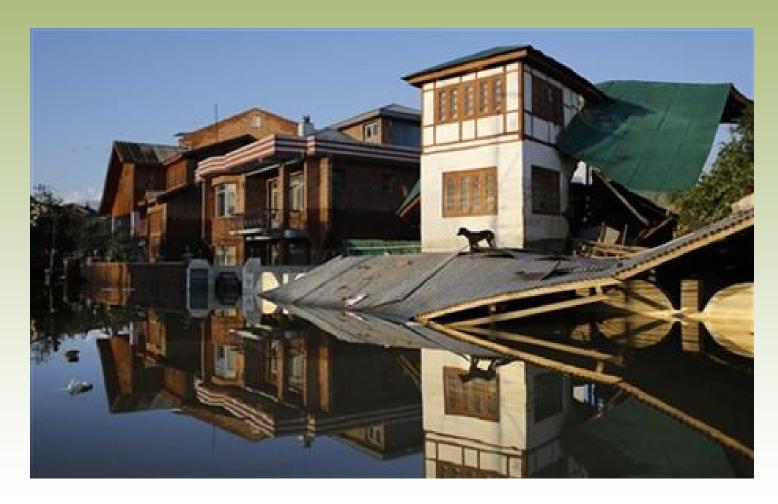
Uttarakhand disaster 2013

Paradigm Shift in Disaster Management

☐ **Response Centric**

☐ **Relief Centric**

- **Mitigation centric**
- **Preparedness centric**
- **Disaster Centric**

- **Hazard Centric**
- **Vulnerability Centric**
- **Environment Centric**

2nd Paradigm shift
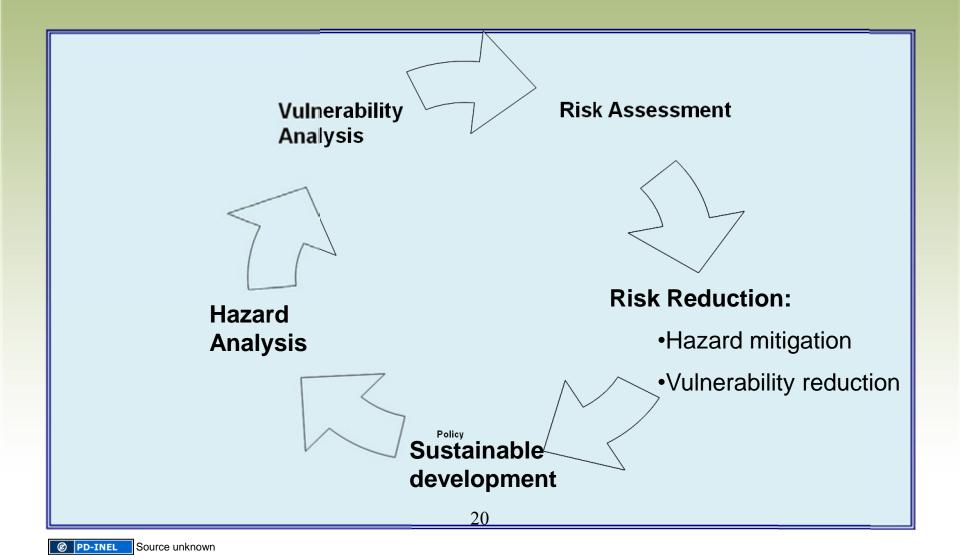
- **From Relief to Risk Reduction**
- **From Compartmental to Integration**
- **From Ad-hoc to Organized**
- **From Single hazard to multi-hazard**

Climate Change Adaptation

The Risk Reduction Cycle

Vulnerability Analysis

Risk Assessment

Hazard Analysis

Risk Reduction:
- Hazard mitigation
- Vulnerability reduction

Policy
Sustainable development

20
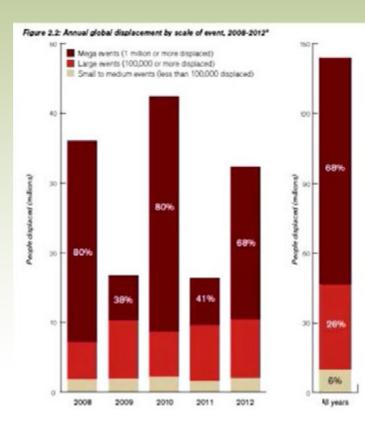
IMPACTS OF DISASTERS
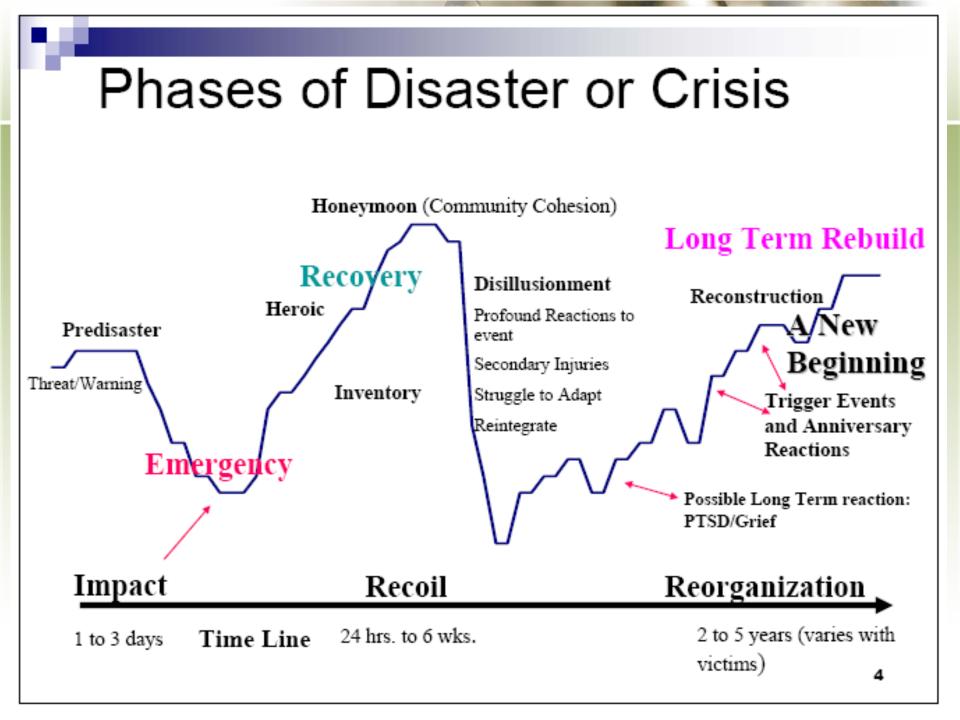
- Physical (buildings, structures, physical property, industry, roads, bridges, etc.)
- Environmental (water, land/soil, land-use, landscape, crops, lake/rivers / estuaries, aquaculture, forests, animals/livestock, wildlife, atmosphere, energy, etc.)
- Social (life, health, employment, relations, security, peace, etc.)
- Economic (assets, deposits, reserves, income, commerce, production, guarantee/insurance, etc.)

Internal migration

Figure 2.2: Annual global displacement by scale of event, 2008-2012*

According to a report, titled *Global Estimates 2012, People displaced by disasters*, prepared by the International Displacement Monitoring Centre, which tracks internal displacements worldwide, in 2012 more people were displaced in India by natural disasters than in any other country. Incessant floods, triggered by monsoon, in the north-eastern states of Assam and Arunachal Pradesh caused most of the displacement, as per the report. It further stated that the

Phases of Disaster or Crisis

Honeymoon (Community Cohesion)

Long Term Rebuild

Recovery

Heroic

Disillusionment

Profound Reactions to event

Secondary Injuries

Struggle to Adapt

Reintegrate

Reconstruction

A New Beginning

Predisaster

Threat/Warning

Inventory

Emergency

Trigger Events and Anniversary Reactions

Possible Long Term reaction: PTSD/Grief

Impact

Recoil

Reorganization

1 to 3 days

Time Line

24 hrs. to 6 wks.

2 to 5 years (varies with victims)

4

Environmental Legislation for Disaster Risk Management
ISBN: 978-3-944152-12-7
Anil K. Gupta,
Sreeja S. Nair and S. Singh

Flood Disaster Risk Management: Gorakhpur Case Study
ISBN: 978-3-944152-14-1
Anil K. Gupta,
Sreeja S. Nair,
Shiraz A. Wajih and
Sunanda Dey

Critical infrastructures and Disaster Risk Reduction in the Light of Natural Hazards
ISBN: 978-3-944152-13-4
Claudia Bach,
Anil K. Gupta,
Sreeja S. Nair and
Jörn Birkmann

Geoinformatics Application in Chemical Risk Management
ISBN: 978-3-944152-33-2
Anandita Sengupta,
Debanjan Bandyopadhyay,
Nilanjan Paul,
Sreeja S. Nair and
Anil K. Gupta

Databases and Statistics for Disaster Risk Management
(4 Modules)
ISBN: 978-3-944152-11-0
Sreeja S. Nair, Klaus Röder
& Anil K. Gupta
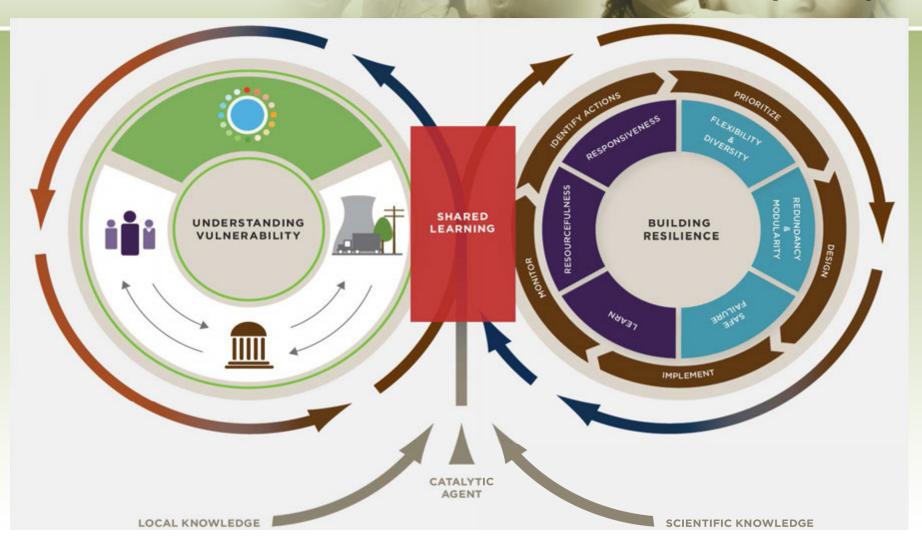
Disaster Management and Risk Reduction

Role of Environmental Knowledge
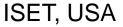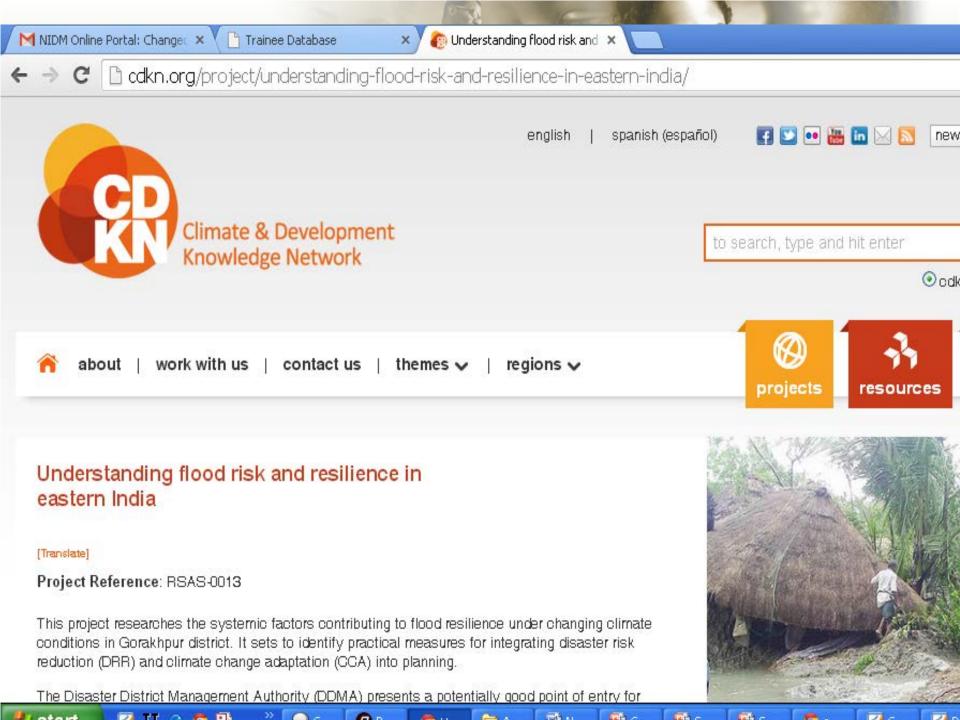
Editors
Anil K. Gupta
Sreeja S. Nair
Florian Bemmerlein-Lux
Sundhya Chatterji

Narosa

The Climate Resilience Framework (CRF)

ISET, USA

english | spanish (español)

new

CDKN
Climate & Development Knowledge Network

to search, type and hit enter

cdk

🏠 about | work with us | contact us | themes ⌄ | regions ⌄

projects

resources

Understanding flood risk and resilience in eastern India

[Translate]

Project Reference: RSAS-0013

This project researches the systemic factors contributing to flood resilience under changing climate conditions in Gorakhpur district. It sets to identify practical measures for integrating disaster risk reduction (DRR) and climate change adaptation (CCA) into planning.

The Disaster District Management Authority (DDMA) presents a potentially good point of entry for

Flow of Policy and Actions on Climate Change

Policy • **NAPCC**

Plan • **SAPCC**

Programmes • **DDMP- Projects, Programmes,** Actions, Resources, Community Participation, Training & Capacity Building

•The Central Government is the apex body to give policy directions; inventive plans and

• programmes are planned at sub-national level, while the actual actions take place at district / local level

•CRS http://geagindia.org/PDF/Towards%20a%20Resilient%20(Englishl).pdf
•Policy Brief CDKN+ GEAG
http://geagindia.org/PDF/EXTREME%20RAINFALL,%20CLIMATE%20CHANGE,%20AND%20FLOODING%20Policy%20Brief%20Gora
khpur%20India.pdf
•Teri Policy Breif http://www.teriin.org/policybrief/
•Process document http://www.start.org/download/2014/geag_mainstreaming-cca-drr_processdocument.pdf
•Training Module http://nidm.gov.in/PDF/modules/climate.pdf
•CRF-ISET http://i-s-e-t.org/projects/crf.html

Coastal DRR

Integrating Climate Resilient Plan into Disaster Management in Coastal Areas of Tamil Nadu and Andhra Pradesh

Andhra Pradesh: Vishakapatnam, Prakasham, Nellore

Tamil Nadu: Cuddalore, Nagapatinam, Thiruvallur

6 cities and 18 villages forming 6 clusters

GIZ Germany - European Union - NIDM Under Indo-German Environment Programme

Urban floods in Bangalore and Chennai: risk management challenges and lessons for sustainable urban ecology

Anil K. Gupta* and Sreeja S. Nair

A number of major cities and towns in India reported a series of devastating urban
cent decade. Mumbai flood 2005 followed by other major cities of South Asia like
bad, Rawalpindi also suffered with urban flooding. Census 2001 figured 285 mill
metro cities of India, and is estimated to cross 600 million with 100 metro cities i
ecological challenges coupled with climatic variability are noted to aggravate flo
pact on affected communities. Urban flooding was primarily a concern of municip
mental governance, has now attained the status of 'disaster', which has drawn
environmental scientists and disaster managers. Challenges of urban flooding in te
and flood mitigation including structural and non-structural measures and key issu
logy in two major metropolitan cities of India – Bangalore and Chennai, have be
management challenges in the context of land-use, city and population growth, we
tion, waste disposal have been discussed.
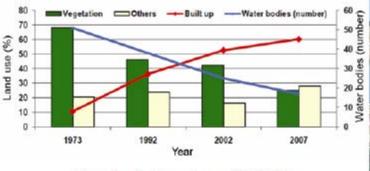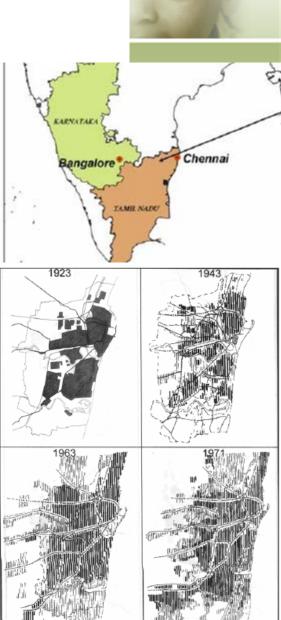
Figure 3. Land-use changes, 1973–2007.

17

Applying environmental impact assessments and strategic environmental assessments in disaster management

Anil Kumar Gupta and Sreeja S. Nair

Rationale: Paradigm shift to ecosystem-based disaster risk reduction

The first paradigm shift in disaster management that took place over the past two decades moved "response- and relief-centric approaches" towards "mitigation and preparedness-centric approaches", but this re-

Chapter on "Role of EIA and SEA in DRR" published by UNU.
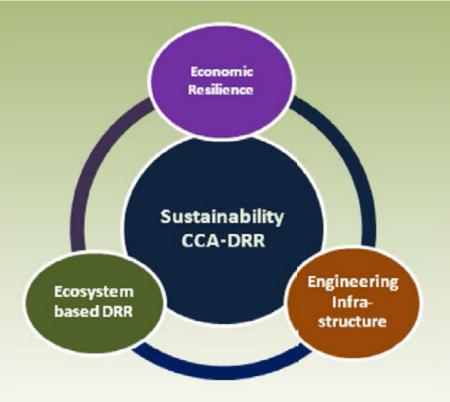
Operational Needs

- Translating Convergence to National/sub-national and local DRR/Development frameworks

- Disaster Management Plans – National/state, local, sector specific, department specific, etc.

District Administration & Local Government

HANDBOOK FOR
DISTRICT COLLECTORS ON
Climate Resilient - Disaster Risk Reduction

National / Sectors

•• All development sectors must

• imbibe the principles of disaster risk

• management

•• Work towards risk coverage for all

•• Encourage greater participation and leadership of women in disaster risk management

•• Invest in risk mapping globally

•• Leverage technology to enhance the efficiency of disaster risk management efforts

•• Develop a network of Universities to work on disaster issues

•• Utilize the opportunities provided by social media and mobile technologies

•• Built local capacities and initiatives

•• Ensure the opportunity to learn from a disaster is not wasted

•• Bring about greater cohesion in international disaster response

PRIME MINISTER'S AGENDA 10:

India's Disaster Risk Management Roadmap to Climate Resilient and Sustainable Development

Anil K Gupta,
Shashikant Chopde,
Swati Singh,
Shiraz A Wajih and
Sakshi Katyal

SYNERGIZING SDGs, PARIS CLIMATE AGREEMENT AND
SENDAI FRAMEWORK FOR DRR – INTEGRATING TO LOCAL
ACTIONS: SUB-NATIONAL AND URBAN CONTEXT

CLIMATE
RESILIENT *and*
DISASTER SAFE
DEVELOPMENT

**Process Framework
Training Manual**

Contributors
Anil K Gupta, Swati Singh, Sakshi Katyal, Shashikant Chopde,
Shiraz A. Wajih, Amit Kumar

Harnessing Synergies

National / Sectors

•• All development sectors must

•imbibe the principles of disaster risk

•management

•• Work towards risk coverage for all

•• Encourage greater participation and leadership of women in disaster risk management

•• Invest in risk mapping globally

•• Leverage technology to enhance the efficiency of disaster risk management efforts

•• Develop a network of Universities to work on disaster issues

•• Utilize the opportunities provided by social media and mobile technologies

•• Built local capacities and initiatives

•• Ensure the opportunity to learn from a disaster is not wasted

•• Bring about greater cohesion in international disaster response

PRIME MINISTER'S AGENDA 10:
India's Disaster Risk Management Roadmap to Climate Resilient and Sustainable Development

Anil K Gupta,
Shashikant Chopde,
Swati Singh,
Shiraz A Wajih and
Sakshi Katyal

There is an Old Saying…

No one plans to fail,
they just fail to plan.

There is an Old Saying…

No one plans to fail,
   they just fail to plan.

CATALOGUE
OF
DISASTERS

Not
Now....
...

THANKS

envirosafe2007@gmail.com

Email: anilg.gov.in@gmail.com

Twitter: @envirosafe2007

Researchgate: www.researchgate.net/profile/Anil_Gupta15

Thank You!

Geoinformatics in Flood and Drought Disaster Risk Management

Pankaj Mani, NIH Patna

mailofpmani@yahoo.com, pmani.nihr@gov.in

Disaster And Its Management

- Disaster-Event causing great damage/ injury /loss of life (natural or manmade)

- Disaster Management – Deals with application of various techniques, management and planning of resources to deal with extreme events,

- Objective of Disaster Management-Prevention of disaster or reduction of losses due to it.

Geoinformatics

- Geoinformatics is the integration of different disciplines dealing with spatial information.
- It assimilates the elements of Photogrammetry, Remote Sensing, GPS and GIS.
- GIS- database management system for spatially distributed features and the associated attributes.

GIS (Geographical Information System

GEOGRAPHIC *implies that locations of the data items are known, or can be calculated, in terms of Geographic coordinates (Latitude, Longitude)*

INFORMATION *implies that the data in a GIS are organized to yield useful knowledge, often as coloured maps and images, but also as statistical graphics, tables, and various on-screen responses to interactive queries.*

SYSTEM *implies that a GIS is made up from several inter-related and linked components with different functions. Thus, GIS have functional capabilities for data capture, input, manipulation, transformation, visualization, combinations, query, analysis, modeling and output.*

Disaster & Geoinformatics

- All disasters are spatial in nature. GIS techniques act as a decision support tool.

- Currently socio-economic and geo-spatial data is useful for management and planning of disasters as well as tackling of disastrous condition.

Phases of Disaster Management Activity

- Prediction

- Prevention

- Mitigation

Pre Event activity

Hazard zone mapping, mitigation strategies and preparedness plans, modeling of disaster risks and human adaptations to hazards

- Emergency management   **During Event activity**

Real time geographic data can improve the allocation of resources for response, EAP
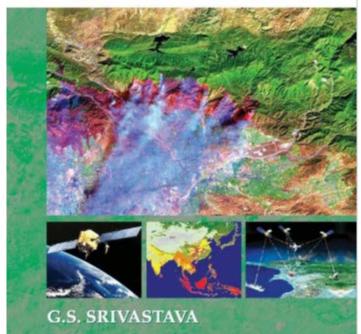
- Recovery   **Post Event activity**

Modelling of disaster risks and human adaptations to hazards. Provides decision support system in disaster management.

GIS in Disaster Management

- Accurate data availability
- Location of event site within permissible time
- Accessibility information between source and destination
- Real time visualization of area of interest
- Reduced the time element involved in activities
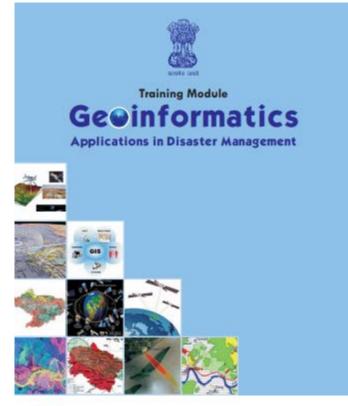
An Introduction to
Geoinformatics

G.S. SRIVASTAVA

Training Module
Geoinformatics
Applications in Disaster Management

Case Study-1
Siting of Nuclear Power Plant at Gorakhpur Harayana

Disaster management through prediction, prevention and mitigation measures

SOURCE OF FLOODING

Breach in FBC

Breach in BML

Catchment flooding

Local site rainfall
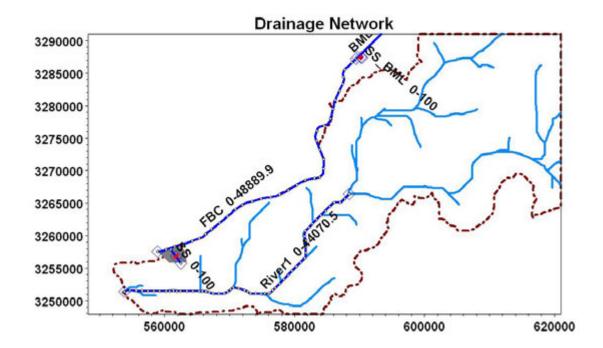
Ghaggar river flowing north of the plant site is in different basin and therefore not considered as flooding source

Flood due to failure of Bhakra dam has also been studied, the plant site remain unaffected
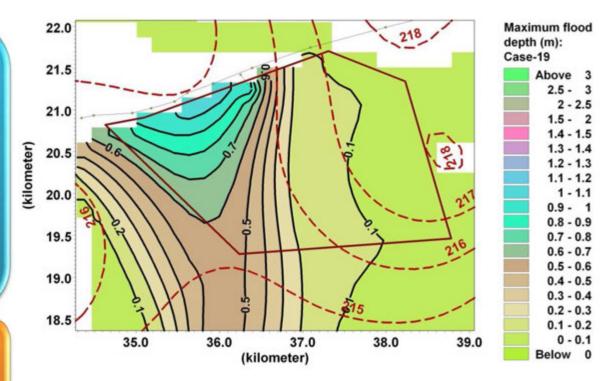
Estimation of flood level due to breach in canal and design flood in River 1

Drainage Network

MIKE FLOOD SIMULATION

Severe flooding scenario
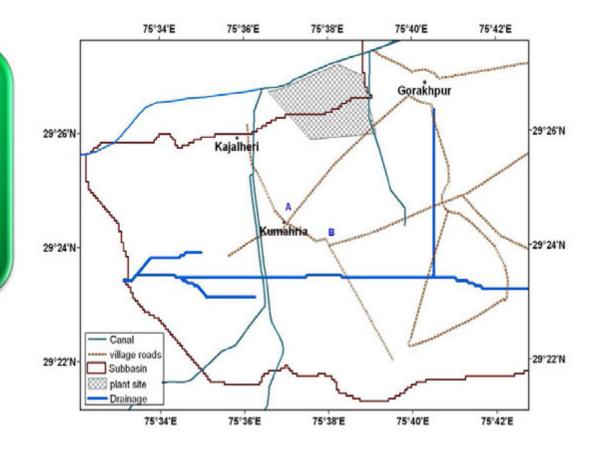
The severe most flooding scenario when bank full FBC flow is fully diverted towards plant site, local rain is PMP & catchment is flooded with PMF

Max flood depth of 1.1 m & max flood elevation of occurs in this case

Maximum flood depth (m): Case-19

Above	3
2.5 -	3
2 - 2.5	
1.5 -	2
1.4 - 1.5	
1.3 - 1.4	
1.2 - 1.3	
1.1 - 1.2	
1 - 1.1	
0.9 -	1
0.8 - 0.9	
0.7 - 0.8	
0.6 - 0.7	
0.5 - 0.6	
0.4 - 0.5	
0.3 - 0.4	
0.2 - 0.3	
0.1 - 0.2	
0 - 0.1	
Below	0
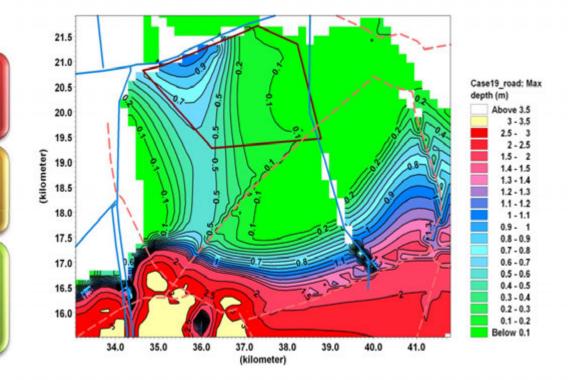
Effects of features affecting flow dynamics

The bathymetry is revised for village roads, other features affecting the flow dynamics around the plant side

13

MIKE FLOOD SIMULATION

Effects of features affecting flow dynamics

Severe most flooding condition is simulated with the revised bathymetry

The flood depth within plant site and also at A & B were studied

It is observed that due to these features the flood depth at A & B changes but plant site remains unaffected.

Case19_road: Max depth (m)

	Above 3.5
	3 - 3.5
	2.5 - 3
	2 - 2.5
	1.5 - 2
	1.4 - 1.5
	1.3 - 1.4
	1.2 - 1.3
	1.1 - 1.2
	1 - 1.1
	0.9 - 1
	0.8 - 0.9
	0.7 - 0.8
	0.6 - 0.7
	0.5 - 0.6
	0.4 - 0.5
	0.3 - 0.4
	0.2 - 0.3
	0.1 - 0.2
	Below 0.1

MIKE FLOOD SIMULATION

Future climate change scenario
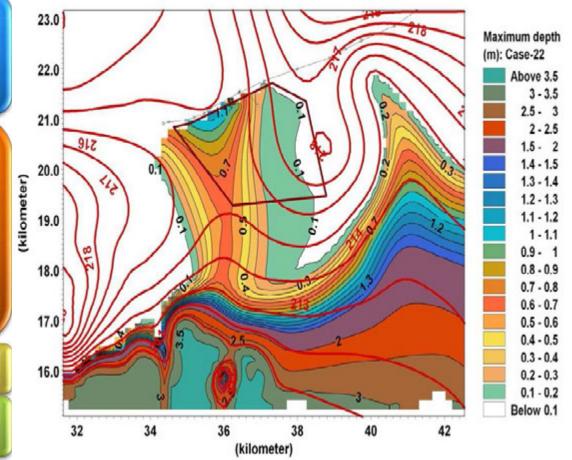
Rainfall estimate is increased by 15% to account for the future climate change

Now the flooding scenario is bank full FBC flow is fully diverted towards plant site, local rain is 1000 yr + σ + 15% increase & catchment is flooded with 1000 yr + σ+15% increased rain

Max flood depth = 1.17 m
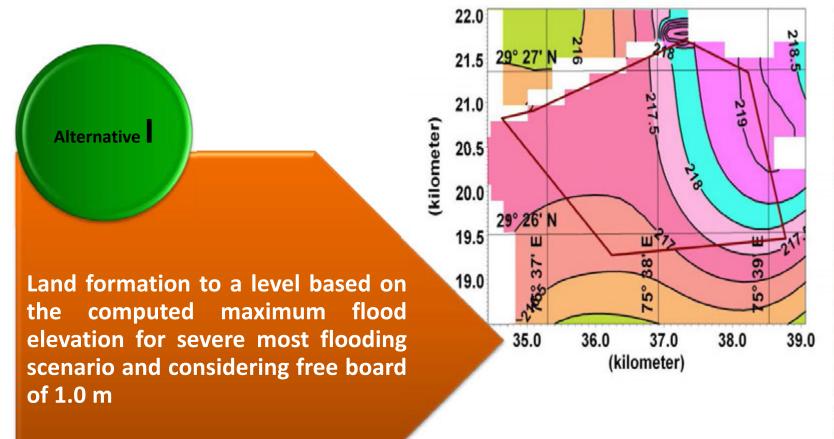
Max flood elevation = 218.25 m, increase of 0.1 m

Maximum depth (m): Case-22

	Above 3.5
	3 - 3.5
	2.5 - 3
	2 - 2.5
	1.5 - 2
	1.4 - 1.5
	1.3 - 1.4
	1.2 - 1.3
	1.1 - 1.2
	1 - 1.1
	0.9 - 1
	0.8 - 0.9
	0.7 - 0.8
	0.6 - 0.7
	0.5 - 0.6
	0.4 - 0.5
	0.3 - 0.4
	0.2 - 0.3
	0.1 - 0.2
	Below 0.1

COMPUTATION OF SAFE GRADE LEVEL

Maximum flood level (Case-21)   = RL 218.15 m

Increase in level for climate change   =   0.10 m

Safety margin   =   1.00 m

Safe grade elevation   = RL 219.25 m
(Say 219.3 m)

Alternative I

Land formation to a level based on the computed maximum flood elevation for severe most flooding scenario and considering free board of 1.0 m

Proposed land formation

Above	221
220 -	221
219.5 -	220
219 -	219.5
218.5 -	219
218 -	218.5
217.5 -	218
217 -	217.5
216.5 -	217
216 -	216.5
215.5 -	216
215 -	215.5
214.5 -	215
214 -	214.5
213 -	214
212.5 -	213
212 -	212.5
211 -	212
210 -	211
Below	210

Alternative II
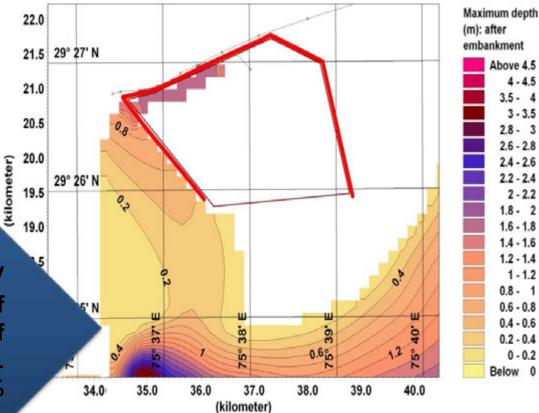
A flood protection wall/ embankment with top elevation of RL 219.3 m and the plinth level of safety related structures at RL 219.1 m (local 1000 yr rainfall with 15% and 1 .0 m free board)
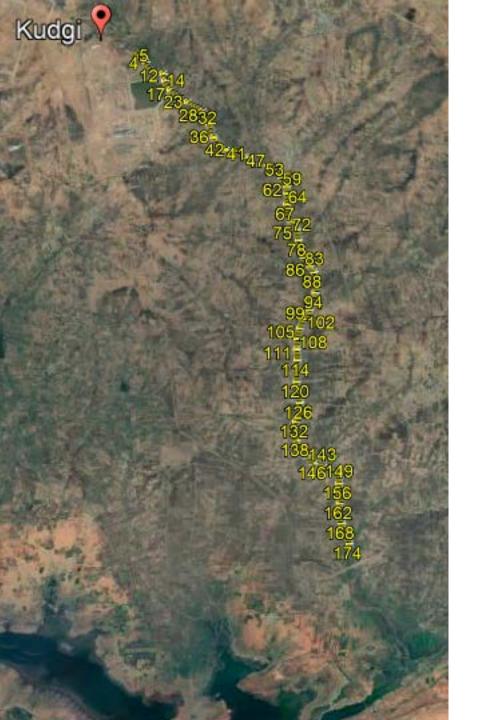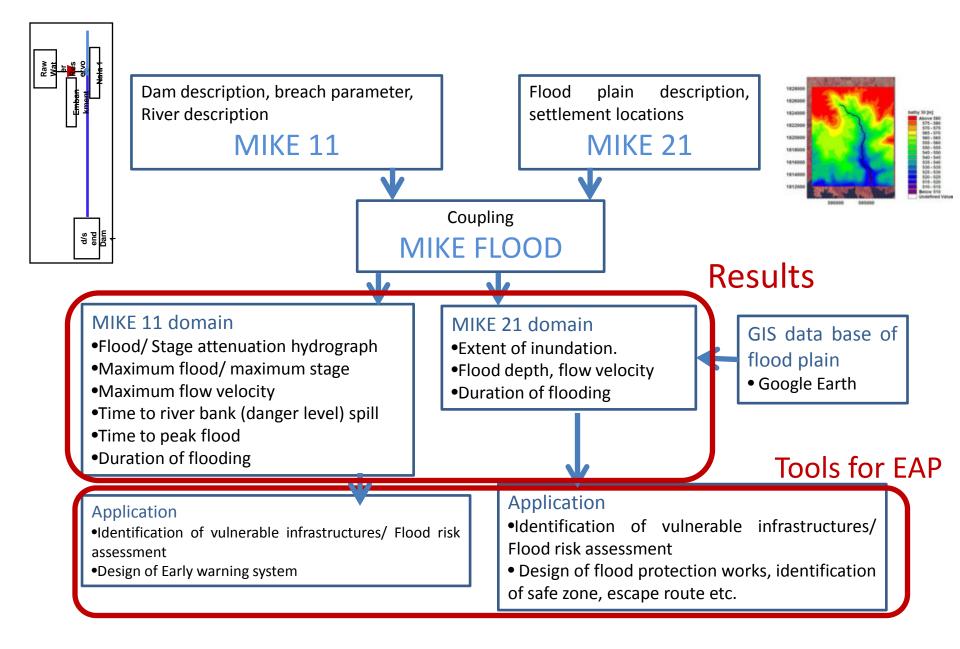
Case Study-2
Emergency action plan for dam break analysis

Emergency management during disaster

Earthen embankment
10.5 MCM storage

Methods

Dam description, breach parameter, River description

MIKE 11

Flood plain description, settlement locations

MIKE 21

Coupling

MIKE FLOOD

Results

MIKE 11 domain
- Flood/ Stage attenuation hydrograph
- Maximum flood/ maximum stage
- Maximum flow velocity
- Time to river bank (danger level) spill
- Time to peak flood
- Duration of flooding

MIKE 21 domain
- Extent of inundation.
- Flood depth, flow velocity
- Duration of flooding

GIS data base of flood plain
- Google Earth

Tools for EAP

Application
- Identification of vulnerable infrastructures/ Flood risk assessment
- Design of Early warning system

Application
- Identification of vulnerable infrastructures/ Flood risk assessment
- Design of flood protection works, identification of safe zone, escape route etc.

Dam break analysis

- **DB analysis including estimation of breach parameters, sensitivity analysis of breach parameters and different flooding scenario.**

- **Three cases of flooding are considered in the study including pre-project and post project scenario.**

  – Case-1, pre-project scenario, design flood in Nala 1 (100-year return period flood).

  – Case-2, post project scenario, flooding from embankment breach (sunny day failure) and

  – Case-3, post project scenario, combination of flooding due to embankment failure and design flood in Nala 1 (extreme flood failure).

- **The breach failure of embankment in all cases of simulation is considered under FRL and the downstream boundary condition is FRL of d/s reservoir, i.e. 519.6**

Maximum inundation for Case 1 (blue shade) and Case 3 (red shade) near Settlement 2

MFL: 542.38 m, 543.64 m
Time to peak: 2 hr, 21 m, 1 hr 42 m

Safe zone

Proposed flood protection alignment

Escape route

Maximum inundation for Case 1 (blue shade) and Case 3 (red shade) near Settlement 6

MFL: 521.61 m, 522.52 m
Time to peak: 3 hr, 1 m, 2 hr 10 m

Wandal

Proposed flood protection alignment

Safe zone

Escape route

335 m
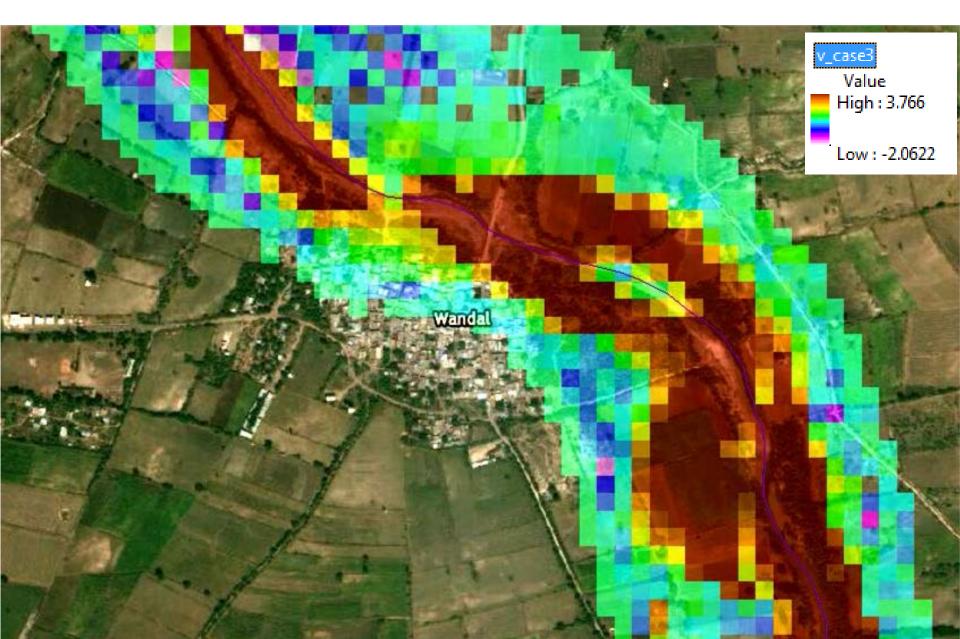
© 2015 Google
Image © 2015 CNES / Astrium

Google earth

16°24'48.25" N   75°53'10.24" E elev 534 m   eye alt 2.00 km

Maximum flow velocity for Case 3 near Settlement 6

Case Study-3
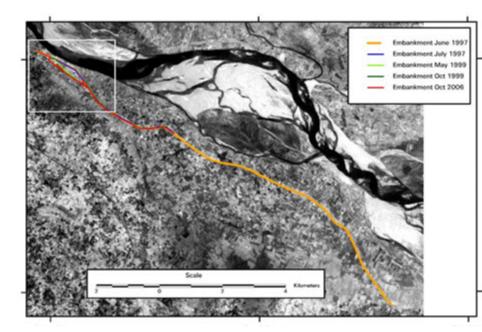
Evaluation study of flood protection work of Raunahi embankment
(from 0.6 km to 1.7 km on the right bank of river Ghaghara in Faizabad District of U.P.

Post event management

Modelling of disaster risks and human adaptations to hazards..
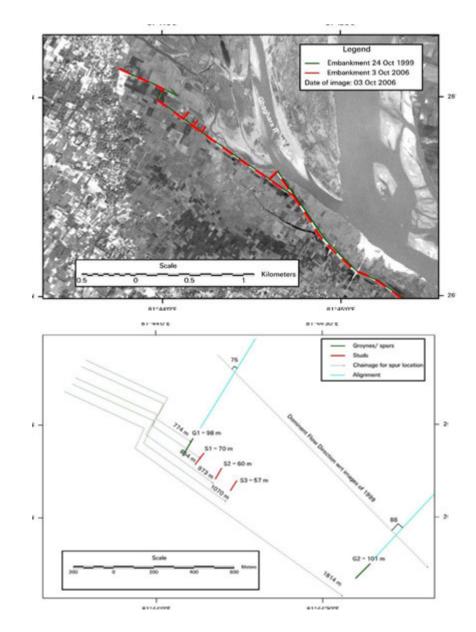
Study Area

- Raunahi embankment, on the right bank of River Ghaghara in the districts of Barabanki and Faizabad in U. P.

- Length = 14.52 km (12-6-1997).

- embankment starts from village Khajuri in Ramsanehi subdivision of Barabanki (Ch-0 km) and extents upto village Dhaurahara in Rudauli subdivision in Faizabad (Ch-14.52 km) .

- The construction of embankment started during 1984 and completed in 1995

Study Area…

- The embankment between Chainage-0.6 km to 1.8 km was eroded during monsoon of 1997.

- To protect this reach a retired bund and 4 spurs were proposed to be constructed between Chainage-0 km to 2 km.

- By June 1999, the retired bund and 2 spurs were constructed.

- Still the river was approaching the retired bund and therefore a 2nd retired bund with 4 spurs were proposed during 2000.

- Various modifications have been added into the project and finally 2 spurs and 3 studs were constructed by post monsoon 2002 .

Data Used

- **Remote Sensing Data**
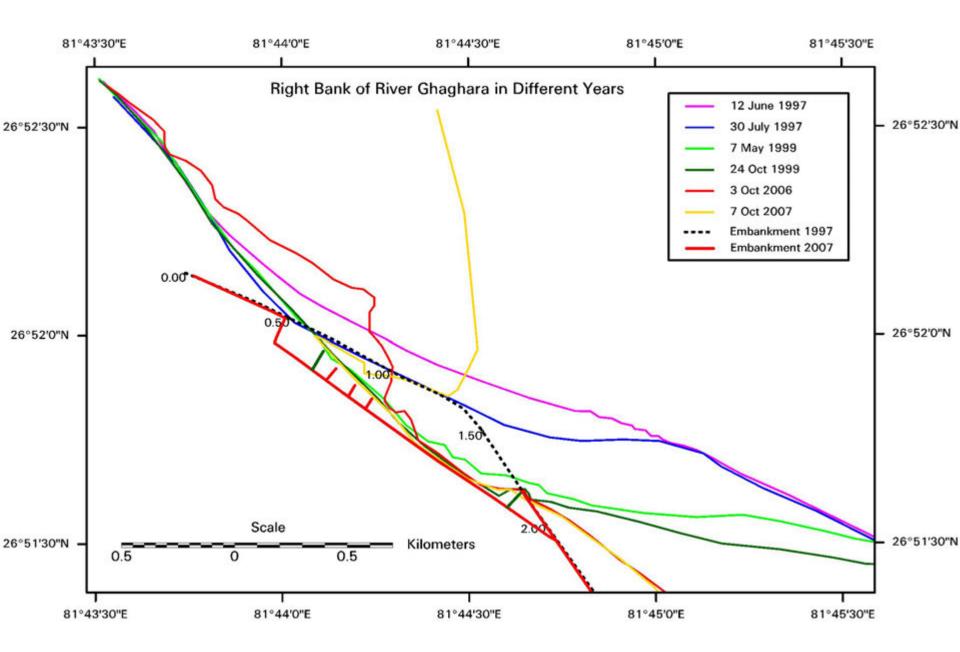
SN	Satellite/ Sensor	Path Row	Date of Satellite Pass
1	IRS 1C/ PAN	101-52	12-June-1997
2	IRS 1C/ PAN	101-52	30-July-1997
3	IRS 1C/ LISS III	101-52	07-May-1999
4	IRS 1C/ PAN	101-52	24-October-1999
5	IRS 1D/ LISS III	101-52	24-October-1999
6	IRS P5 (Cartosat-1)	550-273	03-October-2006
7	IRS 1D/ PAN	101-52	07-October-2007
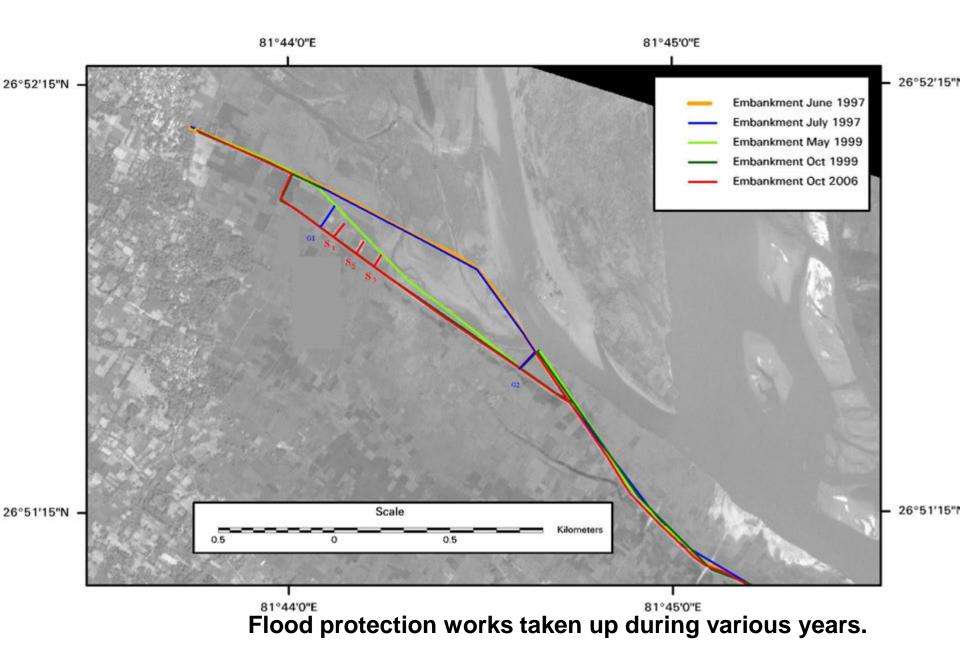
- **Hydrological Data**
  - Annual maximum GD data Elginbridge 1975-2005
  - Annual maximum GD of Ayodhya (ghaghara) and Buxor, Gandhighat (Ganga) and Koelwar (Sone)
- **Socio Economic Data**
  - Field Survey in the form of Questionnaire
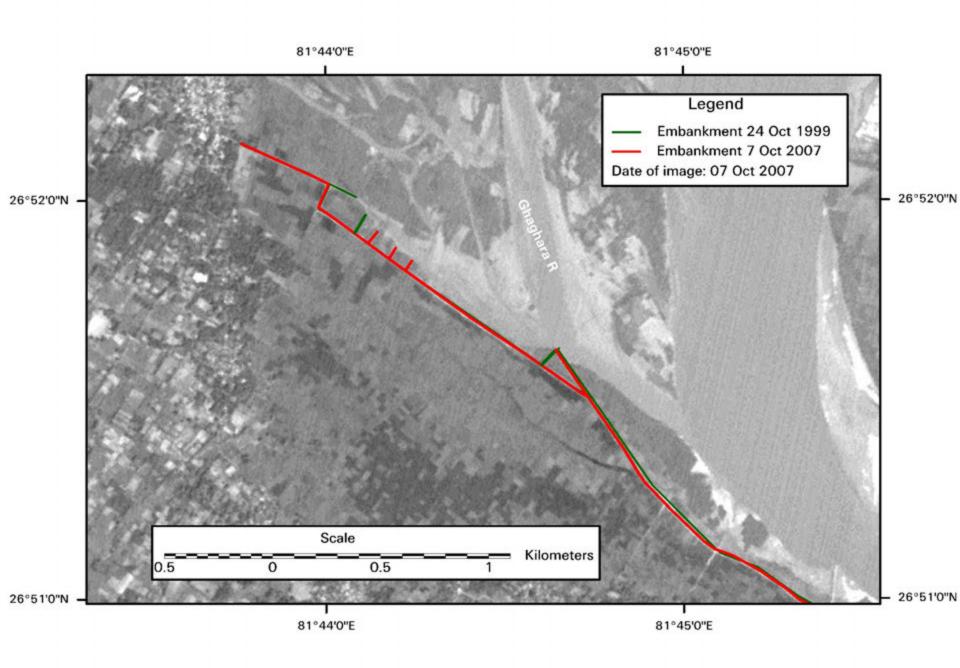
Right Bank of River Ghaghara in Different Years

12 June 1997	
30 July 1997	
7 May 1999	
24 Oct 1999	
3 Oct 2006	
7 Oct 2007	
Embankment 1997	
Embankment 2007	

81°43'30"E   81°44'0"E   81°44'30"E   81°45'0"E   81°45'30"E

26°52'30"N

26°52'0"N

26°51'30"N

0.00

0.50

1.00

1.50

2.00

Scale

0.5   0   0.5   Kilometers

Flood protection works taken up during various years.

Legend

— Embankment 24 Oct 1999
— Embankment 7 Oct 2007

Date of image: 07 Oct 2007

Ghaghara R

Scale

0.5   0   0.5   1   Kilometers

81°44'0"E   81°45'0"E

26°52'0"N

26°51'0"N

Return period of annual floods between 1997-2005.

Year	Annual Max (Cumecs)	Return period (Year)	
		FFA – LPIII	RFFA – L-moments
1983	*22996*	*54.17705*	*107.2041*
1997	*10126.2*	*1.289834*	*<2*
1998	13750.6	2.533115	4.586967
1999	11142.6	1.495824	2.230818
2000	14147.1	2.760033	5.464391
2001	8522.11	1.100088	<2
2002	8564.73	1.102987	<2
2003	11610.2	1.622502	2.457111
2004	7404.22	1.0409	<2
2005	11688.9	1.646017	2.499788

Thanks

Flood: Changing scenario, increasing vulnerability and state actions

Piyoosh Rautela

Executive Director
Disaster Mitigation and Management Centre (DMMC)
Department of Disaster Management
Government of Uttarakhand

☎   0091 135 2710232, 2710233, 2710334, 1070
⌨   0091 135 2710199, 2710335
🖥   Visit us at <http://www.dmmc.uk.gov.in>   or
🖥   <www.facebook.com/#!/pages/Disaster-Mitigation-and-Management-Centre-DMMC>

The great flood

River Valley Civilizations

Mesopotamia	Egypt	Harappa	China
Tigris-Euphrates valley	Nile valley	Indus valley	Yellow river valley

Human Intervention

Dams	Embankments
Reduced speed of water Reduced erosional capacity Reduced carrying capacity	Water unable to spill over levees Load deposited on river bed rather than floodplain False sense of security

Hills: Relief reduces chances of flood

Nevertheless there have been floods in the hills

Dam breach	Intense rains	Landslide
Gohna in Birahi Ganga 6 September 1893 TH Holland, District Surveyor Lt. Crookshank 25 August, 1894 in place of 24 28.32 crore cu m water released **Alaknanda 1970** Gohna Tal, Patal Ganga, Rishi Ganga, Dhwal Ganga, Garur Ganga Belakuchi, Tapovan, Srinagar, Chamoli	**Bhagirathi 2010** **Bhagirathi 2012** **Alaknanda 2013**	**Gundyar Tal in Birahi Ganga valley - 1868** 2 villages and 75 pilgrims washed off in Chamoli

Release from the dam

Release from Larji
8th June, 2014
Shangala on Byas river
25 students and 01 other washed away

Despite relief water level can rise during spells of heavy rains

Water level can rise dangerously

March, 2013   16 June, 2013   17 June, 2013

Flow can be highly unpredictable

Wash away assets

Damage infrastructure
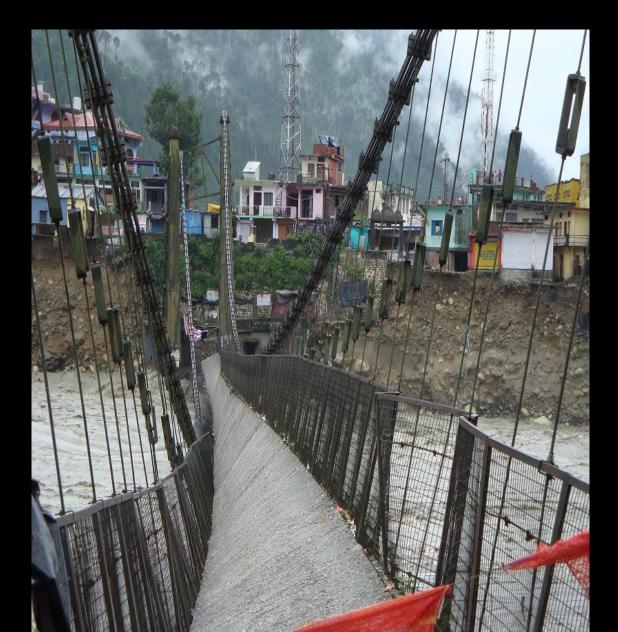
Block highways
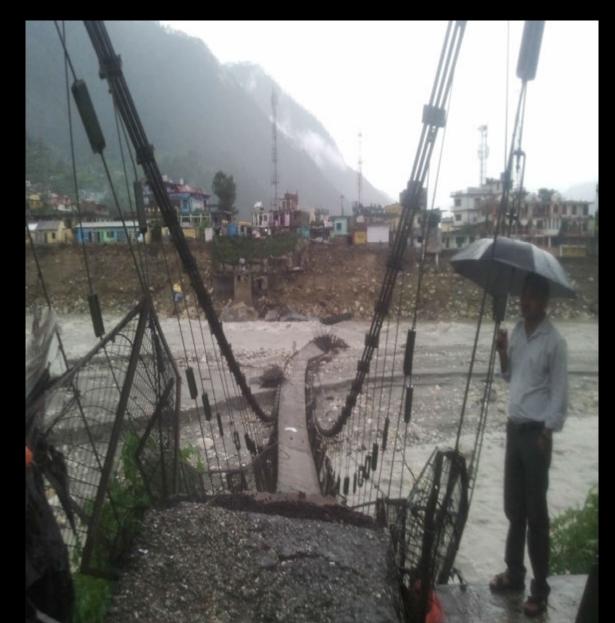
Block highways

Wash off bridges

Tawaghat

Erode highways

AM11:01 17/JUN/2013

17

Threaten habitations

Threaten habitations

Even obliterate habitations

Instances of floods are on the increase

And so are the losses

2001	28	2010	220
2002	37	2011	68
2003	19	2012	176
2004	56	2013	4218
2005	74	2014	66
2006	19	2015	53
2007	57	2016	107
2008	77	2017	111
2009	66	2018	109
Total		5561	
Average		309	
Average w/o 2013		79	

This was not the case always as people

Conserved water	Mastered art of exploiting groundwater	Devised means of tackling scarcity / excess
Chaal / Khal (Recharge pits) Scared groves Religi-magical rites	Dhara Naula	Settlement pattern Seasonal migration Agricultural terraces Bunds

Chaal (traditional recharge pit)
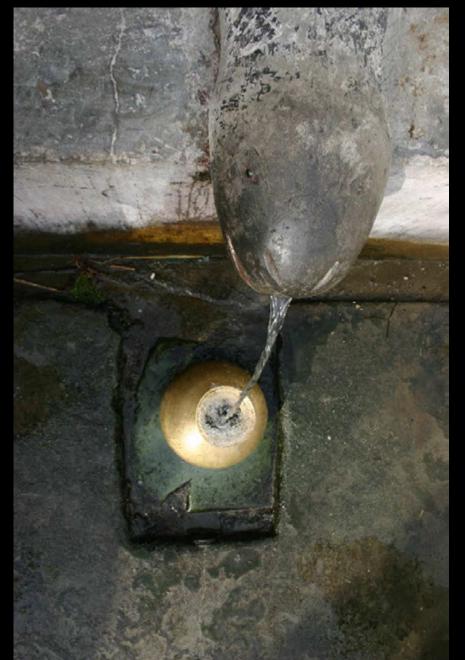
Sacred groves (promoting recharge)

Water: Available abundantly but not easily

Dhara (utilizing seepages)

Naula (Shallow dug well)

Naula (Shallow dug well)

Naula (Shallow dug well)

Naula (Shallow dug well)

Naula (Shallow dug well)
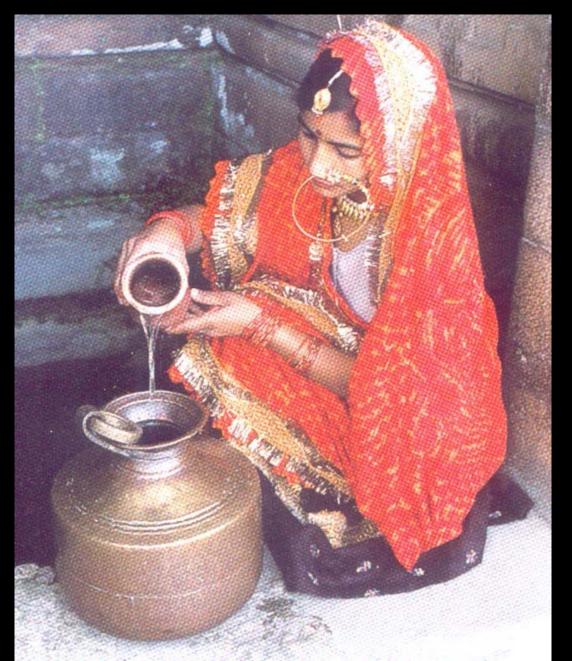
The people could also prospect deep aquifers

Deep dug well at Almora

Religio-magical rites invoked around water sources

Groundwater exploitation was a landmark discovery

Relationship of water with flood and slope instability was well understood;
hence mitigation measures

Jungle guls

Terracing of hill slope

Unbunded far flung fields

Seasonal migration

Efforts being made presently

Preparedness	Mitigation	Response
Flood modelling Rainfall forecasting Flood warning dissemination Awareness Mock exercises	Dams and **barrages** Embankments	SDRF Jal Police Apda Mitra Training of volunteers Prepositioning

107 AWS, 28 ARG, 16 Snow Gauges and 25 surface field observatories (combination of single Stevenson screen, optical rain gauge and AWS), **are being setup**
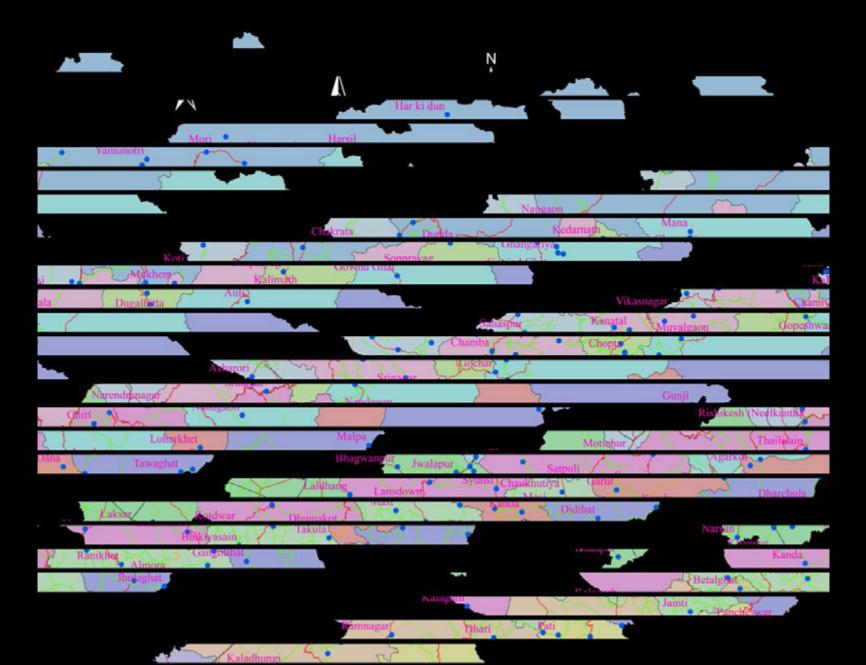
Badrinath (Chamoli)

Kedarnath (Rudraprayag)
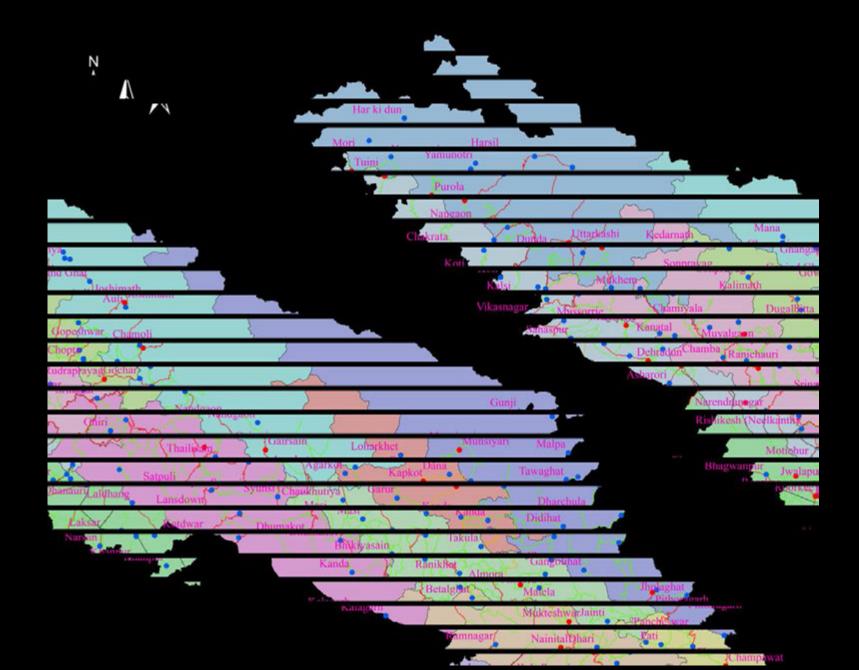
Existing AWS network of IMD

Proposed AWS network

AWS network (Existing + Proposed)

Sirens with voice message dissemination facility installed along the course of Bhagirathi / Ganga between Koteshwar and Rishikesh at 08 places with the support of THDCIL

Devprayag

Byasi
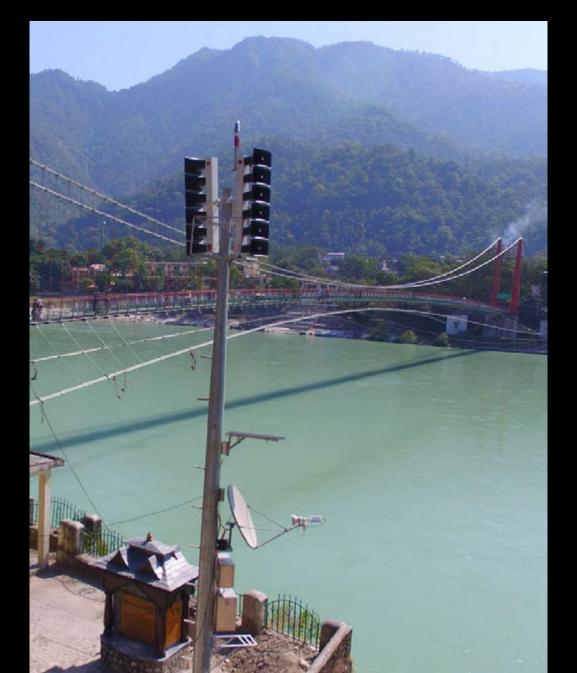
Koteshwar

Triveni Ghat, Rishikesh

Ram Jhoola, Rishikesh

Sms service being utilised for sending warning messages

Possibility of location based messaging being explored

Mock exercises are organised regularly

Mock exercise in progress

Mock exercise in progress

Mock exercise in progress

State Disaster Response Force (SDRF)

Weather	Connectivity	Local familiarity
Rain Visibility	Disrupted roads Washed off bridges	Routes Disaster history Resources

Local volunteers being trained

10 days duration	612 programs	15, 300 trained
Search and rescue First aid Emergency communication	Nyaya Panchayat level	25 in each Nyaya Panchayat Web based inventory

Capacity building of community for effective response

09/12/2005

Online record of trained volunteers

Online record of trained volunteers

File   Edit   View   History   Bookmarks   Yahoo!   Tools   Help

http://atal.uttarain.org/members.aspx?nid=2

Most Visited   Getting Started   Latest Headlines

Search Web •   eSupport •   Mail •   My Yahoo! •   Answers •   Games •

Untitled Page

आपदा प्रबंधन विभाग उत्तरखण्ड

District	बागेश्वर	Block	कपकोट	Nyaay Panchayat	लोहार खेत

id	Name	Father's/Husband's Name	Date of Birth	Addres	PSTN	Mobile	Icardno	Photograph
349	श्री दुर्गा सिंह धानिक	श्री भूपाल सिंह	01-01-1971	ग्राम-सूड़िंग, तहसील-कपकोट,जिला-बागेश्वर।		0899132502	UP/03/001/0051009	
350	श्रीमती हंसा धानिक	श्री दुर्गा सिंह	01-01-1979	ग्राम-सूड़िंग, तहसील-कपकोट,जिला-बागेश्वर।		8991325021	SQL0030551	
351	महेश सिंह टाकुली	श्री मोहन सिंह टाकुली	01-01-1994	ग्राम-सूड़िंग, तहसील-कपकोट,जिला-बागेश्वर।	05963219913	0000000000	राशन कार्ड संख्या-028447	
352	गजेन्द्र सिंह टाकुली	श्री धन सिंह टाकुली	01-01-1982	ग्राम-सूड़िंग, तहसील-कपकोट,जिला-बागेश्वर।		9456394558	MVT5001540	
353	दुर्गा सिंह मटियानी	श्री गोविन्द सिंह मटियानी	01-01-1979	ग्राम-सूड़िंग, तहसील-कपकोट,जिला-बागेश्वर।	05963219177	9456212688	UP/03/011/051074	
354	गोविन्द सिंह	श्री प्रेम सिंह	01-01-1980	ग्राम-सूड़िंग, तहसील-कपकोट,जिला-बागेश्वर।		9456401775	SQL0051847	
355	चंदन सिंह खिंचाल	श्री हर सिंह	01-01-1985	ग्राम-चौंडा, तहसील-कपकोट,जिला-बागेश्वर।		7599249089	MVT5002555	
356	श्री मोहन राम	श्री इंगरराम	01-01-1987	ग्राम-चौंडा, तहसील-कपकोट,जिला-बागेश्वर।		0000000000	राशन कार्ड संख्या-015681	
357	बसन्त बल्लभ जोशी	स्व0 श्री देवी दत्त जोशी	01-01-1965	ग्राम-सुमगड, तहसील-कपकोट,जिला-बागेश्वर।		9410235519	UP/03/011/024023	

Mass awareness

School Curriculum	Special programs	IEC material
	School awareness Mass awareness Targeted awareness Workshops and seminars Rallies	Popular films Printed and audiovisual Newsletter

Mass awareness for voluntary compliance and informed decision making

Mass awareness for voluntary compliance and informed decision making

शोध यात्रा पर आधारित वृतचित्र - १

एक हजार साल पुरानी इमारत,
इमारत क्या
अपने आप में पूरा
भूकम्पअवरोधी
भवन निर्माण कला का
पारम्परिक विज्ञान।,
उसी को देखने, जानने
वैज्ञानिकों का दल निकला
उत्तराखण्ड में
उत्तरकाशी जिले के
जनजातीय क्षेत्र
रंवाई में।
उसी यात्रा को समेटे है
ये वृतचित्र
कोटी बनाल-एक गुमनाम विरासत

शोध : डा० पीयूष रौतेला
गिरीश चन्द्र जोशी

प्रस्तुति : महेश भट्ट,
सरोकार (Centre for Developmental Communication)
mail_sarokaar@yahoo.com

निर्माण : आपदा न्यूनीकरण एवं प्रबन्धन केन्द्र,
आपदा प्रबन्धन विभाग, उत्तराखण्ड शासन।
सम्पर्क : 91-135-2710232, 2710233
www.dmmcuttarakhand.org

कोटी बनाल - एक गुमनाम विरासत   डी.एम.एम.सी. उत्तराखण्ड

कोटी बनाल
एक गुमनाम विरासत
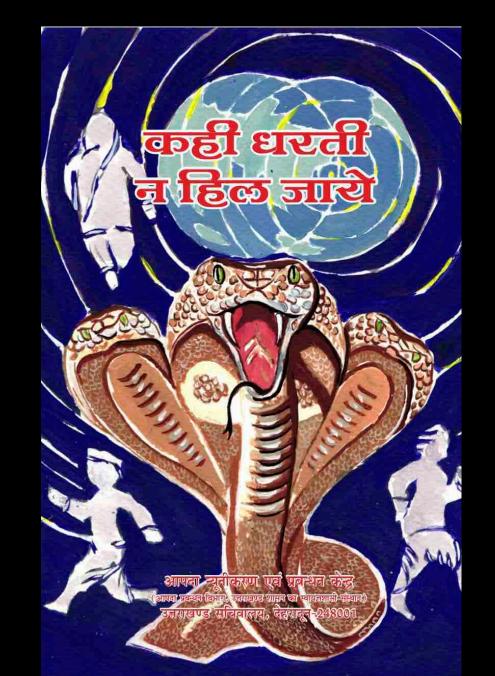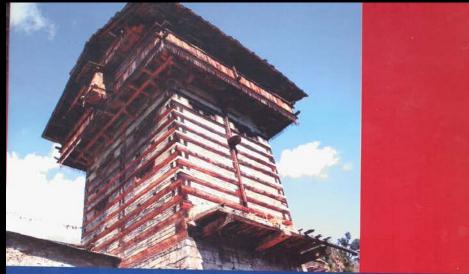
आपदा न्यूनीकरण एवं प्रबन्धन केन्द्र
आपदा प्रबन्धन विभाग
उत्तराखण्ड

Printed IEC
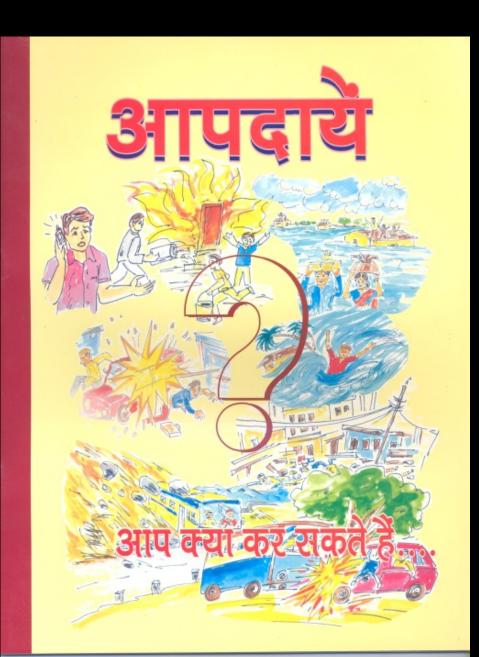
Mass awareness for voluntary compliance and informed decision making

Mass awareness for voluntary compliance and informed decision making

Mass awareness for voluntary compliance and informed decision making

Mass awareness for voluntary compliance and informed decision making

Mass awareness for voluntary compliance and informed decision making

भूकम्प सुरक्षित भवन निर्माण मार्गनिर्देशिका

आपदा न्यूनीकरण एवं प्रबन्धन केन्द्र

(आपदा प्रबन्धन विभाग, उत्तराखण्ड शासन का स्वायत्तशासी संस्थान)

उत्तराखण्ड सचिवालय, देहरादून

आपदा प्रबन्धन

समाचार पत्रिका 3 (4), 2009

मुख्य सम्पादकः

डा. पीयूष रौतेला

सम्पादक मण्डलः

डा. गिरीश चन्द्र जोशी
डा. के. एन. पाण्डे
मे. (से. नि.) राहुल जुगरान
भूपेन्द्र भैसोड़ा
राजीव कुमार

प्रारूपः

गोविन्द रौतेला

सम्पर्कः
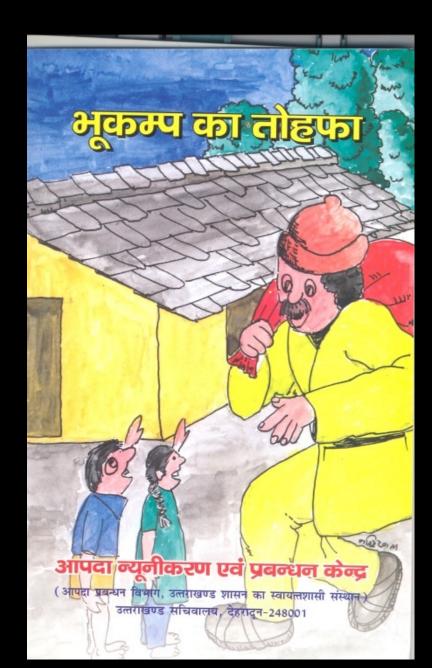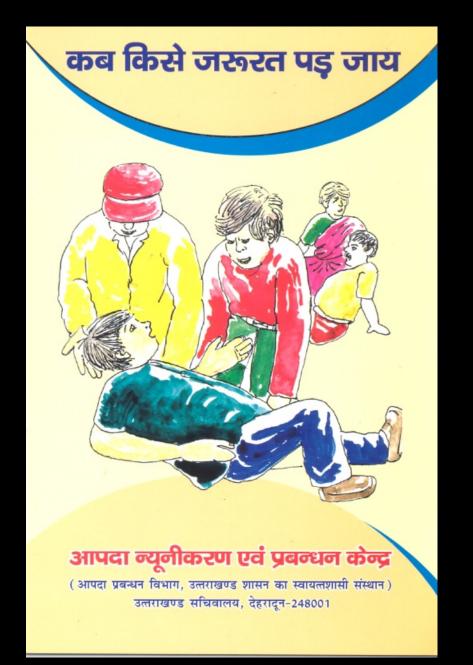
अधिशासी निदेशक
आपदा न्यूनीकरण एवं प्रबन्धन केन्द्र
उत्तराखण्ड सचिवालय
देहरादून–248001 (उत्तराखण्ड)
दूरभाषः 91–135–2710232
          –2710233
फैक्स : 91–135–2710199
वैब साईटः www.dmmcuttarakhand.org

Initiatives from the grassroots
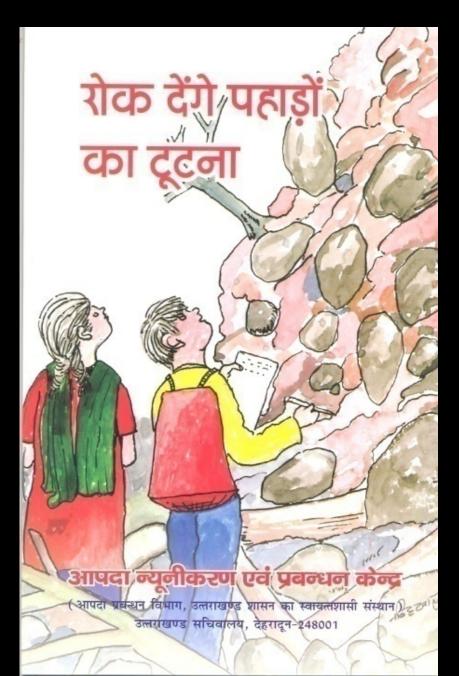
Much has been written on the issue of climate change since the beginning of the climate talks in the Danish capital. World seems to have suddenly become aware of the threat looming large on the very existence of the planet Earth, and is keenly following the deliberations. Hue and cry over the issue certainly makes one believe that people as well as the states around the globe are serious over the issue. "Polluter pays" and "equal opportunity for the underdeveloped nations" are the twin buzzwords dominating the news.
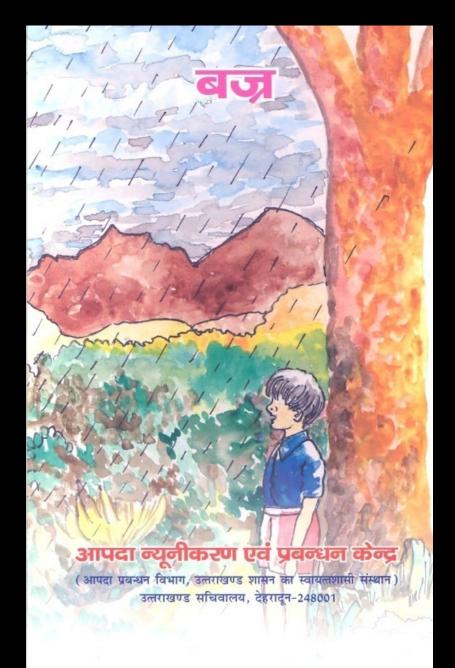
Events over the recent years suggest that in the uni-polar world of present times, the West led by United States has decided to forcefully enforce its decisions. Economic sanctions and differential taxes are increasingly being utilized to enforce the western ideas of equality, exploitation and humanity.

More than just the fate of planet Earth, the outcome of the Copenhagen meet is sure to decide the geo-politics of the times to come. Even if the western world doesn't succeed in carrying through its draft proposal on emission reduction deadlines for the developing nations, they are sure to attempt for its compliance. One should therefore be ready for still more sanctions that might come by in the name of carbon tax. Given the ground realities of today, we would rather be left with literally no option but to kneel down to the diktat.

Copenhagen or no Copenhagen one would agree that the polluter must pay. Looking around from that lens, there would be clear cut need of having a differential tax regime even in our day to day life. If we go by that very principle, the ones using high end electrical gadgets and inefficient / more polluting vehicles should pay more. Charging the poor man lighting a few bulbs at par with someone fuelling his air conditioner is really not justified. Similarly the fuel rates also need to be high for those using high end luxury vehicles; the cost of diesel for a transporter plying a bus / truck and dutifully paying all the taxes being at par with a person using a car worth 15 - 30 / 40 lakh, forces the transporters to go in for adulterated diesel and in the process he ends up polluting the environment. Fuel and electricity rates also need a hike for the industries, particularly the ones found to be polluting.

In the light of the world politics and trade being dictated by global

Mass awareness for voluntary compliance and informed decision making

Awareness programs

Mass awareness for voluntary compliance and informed decision making

Mass awareness for voluntary compliance and informed decision making

Mass awareness for voluntary compliance and informed decision making

Mass awareness for voluntary compliance and informed decision making

Mass awareness for voluntary compliance and informed decision making

Mass awareness for voluntary compliance and informed decision making

Mass awareness for voluntary compliance and informed decision making

Mass awareness for voluntary compliance and informed decision making

Mass awareness for voluntary compliance and informed decision making

Mass awareness for voluntary compliance and informed decision making

Emergency Operations Centres

All EOCs connected with Police wireless network

74 Satellite phones provided to districts and EOCs

79 more Satellite phones being purchased

That's all; thanks a lot

Flood Mitigation Measure and Disaster Risk Reduction (DRR): Structural Measures

Pankaj Mani

mailofpmani@yahoo.com, pmani.nihr@gov.in

Disaster Risk Reduction

- **Disaster Risk Reduction is "Action taken to reduce the risk of disasters and the adverse impacts of natural hazards through systematic efforts to analyse and manage the cause of disasters, including through avoidance of hazards, reduced social and economical vulnerability to hazards, and improved preparedness for adverse events'**

-UN International Strategy for Disaster Reduction (ISDR)
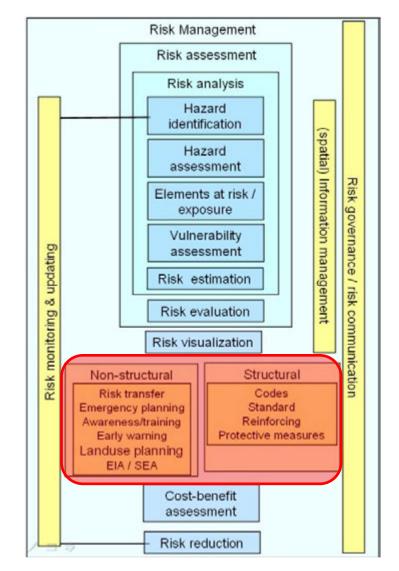
Tools for risk reduction measures

Risk (R) = f (H, V, C)

R = Risk

H = Hazard

V = Vulnerability

C = Coping capacity

Risk can be reduced by:

- Reducing the hazard
- Reducing the vulnerability of the elements at risk
- Reducing the amount of the elements at risk
- Increasing the coping capacity

Disaster Risk Management

Pre-disaster activities				Post-disaster activities	
Risk identification	**Mitigation**	**Risk transfer**	**Preparedness**	**Emergency response**	**Rehabilitation-reconstruction**
Hazard assessment (frequency, magnitude, location)	Structural and non-structural works and actions	Insurance, reinsurance of public infrastructure and private assets	Warning systems, communication systems, protocols	Humanitarian assistance	Rehabilitation, reconstruction of damaged critical infrastructure
Vulnerability assessment (population and assets exposed)	Land-use planning and building codes	Financial market instruments (catastrophe bonds, weather-indexed hedge funds)	Contingency planning (utility companies, public services)	Clean-up, temporary repairs and restoration of services	Macroeconomic and budget management (stabilization, protection of social expenditures)
Risk assessment (function of hazards and vulnerability)	Financial incentives for preventive behavior	Public services with safety regulations (e.g. energy, water, transportation)	Networks of emergency responders (local, national)	Damage assessment and identification of priorities for recovery	Revitalization of affected sectors (e.g. exports, tourism, agriculture)
Hazard monitoring and forecasting (space-time modeling, scenario building)	Education, training and awareness about risks and prevention	Financial protection strategies	Shelter facilities, evacuation plans	Mobilization of recovery resources (public-multilateral, insurance)	Incorporation of risk management in reconstruction processes

Risk reduction strategies

- **Structural measures**:

    refer to any physical construction to reduce or avoid possible impacts of hazards, which include engineering measures and construction of hazard-resistant and protective structures and infrastructure

- **Non-Structural measures**:

    refer to policies, awareness, knowledge development, public commitment, and methods and operating practices, including participatory mechanisms and the provision of information, which can reduce risk and related impacts.

Risk reduction strategies

- Avoidance (eliminate) i.e. modify the hazard
- Reduction (mitigate) i.e. modify the susceptibility of hazard damage and disruption.
- Transference (outsource or insure) i.e. modify the impact of hazards on individuals and the community.
- Retention (accept and budget)

Strategy to reduce vulnerability

Strengthen four capacities* to reduce vulnerability

* Graaf, R. de, N. van de Giesen and F. van de Ven, 2007, Alternative water management
options to reduce vulnerability for climate change in the Netherlands, Natural Hazards nov.
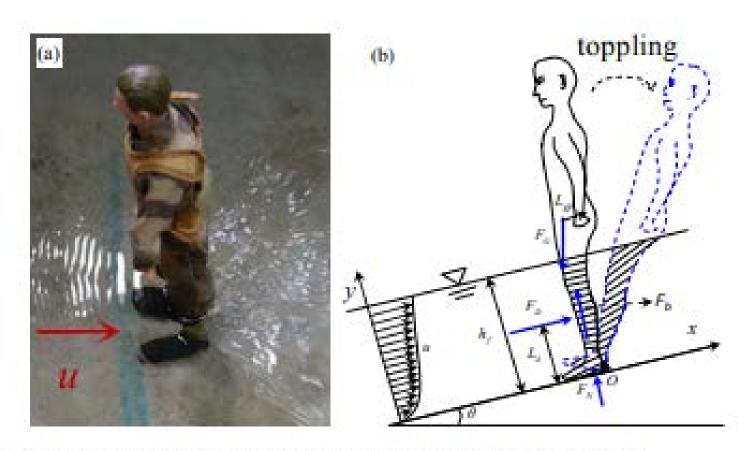
Figure 1 Sketch of governing forces acting on a flooded human body

Hazard classification Scheme

Mani et al., 2014

Table 4 Hazard category for individual flooding parameters

Hazard category	Depth of flooding (m)	Depth × flow velocity (m²/s)	Flood duration (hour)	Parameter hazard index
Very low	0–0.2	0–0.3	0–25	0
Low	0.2–0.6	0.3–0.7	25–50	1
Medium	0.6–1.5	0.7–1.2	50–100	2
High	1.5–3.5	1.2–1.6	100–175	3
Very high	>3.5	>1.6	>175	4

Table 5 Hazard classification scheme based on combination of flow parameters
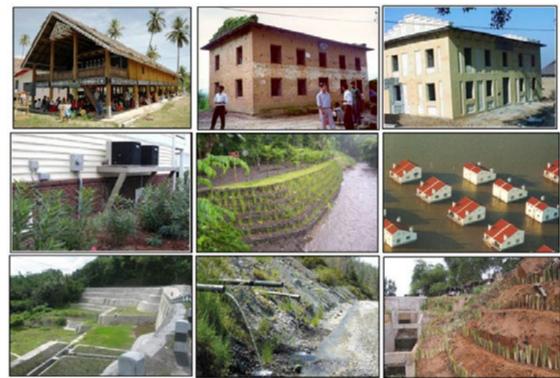
S. no.	Function of depth, depth × velocity and duration	Hazard index	Hazard category
1	$0 < d < 0.2$ and $0 < dv < 0.3$ and $0 < T < 50$	0	Very low
2	$0 < d < 0.2$ and $0 < dv < 0.3$ and $T > 50$	1	Low
3	$0.2 < d < 0.6$ or $0.3 < dv < 0.7$ and $0 < T < 25$	1	Low
4	$0.2 < d < 0.6$ or $0.3 < dv < 0.7$ and $T > 25$	2	Medium
5	$0.6 < d < 1.5$ or $0.7 < dv < 1.2$ and $0 < T < 25$	2	Medium
6	$0.6 < d < 1.5$ or $0.7 < dv < 1.2$ and > 25	3	High
7	$1.5 < d < 3.5$ or $1.2 < dv < 1.6$ and $0 < T < 25$	3	High
8	$1.5 < d < 3.5$ or $1.2 < dv < 1.6$ and $T > 25$	4	Very high
9	$d > 3.5$ or $dv > 1.2$ and $T > 0$	4	Very high
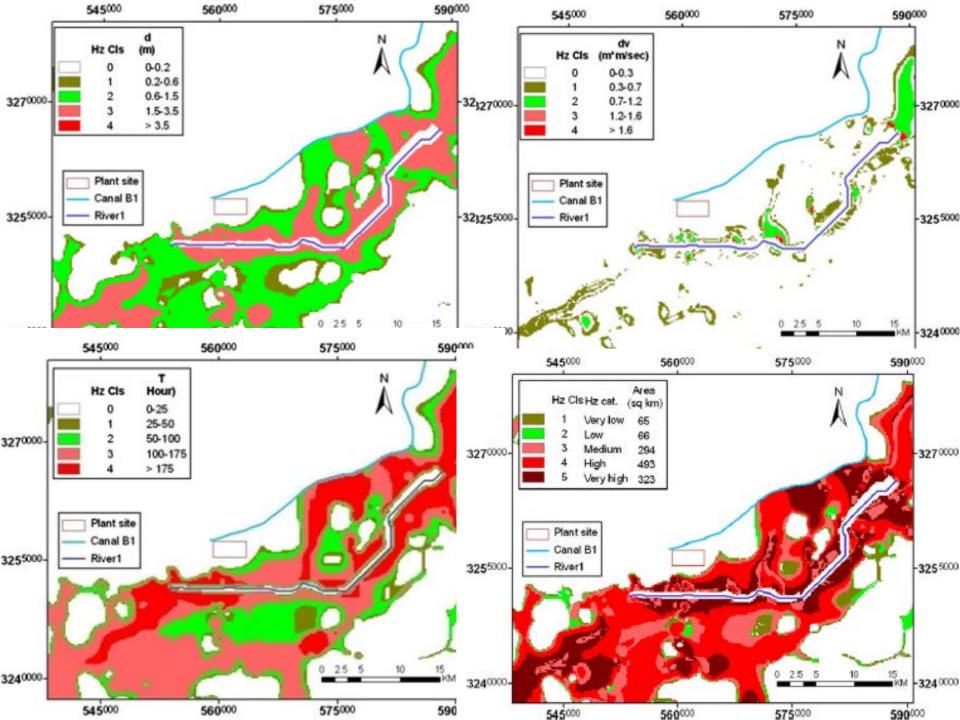
Risk reducing measures

Structural measures

Any physical construction to reduce or avoid possible impacts of hazards

- **engineering measures**
- construction of hazard-resistant and protective structures and infrastructure
- retrofitting

Case study-1

Flood Mitigation Plan for Vadodara City

Flood mitigation through structural measures

- Construction of embankment
- Capacity improvement in existing reservoir
- Rainwater harvesting
- Flood diversion
- Modification in river Cross section

Study Area

Vishwamitri River flow across Vadodara city

Total stretch 70km

With a varying size of cross section of 30-60m.

Major settlement is about 18 km of river stretch

Methodology

Design Flood Estimation

- Frequency analysis of daily rainfall data (L-moments approach)
- Terrain analysis (SRTM data & GIS)
- Generation of SUH (CWC approach)
- Computation of design flood hydrograph
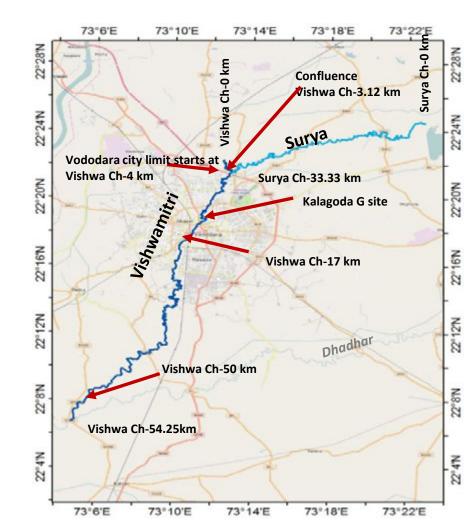
Development of river flow model
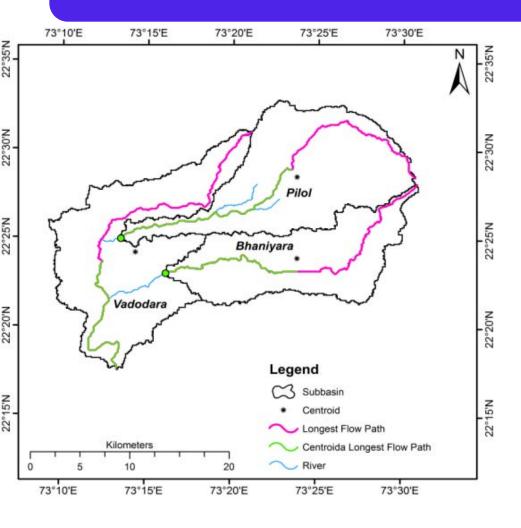
- Flow data is required for model calibration validation.
- No concurrent flow data is available.
- So rainfall data is used to generate flow data.
- Thus rainfall runoff model is first developed using NAM model (deterministic, lumped and conceptual rainfall-runoff model)
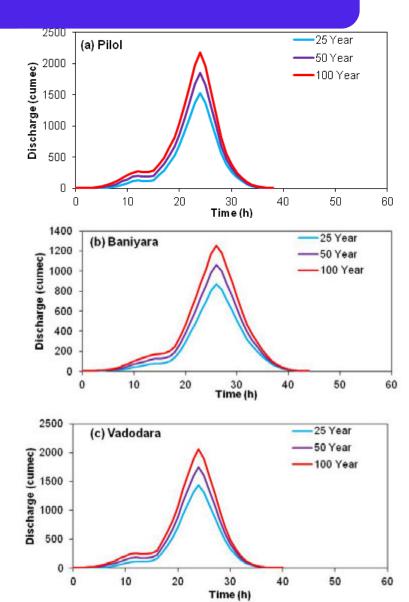
Flood Modelling

River flow model

- **Model includes 2 branches; Vishwamitri, Ch. 0 to 54255 m, Surya, Ch. 0 to 33331.3 m,**

- **Surya joins Vishwamitri at Ch. 3122.4.**

- **Has 905 river cross sections; 336 in Surya and 569 in Vishwamitri.**

- **32 bridges; 10 in Surya and 22 in Vishwamitri**

Analysis & Results

Analysis & Results
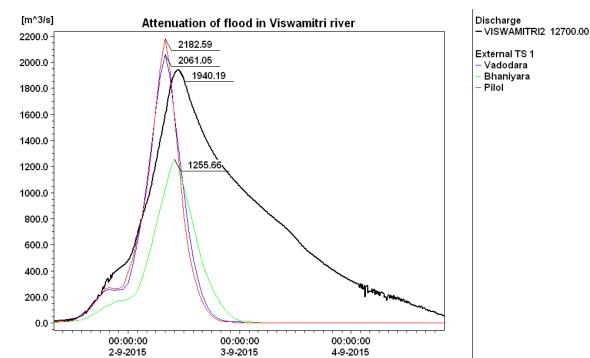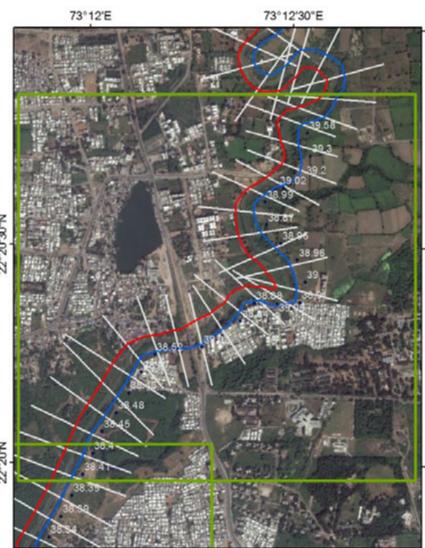
River flow model: Design flood simulation

- **As per BIS code IS 12094:2000, 100 year return period flood will be the design flood for flood protection of an important town.**

- **100 year design flood is induced at Pilol, Bhaniyara and Vadodara (lateral flow in Vishwamitri), design flood at Kalagoda is computed.**

Analysis & Results

Flood mitigation by proposed embankment

- **Embankment alignments have been proposed based on open land available along the river banks as observed from Google Earth Image.**
- Four cases of simulation are done:
- **(i) Case1- design flood simulation in the present river condition,**
- **(ii) Case2- design flood simulation with 2 m embankment**
- **(iii) Case3- design flood simulation with 3 m embankment and**
- **(iv) Case-4 design flood simulation with +4 m embankment.**
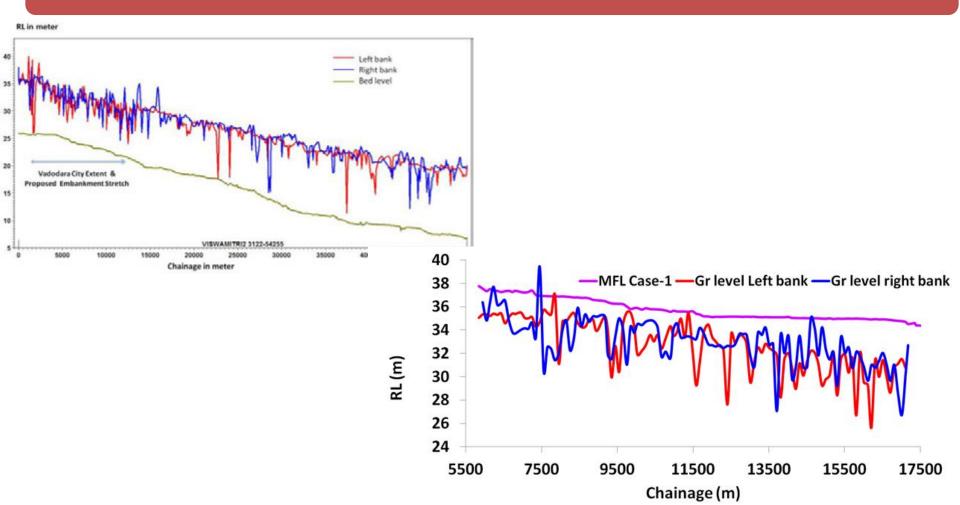
Analysis & Results

Flood mitigation by proposed embankment: Case-1

Analysis & Results

Flood mitigation by proposed embankment: Case-1

Analysis & Results
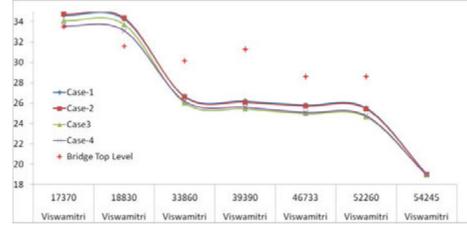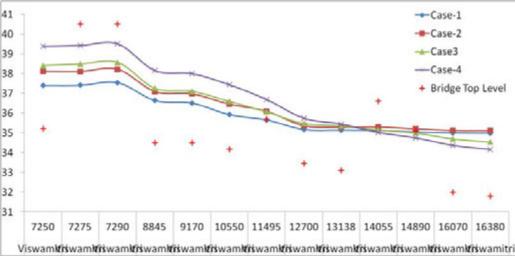
Overtopping of bridges
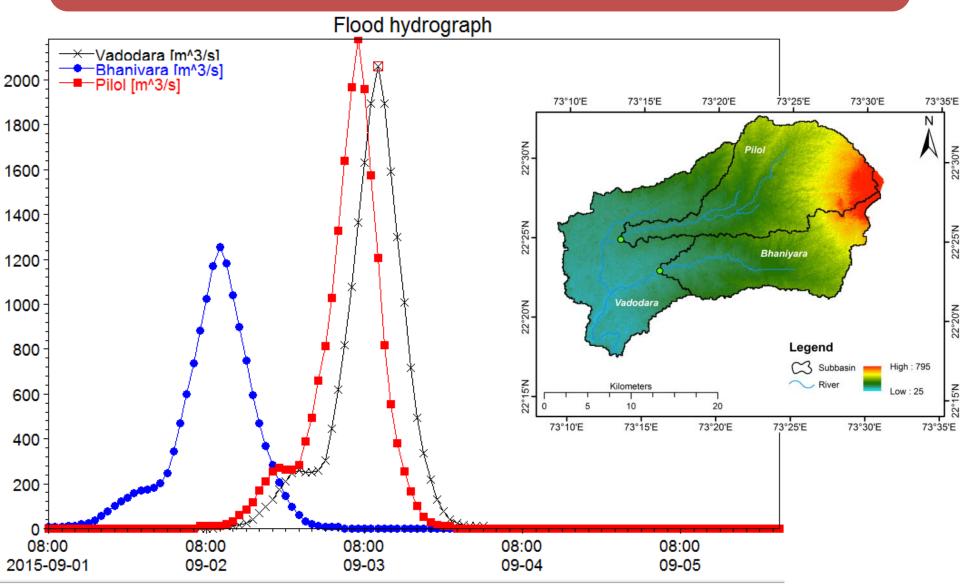
Several bridges overtopped during design flood.

Their design level and waterway is estimated
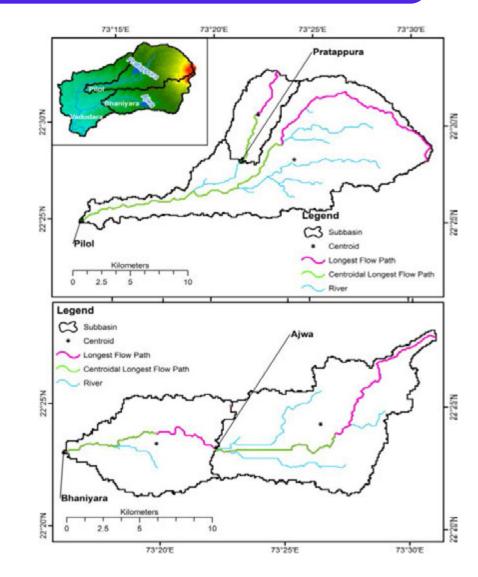
Evaluating Existing Reservoir for Flood Moderation

Flood hydrograph

Analysis & Results

Design Flood Estimation considering reservoirs separately
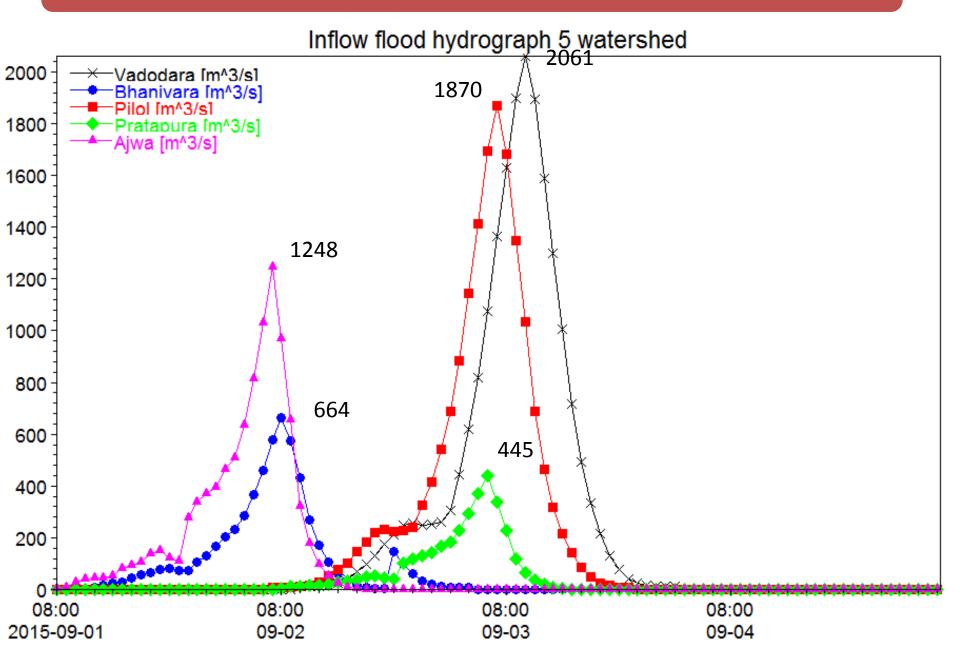
For two reservoirs Pratapura and Ajwa in Pilol and Bhaniyara watersheds, each watershed is divided and design flood is computed for each watershed.

This is done to evaluate performance of these reservoirs for flood mitigation plan.

Inflow flood hydrograph 5 watershed
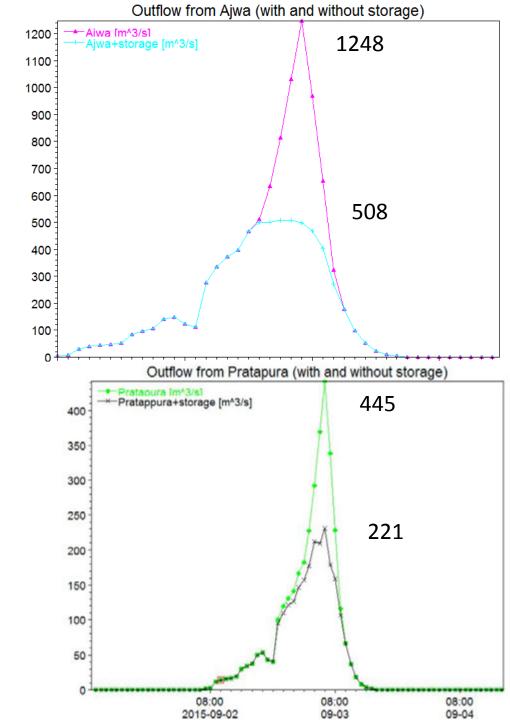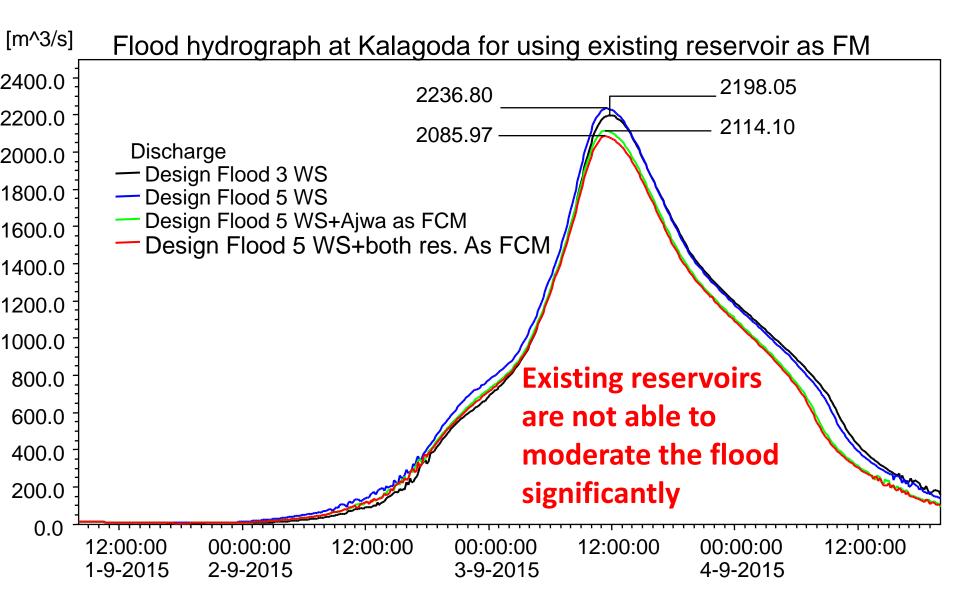
Flood Moderation when reservoir storage is used for FC

Ajwa spread area = 17.8 sq km
if 1 m depth is increased, Additional capacity of 17.8 MCM will be available.

Similarly for Pratappura
spread area = 3 sq km
if 1 m depth is increased additional capacity =3 MCM will be available.

Outflow from Ajwa (with and without storage)
Ajwa [m^3/s]
Ajwa+storage [m^3/s]
1248
508

Outflow from Pratapura (with and without storage)
Pratapura [m^3/s]
Pratappura+storage [m^3/s]
445
221

Flood hydrograph at Kalagoda for using existing reservoir as FM
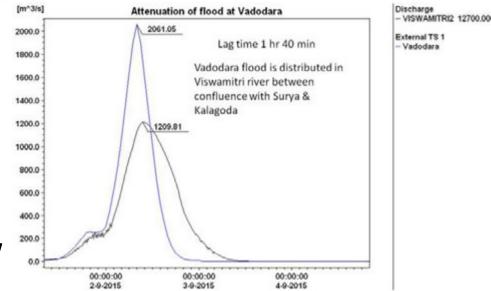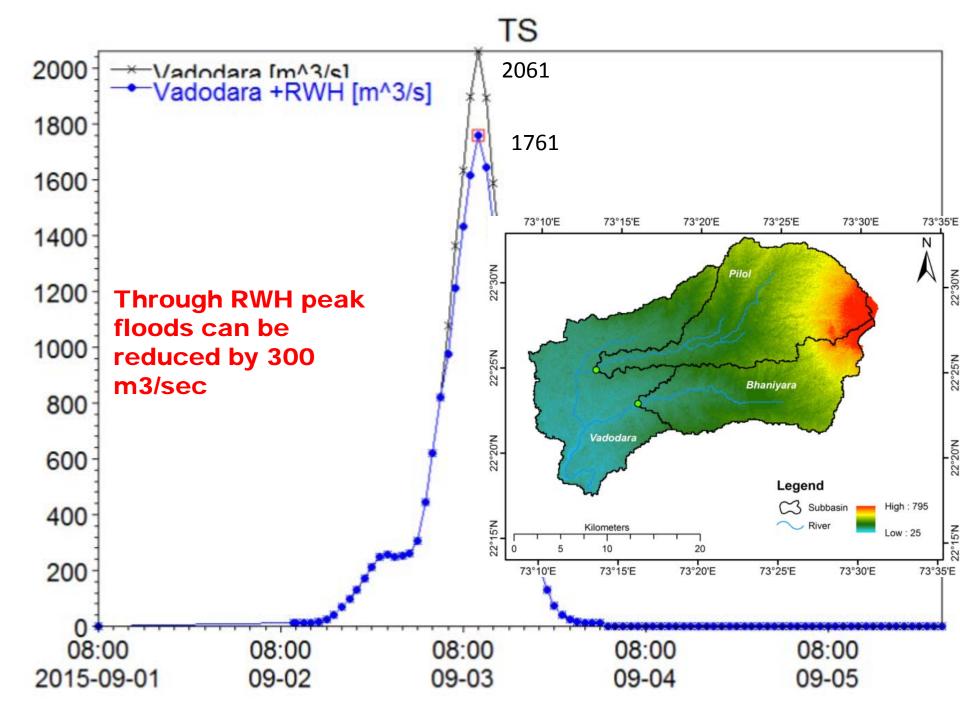
Flood Moderation with RWH structures

Most influencing inflow is from Vadodara catchment. Peak is

No. Of house hold in Vadodara city = 213540 *

If a RWH structure of size 3x3x3 is constructed

Total capacity will be = 5.76558 MCM

And will be used to moderate the inflow
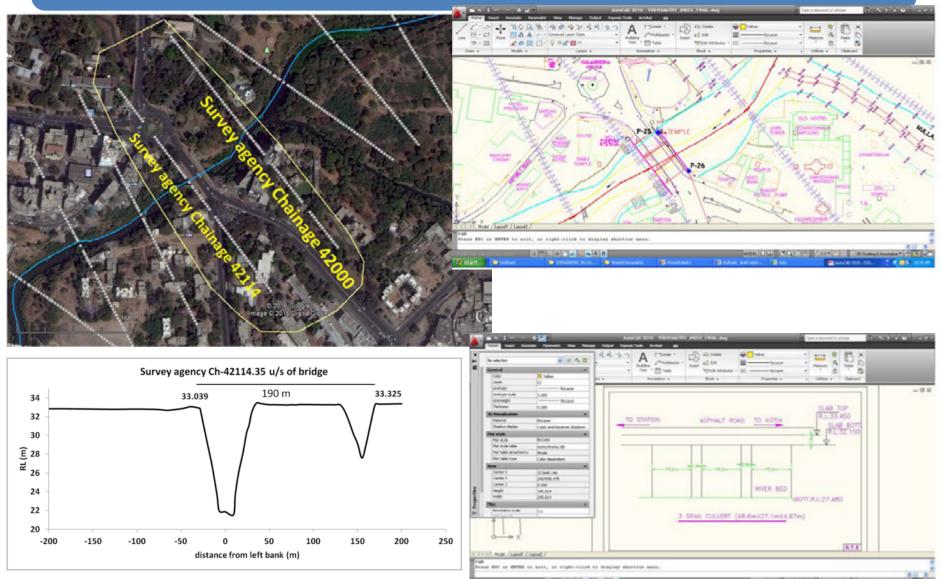
Source:

*http://www.baroda.com/aboutvadodara.php

[m^3/s]

Attenuation of flood at Vadodara

2061.05

Lag time 1 hr 40 min

Vadodara flood is distributed in Viswamitri river between confluence with Surya & Kalagoda

1209.81

2000.0
1800.0
1600.0
1400.0
1200.0
1000.0
800.0
600.0
400.0
200.0
0.0

00:00:00
2-9-2015

00:00:00
3-9-2015

00:00:00
4-9-2015

Discharge
— VISWAMITRI2 12700.00
External TS 1
— Vadodara

TS

2061

1761

Through RWH peak floods can be reduced by 300 m3/sec
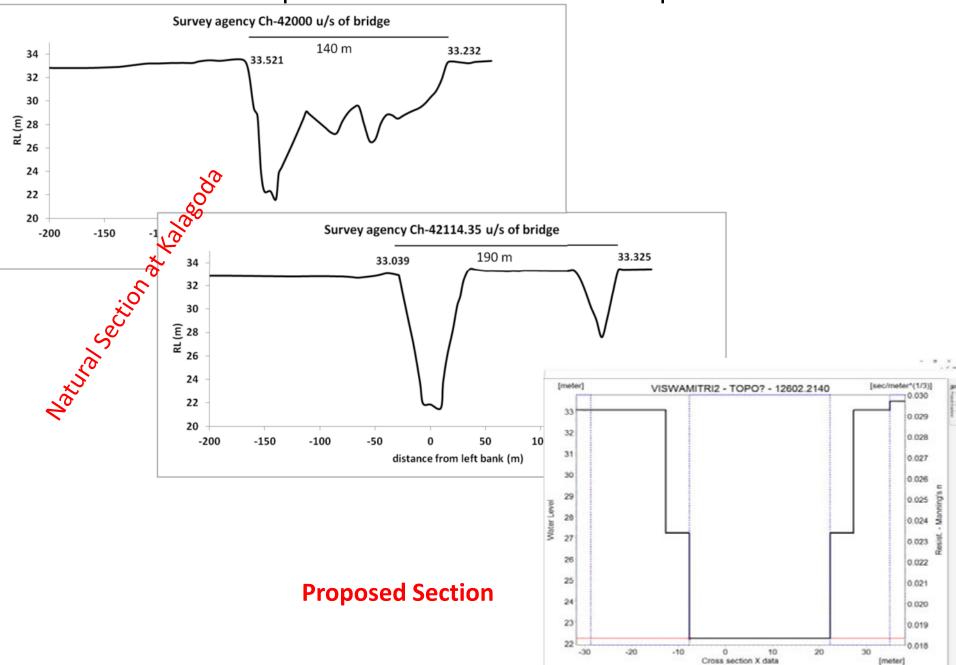
Flood Moderation through Channel improvement

Existing and Proposed Section at Kalagoda
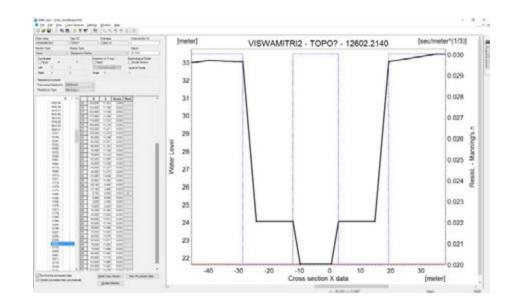
Proposed section for Channel improvement

Natural Section at Kalagoda

Survey agency Ch-42000 u/s of bridge

140 m

33.521   33.232

Survey agency Ch-42114.35 u/s of bridge

33.039   190 m   33.325

distance from left bank (m)

VISWAMITRI2 - TOPO? - 12602.2140

Proposed Section
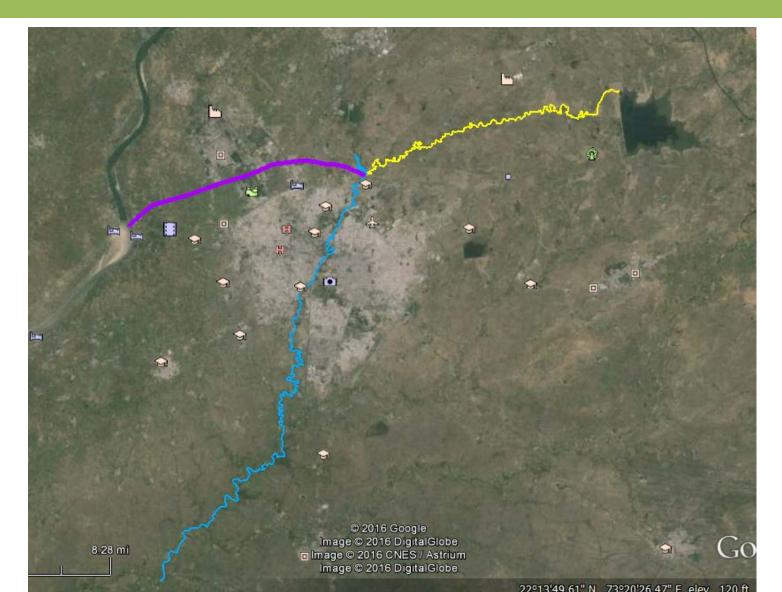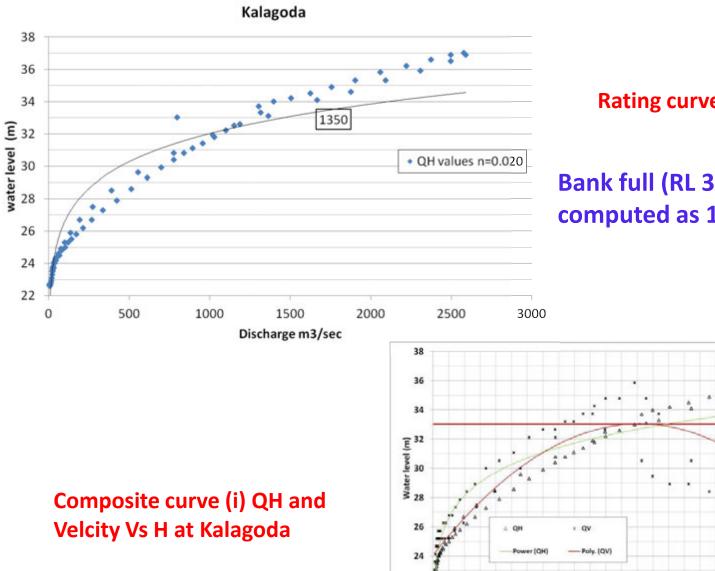
HCP proposed section and 'n'

The maximum carrying capacity of section proposed by HCP for modified n value corresponding to RL 31.9 m is 1000 m³/sec.

Flood Moderation through Channel improvement & diversion

Rating curve QH at Kalagoda

Bank full (RL 33 m) discharge is computed as 1350 m3/sec

Composite curve (i) QH and Velcity Vs H at Kalagoda
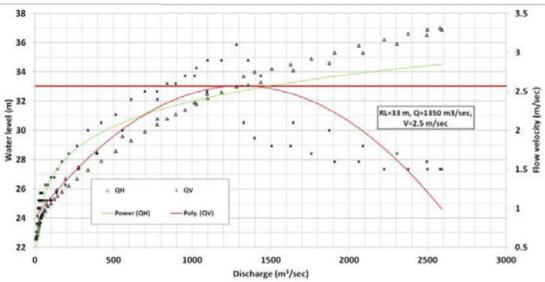
Table 2 Maximum Permissible Velocities

(*Clause* 8.1.2.2)

Sl No.	Types of Floors	Maximum Permissible Velocity
(1)	(2)	(3) m/s
i)	Metals face (steel and cast iron lined)	10
ii)	Face of concrete grade M 30 and above	6
	– grade below M 30	4
iii)	Stone masonry face with cement pointing	3
iv)	Stone masonry face with cement plaster	4
v)	Brick masonry face with cement plaster	2·5
vi)	Brick masonry with cement pointing	2
vii)	Hard rock	4
viii)	Murum	1·5-2
ix)	Soil silt	0·7-1

NOTES

1 When the flow carries abrasive materials with it, the permissible values may be further reduced by 25%.
2 Hard steel troweling, power floating, smooth surface finish and continuous long curing can have higher abrasion resistance, and higher velocities than that given in this table can be permitted, for surface using cement.
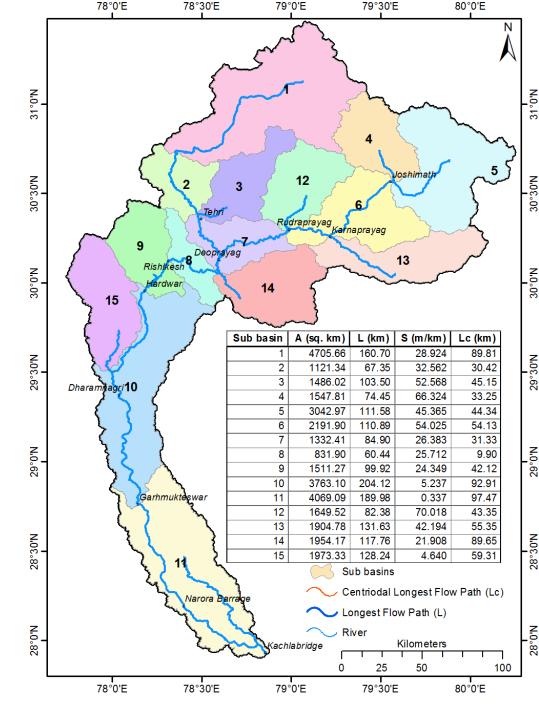
BIS 7784:2000

Dam Break Analysis

Sub basin	A (sq. km)	L (km)	S (m/km)	Lc (km)
1	4705.66	160.70	28.924	89.81
2	1121.34	67.35	32.562	30.42
3	1486.02	103.50	52.568	45.15
4	1547.81	74.45	66.324	33.25
5	3042.97	111.58	45.365	44.34
6	2191.90	110.89	54.025	54.13
7	1332.41	84.90	26.383	31.33
8	831.90	60.44	25.712	9.90
9	1511.27	99.92	24.349	42.12
10	3763.10	204.12	5.237	92.91
11	4069.09	189.98	0.337	97.47
12	1649.52	82.38	70.018	43.35
13	1904.78	131.63	42.194	55.35
14	1954.17	117.76	21.908	89.65
15	1973.33	128.24	4.640	59.31

Sub basins

Centriodal Longest Flow Path (Lc)

Longest Flow Path (L)

River

Dam Break Analysis

Initial Condition

- Reservoir is at FRL
- Inflow in to the reservoir = PMF at Tehri dam site (source CWC report)

Estimation of breach parameters

- Regression analysis

Dam Break Analysis

DAM

Type	Earth and Rock fill dam
Crest Level	El 839.5 m
Height	260.5 m
Width at Riverbed	1125 m
Width at Top	25.5 m flared to 30.5 m at abutments
Length at Top	575 m

Slope

Upstream	1: 2.5
Downstream	1: 2

SPILLWAYS

Chute Spillway

Crest Level	El 815.0 m
Waterway	3 bays each of 10.5 m width
Design Discharge	5500 cumecs
Type & No. of Gates	Radial Gates, 3 Nos

Right Bank Shaft Spillway

Type & Nos.	Ungated, 2 Nos.
Crest Level	El 830.2 m
Dia of Shaft	12 m

Dam Break Analysis

Dam Break Analysis

Dam Break Analysis

Flood attenuation of dam breach flood

FLOOD FORECASTING, EARLY WARNING AND DISASTER RISK MANAGEMENT

Dr. A.K. Lohani
Scientist G
National Institute of Hydrology
Roorkee

TYPES OF FLOOD

- *Flash floods*
- *Single event floods*
- *Multiple event flooding*
- *Seasonal floods*
- *Floods due to drainage congestion*
- *Dam break floods*
- *GLOF*

FLOOD MANAGEMENT AND CONTROL

- ## Structural Measures

- ## Non-structural Measures

FLOOD MANAGEMENT

STRUCTURAL MEASURES

- Multipurpose reservoirs
- Retarding structures which store flood waters
- Channel improvements which increase floods carrying capacity of the river
- Embankments and levees which keep the water away from floods prone areas
- Detention basins which retard and absorb some flood water
- Flood-ways which divert flood flows from one channels to another
- Over all improvement in the drainage system.

FLOOD MANAGEMENT…

NON STRUCTURAL MEASURES

- **Real Time Flood Forecasting**
- **Flood Plain Zoning**
- **Flood Insurance Scheme**
- **Dam Break Flood Simulation**
- **GLOF Modelling**

NON-STRUCTURAL MEASURES
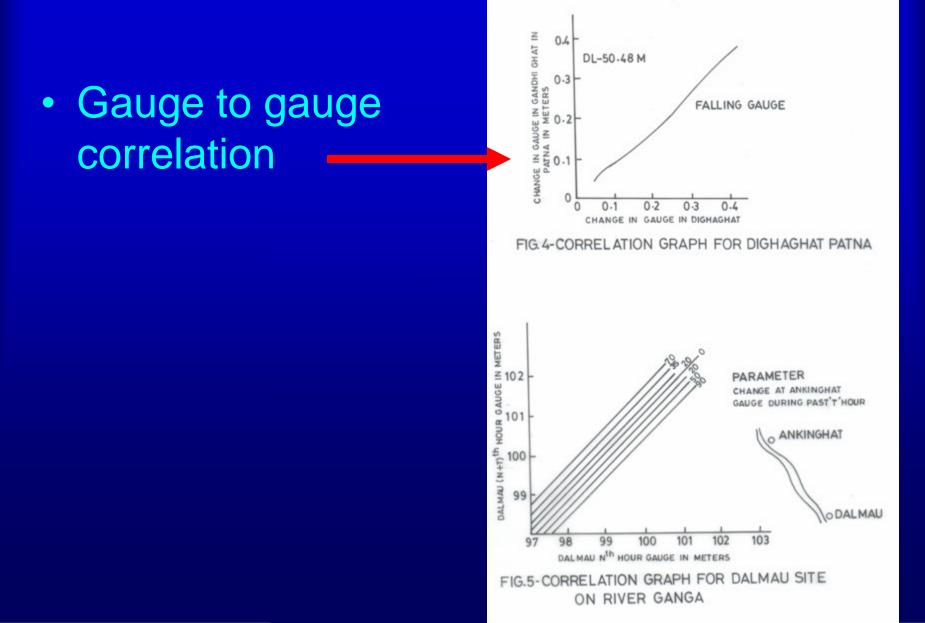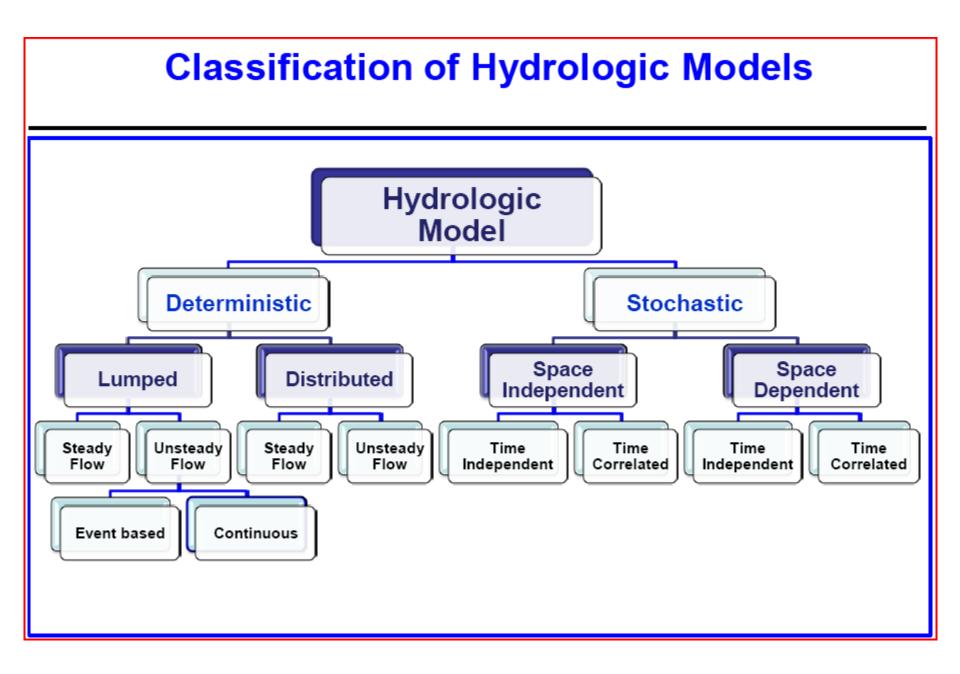
Real Time Flood Forecasting

- **Conventional Methods**
- **Hydrological Models**
- **ANN Models**
- **Fuzzy logic based models**

Conventional Method

- Gauge to gauge correlation

FIG.4-CORRELATION GRAPH FOR DIGHAGHAT PATNA

FIG.5-CORRELATION GRAPH FOR DALMAU SITE ON RIVER GANGA
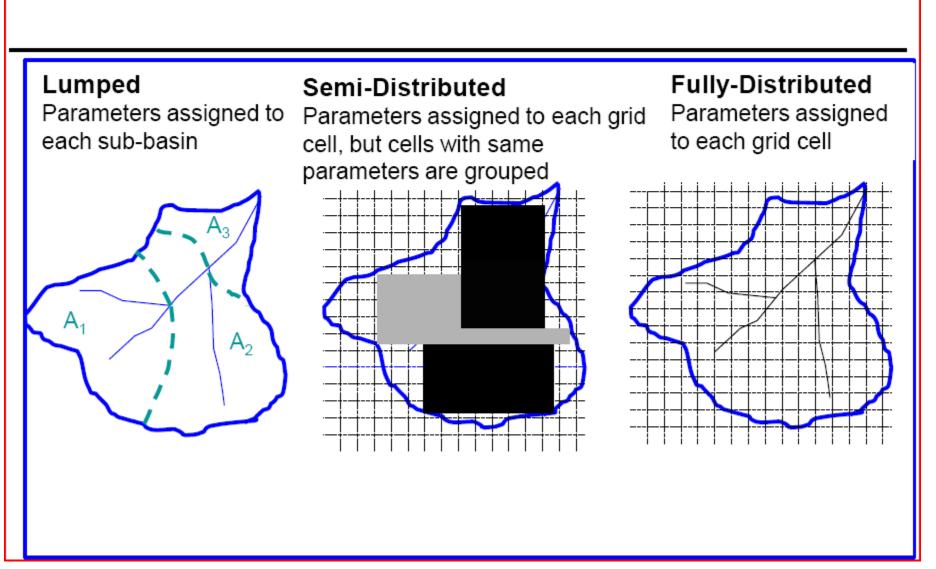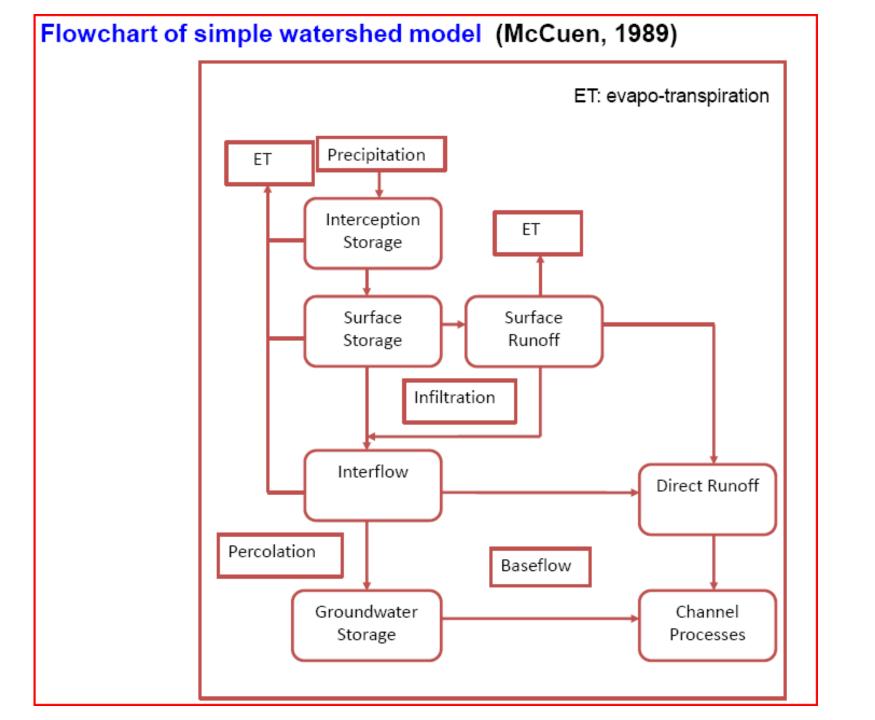
Spatial Scaling of Models

Lumped
Parameters assigned to each sub-basin

Semi-Distributed
Parameters assigned to each grid cell, but cells with same parameters are grouped

Fully-Distributed
Parameters assigned to each grid cell

Flowchart of simple watershed model (McCuen, 1989)

ET: evapo-transpiration

Hydrologic Models

Model Type	Example of Model
Lumped parameter	Snyder or Clark UH
Distributed	Kinematic wave
Event	HEC-1, HEC-HMS, SWMM, SCS TR-20
Continuous	Stanford Model, SWMM, HSPF, STORM
Physically based	HEC-1, HEC-HMS, SWMM, HSPF
Stochastic	Synthetic streamflows
Numerical	Kinematic or dynamic wave models
Analytical	Rational Method, Nash IUH
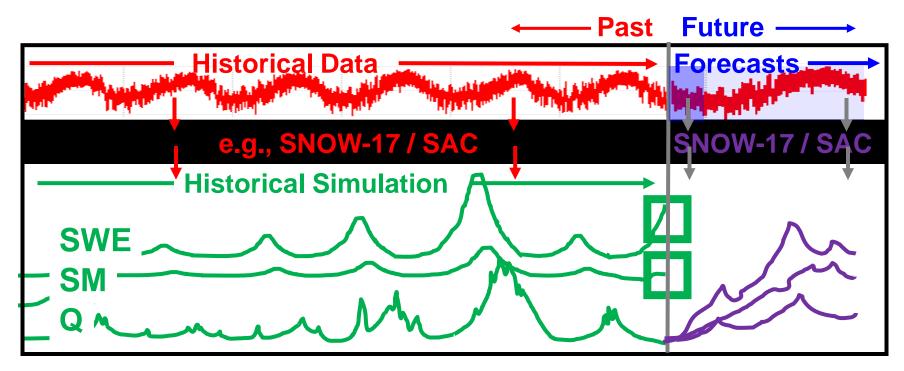
Models	Application Areas
HEC-HMS	Design of drainage systems, quantifying the effect of land use change on flooding
National Weather Service (NWS)	Flood forecasting.
Modular Modeling System (MMS)	Water resources planning and management works
University of British Columbia (UBC) & WATFLOOD	Hydrologic simulation
Runoff-Routing model (RORB) & WBN	Flood forecasting, drainage design, and evaluating the effect of land use change
TOPMODEL & SHE	Hydrologic analysis
HBV	Flow forecasting

FLOOD FORECAST PROCESS

Hydrologic Model Analysis

hydrologic expertise & judgment

model guidance

Weather and Climate Forecasts

Forecast precip / temp

River Forecast Modeling System

Outputs Graphics

River Forecasts

Analysis & Quality Control

parameters

Rules, values, other factors, politics

Observed Data

Calibration

Decisions

End-to-End Operational Forecast Process

Data Assimilation
- Data collation
- Data assimilation
- Quality control
- Forcing construction (HAS)
- Forecast Review

Modeling
- Model simulations
- Hydrologic analysis
- Hydraulic analysis
- Bias & error adjustments
- Regulation Integration
- Collaboration

Dissemination
- Forecast generation
- Quality assurance
- Dissemination
- Web services
- Coordination & collaboration
- Basin monitoring & review

Streamflow Forecasting is an iterative & interactive process
Analysis & Assessment
Bias adjustments and error corrections

Temperature index model for simulating snowpack accumulation and melt

Simulation and Analysis

Observed Hydrology

Sacramento Soil Moisture Accounting Model

Streamflow Prediction Challenges:
forecast future weather (hours to seasons)

General State of Practice

- conduct ensemble simulation at fine-time step (e.g., sub-daily); aggregate to client needs (e.g., daily to seasonal information)
- adjust results to compensate for known model biases (practice varies)

CONTINUOUS SIMULATION OF STREAMFLOW WITH HEC-HMS

- HEC-HMS basin models for single-event and continuous simulation differ only at the subbasin level.

- Surface runoff and groundwater flow are computed with a soil-moisture accounting (SMA) model rather than a simple loss model.

- The SMA model accounts for evapotranspiration and percolation between rainfall events as well as infiltration and other losses during rainfall events.
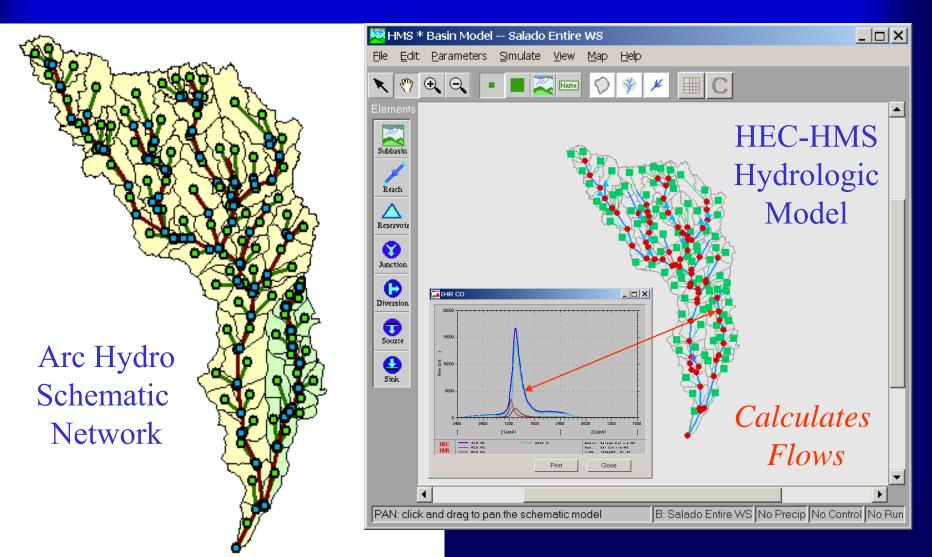
CONTINUOUS SIMULATION OF STREAMFLOW WITH HEC-HMS...

- Modeling of snowpack accumulation and snowmelt is optional.

- HEC-HMS generates a continuous streamflow record for the subbasin from the direct-runoff and baseflow records by the same methods used in single-event simulation.

- Direct runoff is transformed to streamflow by a user-selected transform method.
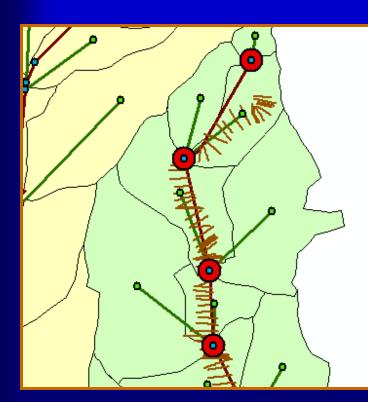
CONTINUOUS SIMULATION OF STREAMFLOW WITH HEC-HMS...

- The transform options include several unit-hydrograph methods, the Clark time-area method and a kinematic wave method.

- Downstream processes such as channel routing and reservoir routing are handled the same for continuous simulation as for single-event simulation.
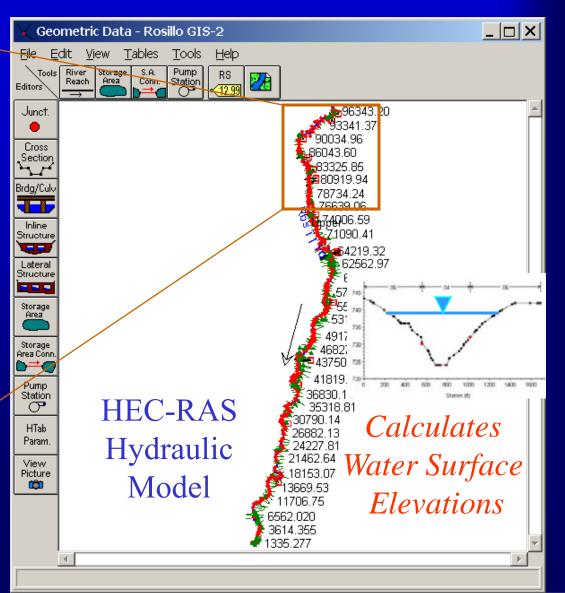
Arc Hydro and HEC-HMS

Arc Hydro Schematic Network

HEC-HMS Hydrologic Model

Calculates Flows
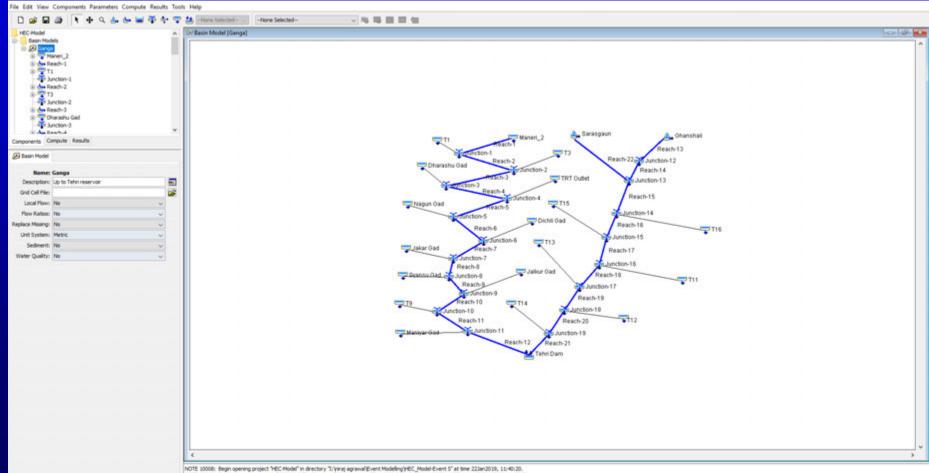
Arc Hydro and HEC-RAS

Arc Hydro
Channel
Cross Sections

HEC-RAS
Hydraulic
Model

*Calculates
Water Surface
Elevations*
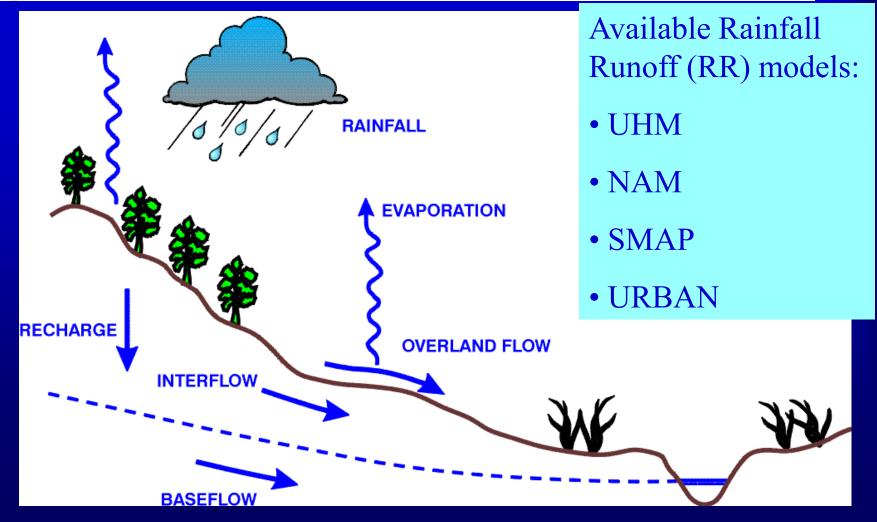
HEC-HMS
(Tehri Dam Inflow Forecasting Model)
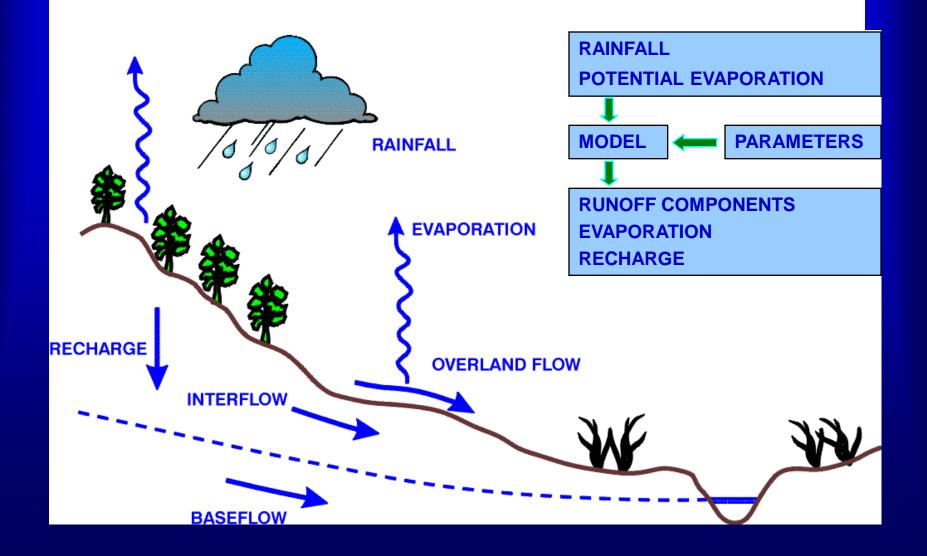
NAM-MIKE-11 MODEL

Modelling the rainfall-runoff process

Available Rainfall Runoff (RR) models:

- UHM
- NAM
- SMAP
- URBAN
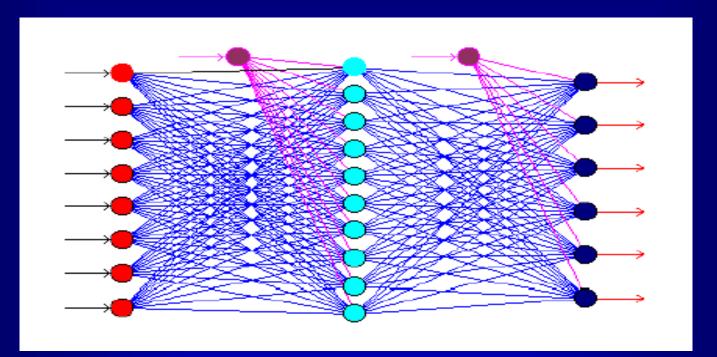
ARTIFICIAL NEURAL NETWORKS (ANNs)

An ANN is a computing system made up of a highly interconnected set of simple information processing elements, analogous to a neuron, called units.

The neuron collects inputs from both a single and multiple sources and produces output in accordance with a predetermined non-linear function.

An ANN model is created by interconnection of many of the neurons in a known configuration. The primary elements characterizing the neural network are the distributed representation of information, local operations and non-linear processing.

Structure Of A Multi-Layer Feed Forward Artificial Neural Network Model

Input Nodes

Hidden Layer Nodes

Output Nodes

Fuzzy Logic in Flood Forecasting

- **It is basically a multi-valued logic that allows intermediate values to be defined between conventional boolean logic like true/false, yes/know, black/white**

CASE STUDIES

- **MAHANADI BASIN**
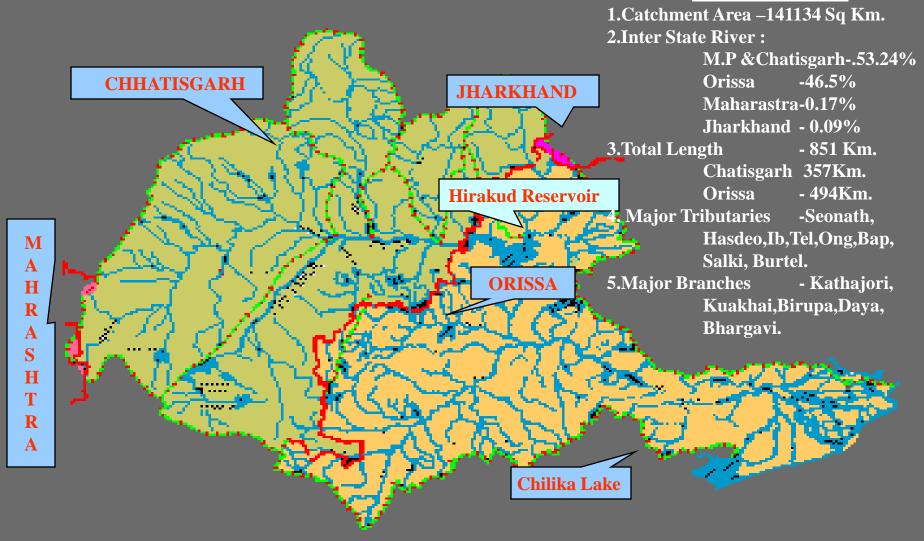
- **NARMADA BASIN**

CASE STUDY - I
MAHANADI BASIN

CHHATISGARH

JHARKHAND

Hirakud Reservoir

ORISSA

MAHRASHTRA

Chilika Lake

Salient Feature

1. Catchment Area –141134 Sq Km.
2. Inter State River :
   M.P &Chatisgarh-.53.24%
   Orissa   -46.5%
   Maharastra-0.17%
   Jharkhand - 0.09%
3. Total Length   - 851 Km.
   Chatisgarh   357Km.
   Orissa   - 494Km.
4. Major Tributaries   -Seonath,
   Hasdeo,Ib,Tel,Ong,Bap,
   Salki, Burtel.
5. Major Branches   - Kathajori,
   Kuakhai,Birupa,Daya,
   Bhargavi.
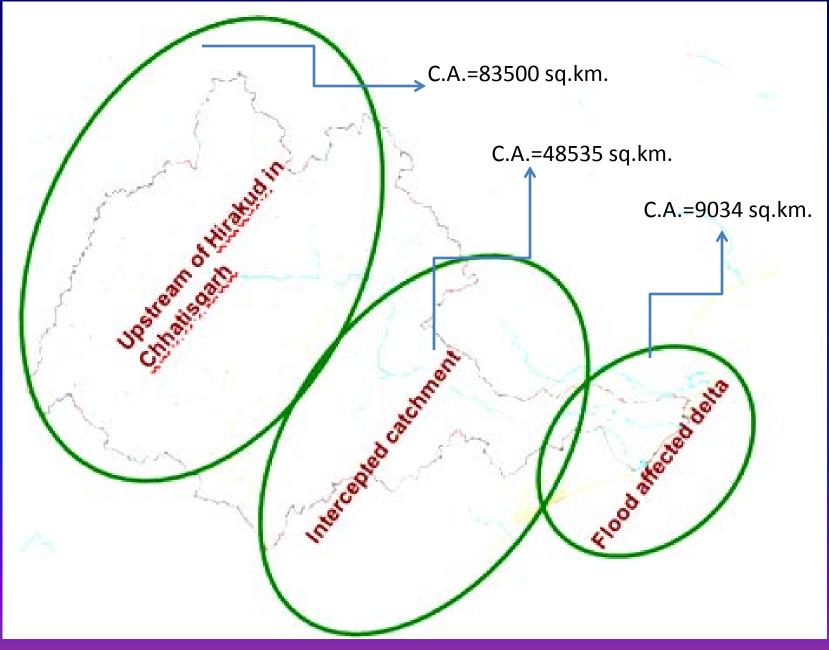
Details of Catchment area of Mahanadi Basin

1. Catchment up to Hirakud Dam –   83400 Sq. Km.
2. Catchment from Hirakud Dam to Khairmal-   33671 Sq. Km.
3. Catchment from Khairmal to Naraj-   15029 Sq.Km.
4. Catchment from Naraj to Bay of Bengal-   9500 Sq. Km.
Total Catchment area up to Bay of Bengal-   141600 Sq.Km.
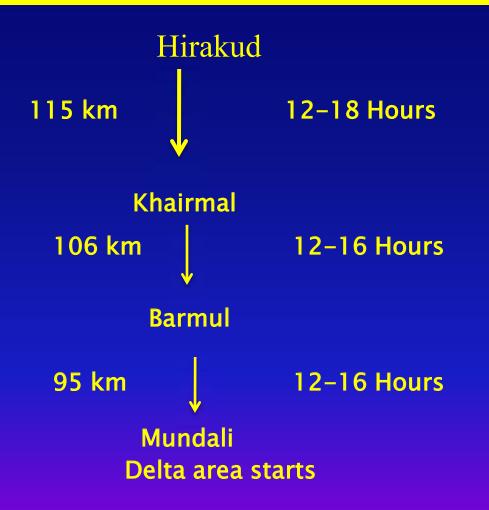
Catchment area of Mahanadi Basin State wise

1. Catchment in Chattishgarh –   75100 Sq. Km.
2. Catchment in Maharastra-   250 Sq. Km.
3. Catchment in Jharkhand -   650 Sq. Km.
4. Catchment in Orissa-   65600 Sq. Km.
Total Catchment area up to Bay of Bengal-   141600 Sq. Km.
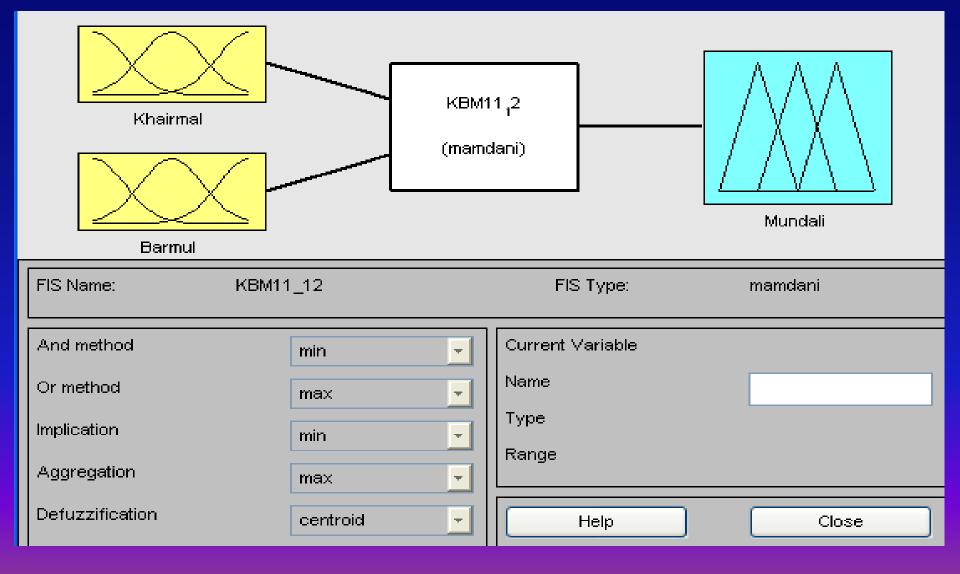
IMPORTANT SEGMENTS OF MAHANADI BASIN

Upstream of Hirakud in Chhatisgarh

Intercepted catchment

Flood affected delta

C.A.=83500 sq.km.

C.A.=48535 sq.km.

C.A.=9034 sq.km.

Existing travel time of flood peaks (observed by DOWR)

Hirakud

115 km ↓ 12–18 Hours

Khairmal

106 km ↓ 12–16 Hours

Barmul

95 km ↓ 12–16 Hours

Mundali
Delta area starts

Mamdani FIS showing inputs and output
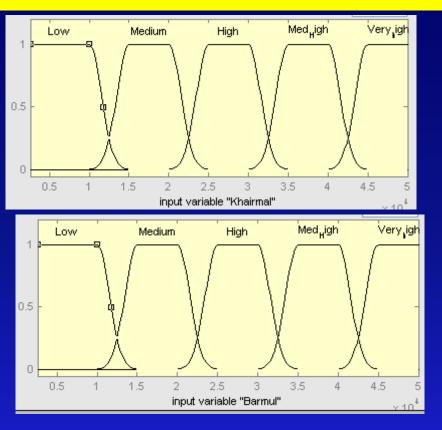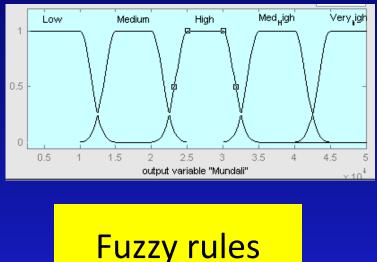
▶ **Peaks in possibly 5 groups named as**

  Low (2660-8630 m3/s)
  Medium (6792-15830 m3/s)
  High (12338-21515 m3/s)
  Medium high (13867-27290 m3/s)
  Vey high (25470-44742 m3/s)

▶ **Different membership functions are trialed and finally gauss2 membership function has been selected.**
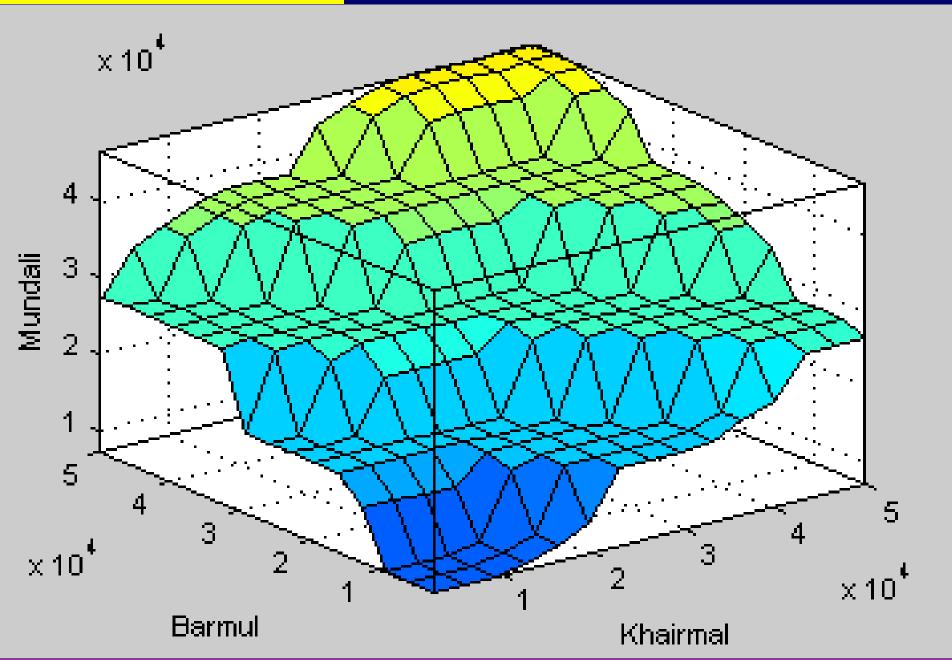
Fuzzy membership functions

Fuzzy rules
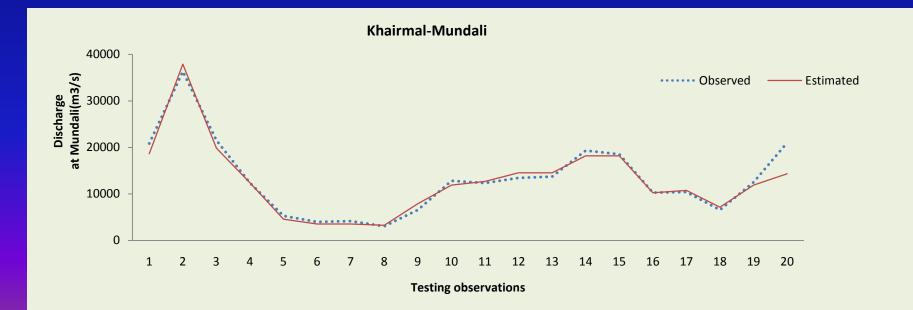
1. If (Khairmal is Low) and (Barmul is Low) then (Mundali is Low) (1)
2. If (Khairmal is Medium) and (Barmul is Medium) then (Mundali is Medium) (1)
3. If (Khairmal is Med_High) and (Barmul is Med_High) then (Mundali is Med_High) (1)
4. If (Khairmal is High) and (Barmul is High) then (Mundali is High) (1)
5. If (Khairmal is Very_high) and (Barmul is Very_high) then (Mundali is Very_high) (1)
6. If (Khairmal is Low) and (Barmul is Medium) then (Mundali is Medium) (1)
7. If (Khairmal is Medium) and (Barmul is High) then (Mundali is High) (1)
8. If (Khairmal is High) and (Barmul is Med_High) then (Mundali is Med_High) (1)
9. If (Khairmal is Med_High) and (Barmul is Very_high) then (Mundali is Very_high) (1)
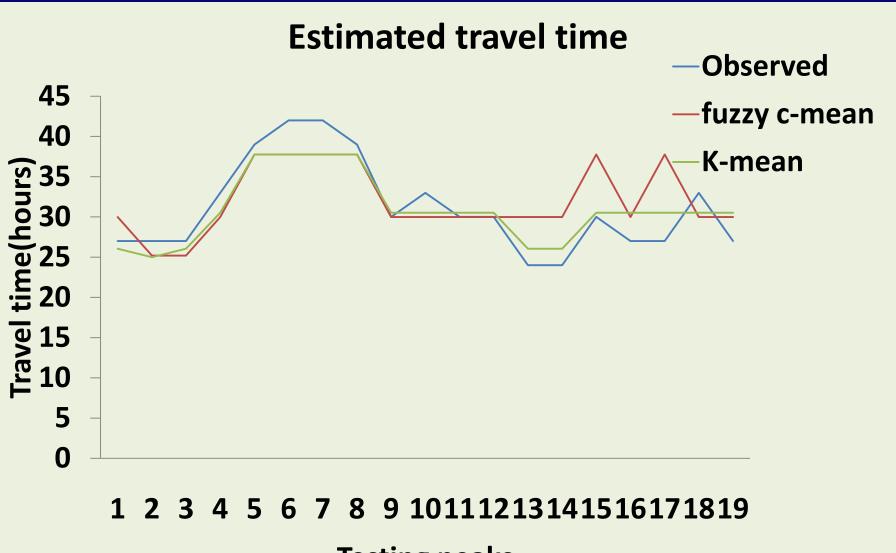
Forecasting of Discharge

Between stations	ANN architecture	Epochs	RMSE(m³/s)		R²		Efficiency	
			Training	Testing	Training	Testing	Training	Testing
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Khairmal-Mundali	FF,7,1	3000	2211.2	1843.7	0.9182	0.9385	0.9301	0.9586

Khairmal-Mundali
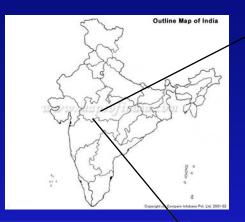
Results of different clustering methods.

K-mean				Fuzzy-C-Mean			
Discharge range (m3/s)	Travel time (hrs)	Testing RMSE (hrs)	Testing Efficiency	Discharge range (m3/s)	Travel time (hours)	Testing RMSE (hrs)	Testing Efficiency
2660-8550	36.77			2660-8550	36.77		
10808-16216	30.53			10329-16921	30		
17102-23826	26.56			16815-25660	27.07		
24900-36300	25	3.52	0.8321	26102-36300	25.2	4.07	0.471

CASE STUDY – II
NARMADA BASIN

Outline Map of India

81°
23°
22°
81°
80°
81°

N

NARMADA R.
DINDORI
MOHGAON
MANOT
MANDLA
BURHNER R.
HRIDYANAGAR
HALON R.
MALAND KHAND

LEGEND
● Self recording raingauge station
River
▲ Gauge site

DATA USED

- **The hourly rainfall data for Jamtara, Dindori and Malankhand**
- **The hourly G&D data at Mandla and Manot**
- **Period from 1989 to 1998.**
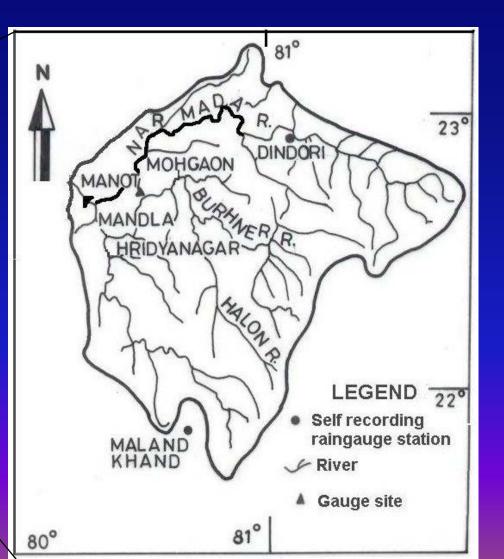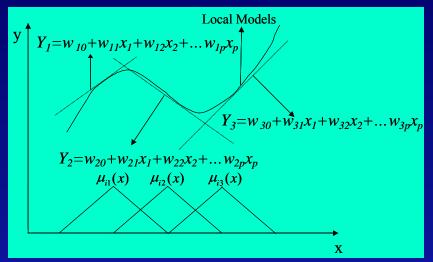
Table : Statistical properties of hypothetical data

	Frequent Events		Rare Events	
	Minimum Value	**Maximum Value**	**Minimum Value**	**Maximum Value**
Calibration Data	0.01	6.72	8.15	20.65
Validation Data	0.02	9.93	10.15	21.25

Takagi-Sugeno fuzzy model as a smooth piece-wise linear approximation of non-linear function
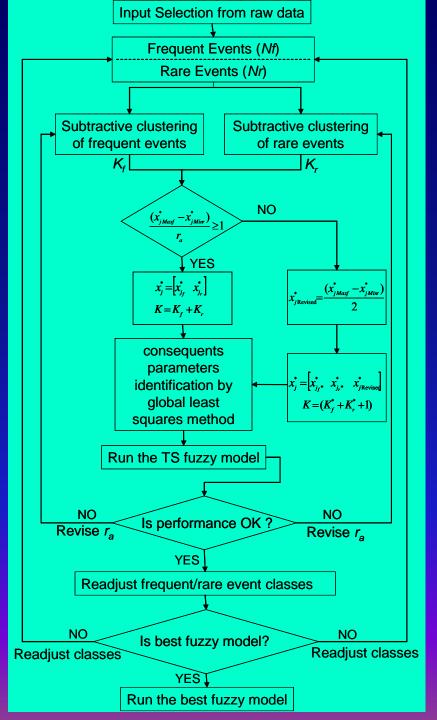
Subtractive Clustering

- **After normalizing and scaling data points in each direction, a density measure at data point *xi* is computed on the basis of its location with respect to other data points and expressed as:**

$$D_i = \sum_{j=1}^{N} \exp\left(-\left(\frac{2}{r_a}\right)^2 . \left\| x_i - x_j \right\|^2 \right)$$

Flow Chart of the TSC-T-S Fuzzy Model Algorithm

MODEL INPUT SELECTION

Model M:

Considering basin rainfall and antecedent discharge at Mandla gauging sites
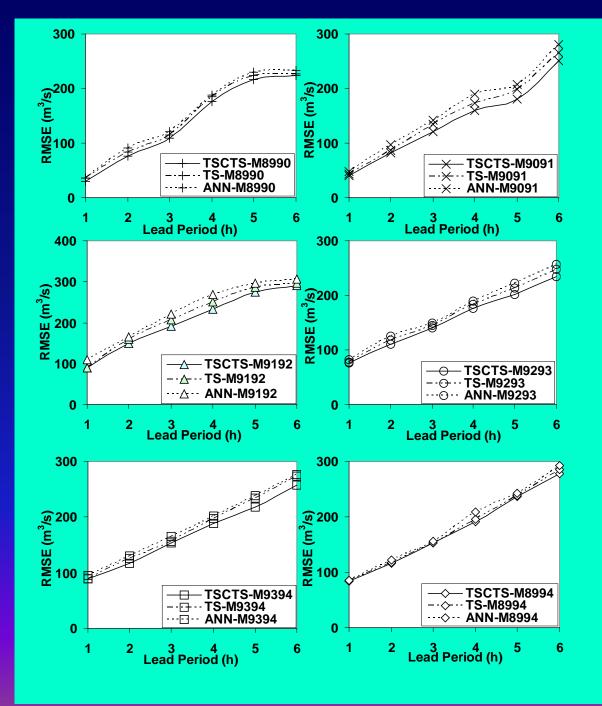
$$Q_{Mandla,t} = f(R_{t-16}, R_{t-17}, R_{t-18}, Q_{Mandla,t-1}, Q_{Mandla,t-2}, Q_{Mandla,t-3}, Q_{Mandla,t-4}, Q_{Mandla,t-5} \text{ and } Q_{Mandla,t-6}).$$

Model MM:

Considering basin rainfall, antecedent discharge at Mandla and Manot gauging sites

$$Q_{Mandla,t} = f(R_{t-16}, R_{t-17}, R_{t-18}, Q_{Mandla,t-1}, Q_{Mandla,t-2}, Q_{Mandla,t-3}, Q_{Mandla,t-4}, Q_{Mandla,t-5} \text{ and } Q_{Mandla,t-6}, QManot,t-3, Q_{Manot,t-4}).$$
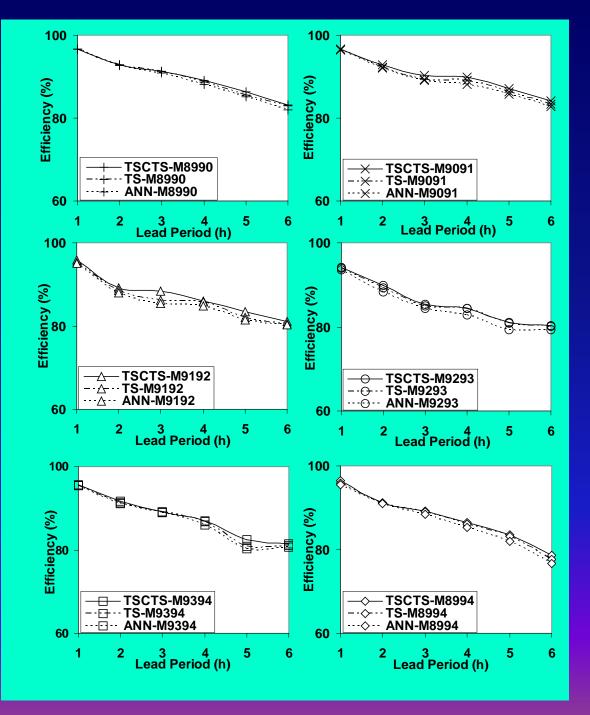
Table : Performance Indices of >1 h Lead Models (Validation Results Model-M)

M8994	2 Hr			4 Hr			6 Hr		
	TSC-T-S	SC-T-S	ANN	TSC-T-S	SC-T-S	ANN	TSC-T-S	SC-T-S	ANN
Correlation	0.9854	0.9745	0.9690	0.9598	0.9587	0.9575	0.9157	0.9129	0.9082
Efficiency	91.2600	91.1900	90.9800	86.5100	86.1400	85.3900	78.6300	77.5600	76.6600
RMSE	115.770	117.300	122.141	191.864	196.270	208.334	278.321	284.980	292.385
AARE	5.485	5.555	5.724	11.673	12.254	12.811	18.369	18.562	19.669
TS1	25.780	25.260	24.070	10.090	8.910	6.790	5.370	4.640	4.480
TS2	37.420	37.220	36.360	18.570	18.450	14.270	11.130	10.790	10.100
TS5	61.610	61.500	61.390	36.970	36.960	35.140	24.540	24.480	23.530
TS10	84.990	84.120	82.560	62.550	62.110	61.670	42.920	42.650	40.740
TS20	94.200	94.150	94.280	83.380	83.320	81.690	71.750	71.530	71.140
TS50	99.260	99.210	99.260	96.600	96.190	95.290	92.900	92.730	92.190
PPTS(2)	6.120	6.630	7.040	11.760	12.560	13.130	17.200	18.180	18.940
PPTS(3)	6.810	7.660	8.380	14.680	14.770	16.970	23.360	25.190	26.610
PPTS(5)	15.320	15.870	16.280	28.200	30.040	31.790	38.140	38.440	39.110
PPTS(10)	11.540	11.670	11.510	22.090	22.680	24.780	29.420	30.610	31.720
PPTS(20)	9.260	9.310	9.280	19.260	19.250	20.810	26.400	26.580	27.180
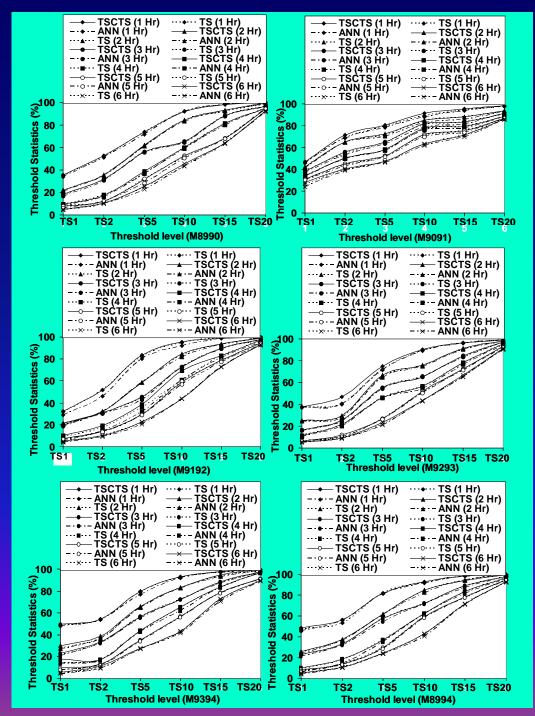
Model -M
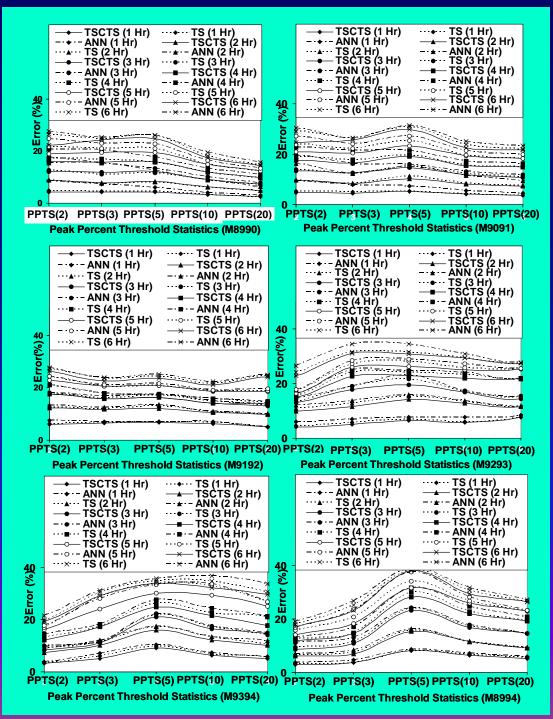
Model-M

Model-M

Model-M

NON-STRUCTURAL MEASURES

Dam Break Flood Wave Simulation

- **Predict Flood Characteristics: Peak Stage, Discharge, volume, flood wave, Travel Time**

- **Analysis is required for planning purpose**
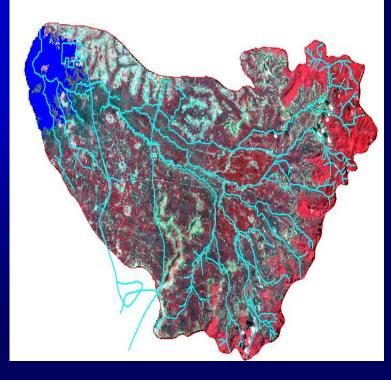
NON-STRUCTURAL MEASURES

DAM BREAK FLOOD ANALYSIS

- Flood Estimation
- Flood Routing
- Application of remote sensing and GIS in flood management
- Development & management of hydrological database
- Socio-economic aspects of water related disasters

Objectives of Dam Break Analysis

- ➢ To establish the required dam spillway capacity
- ➢ To evaluate environmental and safety impact of dams or other structure built in a river valley
- ➢ Valley planning and flood plain zoning
- ➢ To formulate emergency procedures such as warning system, evacuation plan etc.
- ➢ To identify and solve unexpected flood problems due to accidents
- ➢ To remove fear in public and make the public aware of the risk
- ➢ To analyze past accidents for advancement of the state of art

POPULAR MODELS
DAM BREAK FLOOD ANALYSIS

➤ DAMBRK by U.S. National Weather Service

➤ MIKE-11 by Danish Hydraulic Institute, Denmark

➤ HEC-RAS

Dambreak Flood Modelling & EAP Studies

- Shri Ram Sagar Dam

- Lower Maner Dam

- Nagarjuna Sagar Dam

- Polavaram Project

- N.S.R.S. Sriselam Project

- Parbati-III Power Station Dam

Dam break flood inundation map (Breach width= 3 km, Time of breach=4 hr.) - SHRI RAMSAGAR DAM

SHRI RAMSAGAR DAM

SUBMERGED AREA

15 km
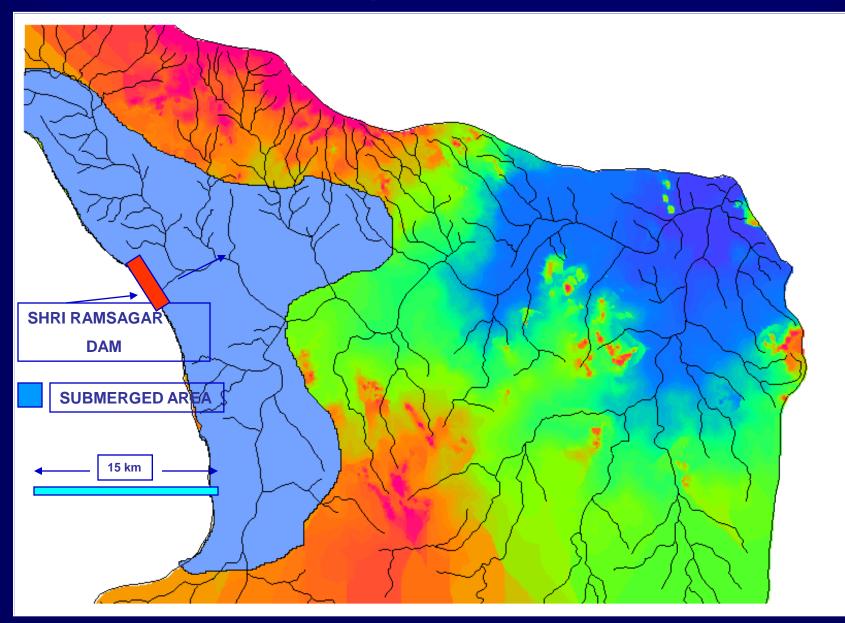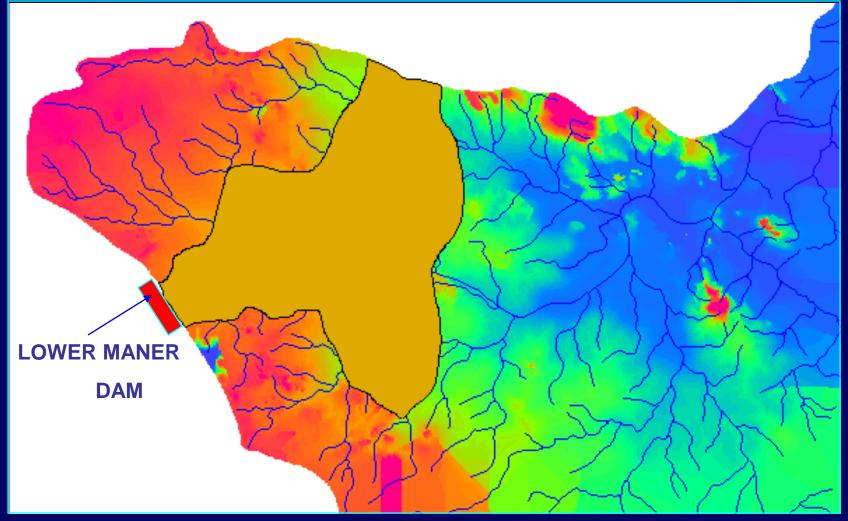
Figure : Dam break flood inundation map (Breach width= 1 km, Time of breach=1 hr.) – LOWER MANER DAM

LOWER MANER DAM
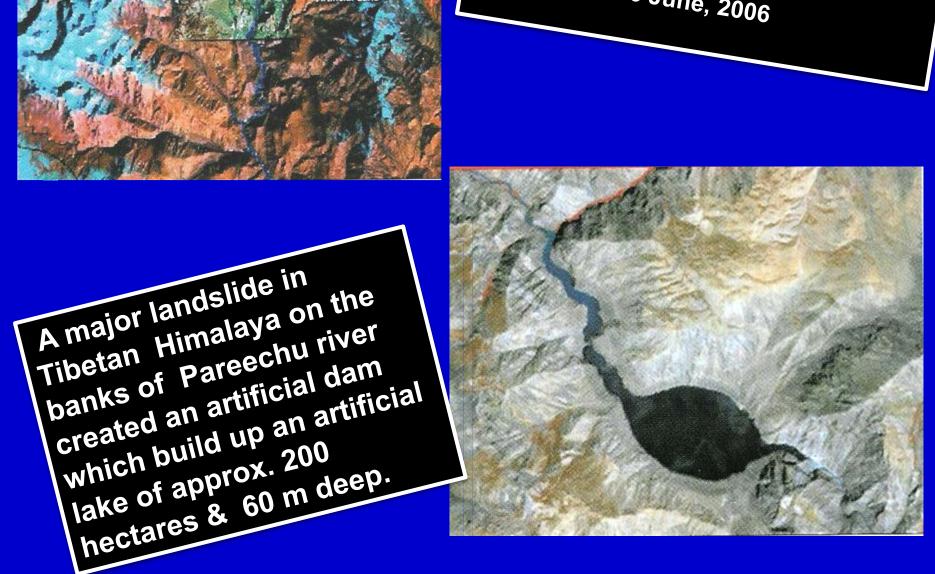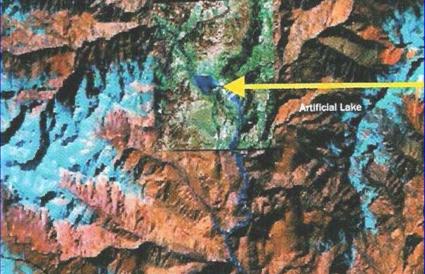
Glacial Lake Outburst Flood (GLOF)

The sudden failure of a moraine dam on a glacial lake can release a very large amount of water called a Glacial Lake Outburst Flood

Outburst flood peak flow is directly related to lake volume, dam height and width, dam material composition, failure mechanism, downstream topography

PAREECHU LANDSLIDE DAM
Land Slide in July, 2003
Dam Failure 26 June, 2006

Artificial Lake

A major landslide in Tibetan Himalaya on the banks of Pareechu river created an artificial dam which build up an artificial lake of approx. 200 hectares & 60 m deep.

IDENTIFICATION OF GLACIAL LAKES
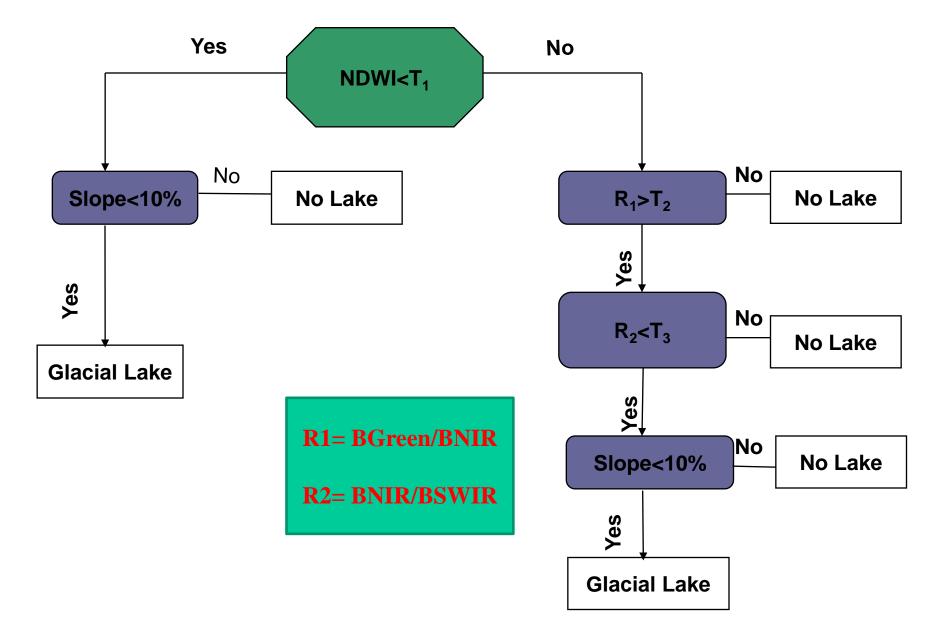
Normalized Difference Water Index

$$NDWI = \frac{(GREEN - NIR)}{(GREEN + NIR)}$$

GREEN is a band that encompasses reflected green light and NIR represents reflected near-infrared radiation

The selection of these wavelengths was done to :

(1)   maximize the typical reflectance of water features by using green light wavelengths
(2)   minimize the low reflectance of NIR by water features; and
(3)   take advantage of the high reflectance of NIR by terrestrial vegetation and soil features.

Yes   NDWI<T_1 **No**

Slope<10%   No   No Lake

R_1>T_2 No   No Lake

Yes

Glacial Lake

Yes

R_2<T_3 No   No Lake

R1= BGreen/BNIR

R2= BNIR/BSWIR

Yes

Slope<10%   No   No Lake

Yes

Glacial Lake

Algorithm to automatically classify glacial lakes on IRS Images, using a decision tree. T_i represents a threshold, whose value is determined empirically on each scene by visual inspection.

CRITERIA FOR IDENTIFICATION OF DANGEROUS LAKE

Rise in lake water level

In general the lakes which have a volume of more than 0.01 km3 are found to have past events. A lake which has a larger volume than this is deeper, with a deeper part near the dam (lower part of lake) rather than near the glacier tongue, and has rapid increase in lake water volume is an indication that a lake is potentially dangerous.

Activity of supraglacial lakes

Groups of closely spaced supraglacial lakes of smaller size at glacier tongues merge as time passes and form bigger lakes. These activities of supraglacial lakes are indications that the lakes are becoming potentially dangerous.

POSITION OF LAKES

The potentially dangerous lakes are generally at the lower part of the ablation area of the glacier near to the end moraine, and the mother glacier should be sufficiently large to create a potentially dangerous lake environment.

The valley lakes with an area bigger than 0.1 km2 and a distance less than 0.5 km from the mother glacier of considerable size are considered to be potentially dangerous.

Cirque lakes even smaller than 0.1 km2 associated (in contact or distance less than 0.5 km) with steep hanging glaciers are considered to be potentially dangerous.

In general, the potentially dangerous status of moraine-dammed lakes can be defined by the conditions of the damming material and the nature of the mother glacier. Even the smaller size steep hanging glacier may pose a danger to the lake.

DAM CONDITIONS

The natural conditions of the moraine damming the lake determine the lake stability. Lake stability will be less if the moraine dam has a combination of the following characteristics:
• narrower in the crest area
• no drainage outflow or outlet not well defined
• steeper slope of the moraine walls
• ice cored
• very tall (from toe to crest)
• mass movement or potential mass movement in the inner slope and/or outer slope
• breached and closed in the past and refilled again with water
• seepage flow at moraine walls

A moraine-dammed lake, which has breached and closed subsequently in the past and has refilled again with water, can breach again.

CONDITION OF ASSOCIATED MOTHER GLACIER

Generally, the bigger valley glaciers with tongues reaching an elevation below 5,000 masl have well developed glacial lakes. Even the actively retreating and steep hanging glaciers on the banks of lakes may be a potential cause of danger.

The following general characteristics of associated mother glaciers can create danger to moraine-dammed lakes:

- hanging glacier in contact with the lake,
- bigger glacier area,
- fast retreating,
- debris cover at glacier tongue area,
- steep gradient at glacier tongue area,
- presence of crevasses and ponds at glacier tongue area,
- toppling/collapses of glacier masses at the glacier tongue, and
- ice blocks draining to lake.

GLOF SIMULATION: INPUT REQUIRED

Glacier and Glacier lake mapping

Drainage network and Length of stream d/s lake
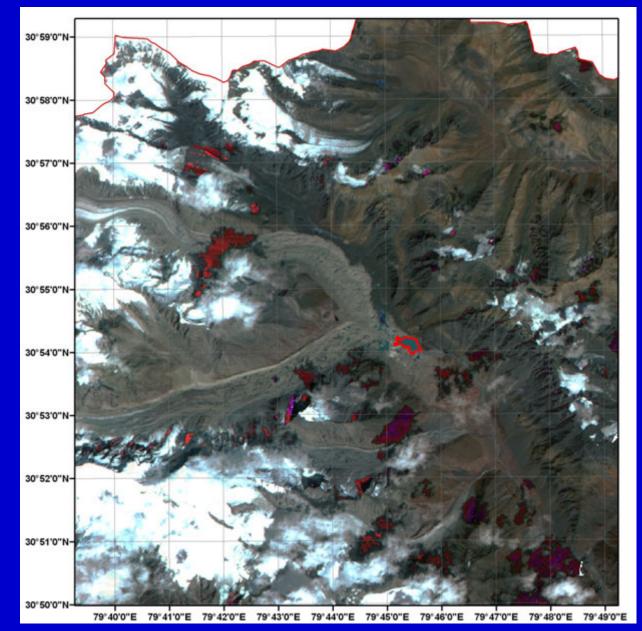
DEM of the basin

Cross Section at regular interval downstream of lake

Area and Volume of the lake

Breach width and Depth

100 year return flood if available

Biggest lake in Alaknanda shown on FCC 2008

MIKE11 DAM BREAK MODELLING

- Hydrodynamic modeling
  - Estuaries
  - Rivers
  - Irrigation systems
  - Dambreak
  - Controllable Weirs
  - Flood Control
  - Flood Forecasting

- Water Quality modeling
  - Balance of Dissolved Oxygen, Ammonia, Nitrate etc.
  - Eutrophication
  - Heavy Metals
  - Wetlands

- Advection Dispersion modeling
  - Salinity Intrusion
  - Temperature
  - Pollutant Transport

- Sediment Transport modeling
  - Cohesive Sediment
  - Non-cohesive Sediment
  - Potential Transport
  - Morphological modelling

Dynamic Wave Routing Method

Based on the complete 1-D equations of unsteady flow (St. Venant equations)

Continuity

$$\frac{\partial Q}{\partial x} + \frac{\partial A}{\partial t} - q_L = 0$$

Momentum
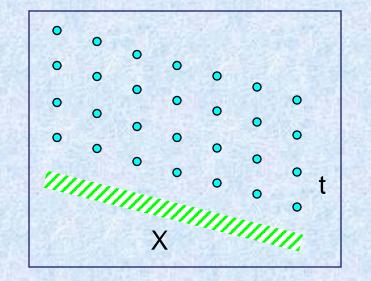
$$\frac{\partial Q}{\partial t} + \frac{\partial (Q^2 / A)}{\partial x} + gA\left(\frac{\partial h}{\partial x} + S_f\right) = 0$$

Where: h = water surface elevation and

$$\frac{\partial h}{\partial x} = \frac{\partial y}{\partial x} - S_o$$

The discharge (Q) and water surface elevation (h) at each location along the river is computed using an algebraic representation of the St. Venant equations.
Q and h are determined for the river system at each time step.
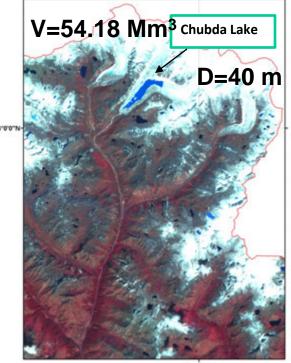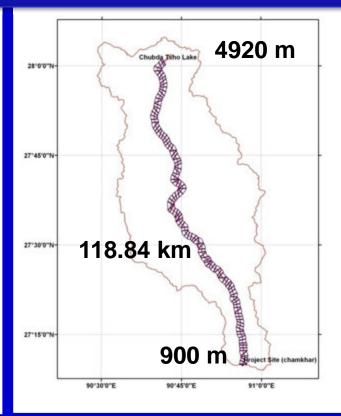
GLOF Studies
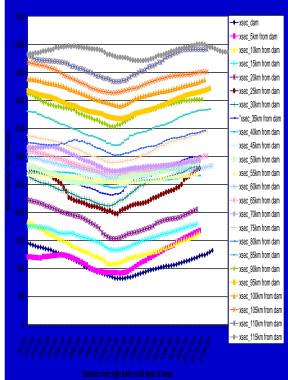
- **Glacier Lake Outburst Flood (GLOF) study for Jelam tamak (THDC, Rishikesh**

- **Glacial Lake Outburst Flood study (GLOF) for Tawang H.E. Project (NHPC, Faridabad)**

- **Snowline estimation, snowmelt runoff study and Glacial Lake Outburst Flood study for Chamkarchhu H.E. Project in Bhutan, (NHPC, Faridabad)**

- **Snowline estimation snowmelt runoff study and Glacial Lake Outburst Flood study for Kuri-Gongri H.E. Project in Bhutan (NHPC, Faridabad)**

- **Glacier Lake Outburst Flood (GLOF) study for Malari Jelam (THDC, Rishikesh)**

- **Glacier Lake Outburst Flood (GLOF) study for Bokang Bailing H.E.Project (THDC, Rishikesh)**

- **Evaluation of GLOF hazard & mitigation plan for Lachung basin, Sikkim (Lachung Hydropower Projects Ltd., Noida)**
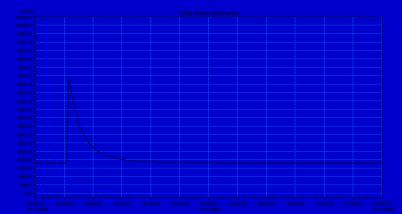
GLOF HYDROGRAPH AT CHAMKHARCHU H.E. PROJECT BHUTAN
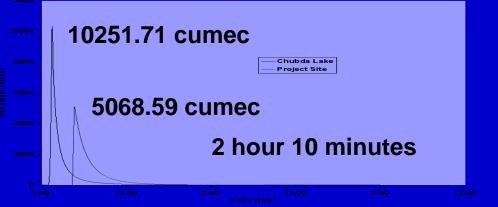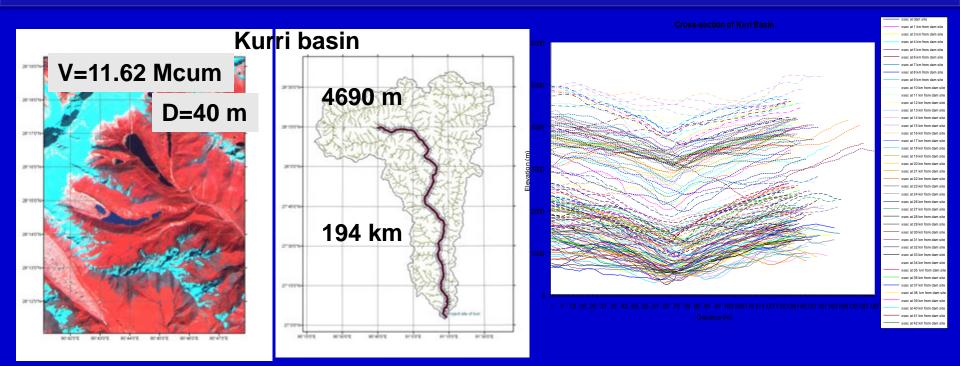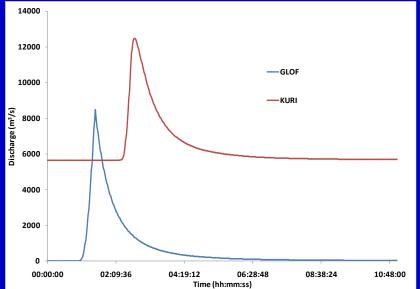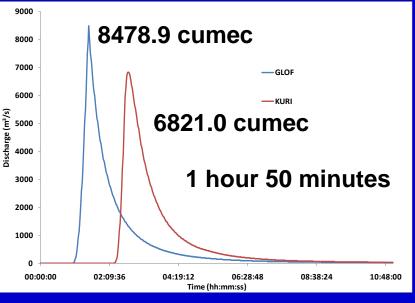
KURI-GONGRI HE PROJECTS, BHUTAN

KURI-GONGRI HE PROJECTS, BHUTAN

Gongri basin

45.56 Mm³

D=25 m

4564 m

114.3 km

Cross section Of Gongri Basin

4685.3 cumec

3850.5 cuemc

1 hour 20 minutes

LACHUNG HE PROJECT, SIKKIM

V= 54.18 Mcum
D= 16 m

4812 m

Site-I 32 km

Site-II 36 km

Site-III 38 km

919.04 cumec

752.69 cumec

Site-I

919.04 cumec

751.10 cumec

50 minutes

Site-III

919.04 cumec

749.29 cumec

Site-III

Flood Risk Management

Floodplain management plans (Structural Measure)

- **Flood mitigation dams**
- **Levees**
- **Spurs**
- **Waterway or floodplain modifications**
- **Land filling**
- **Flood proofing**
- **House raising**
- **Removal of development**

Floodplain management plans (Structural Measure)

- **Flood Plain Zoning**
- **EAP**
- **Early Warning System**

Figure 3: Flood Hazard Area
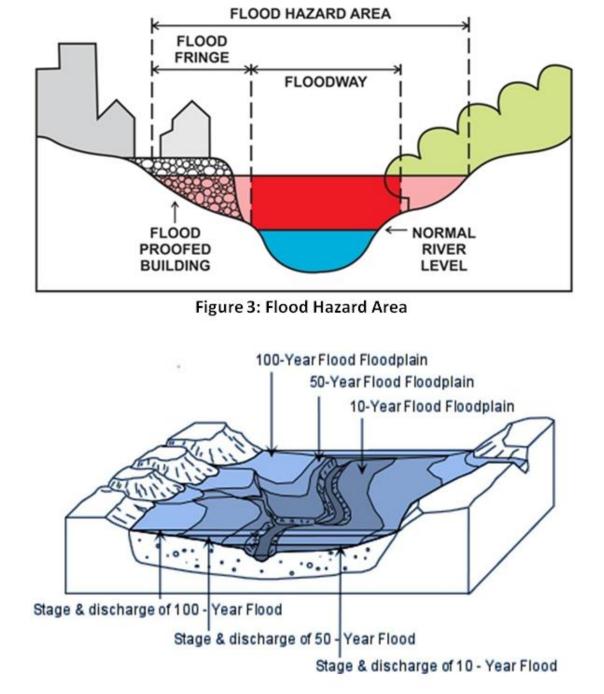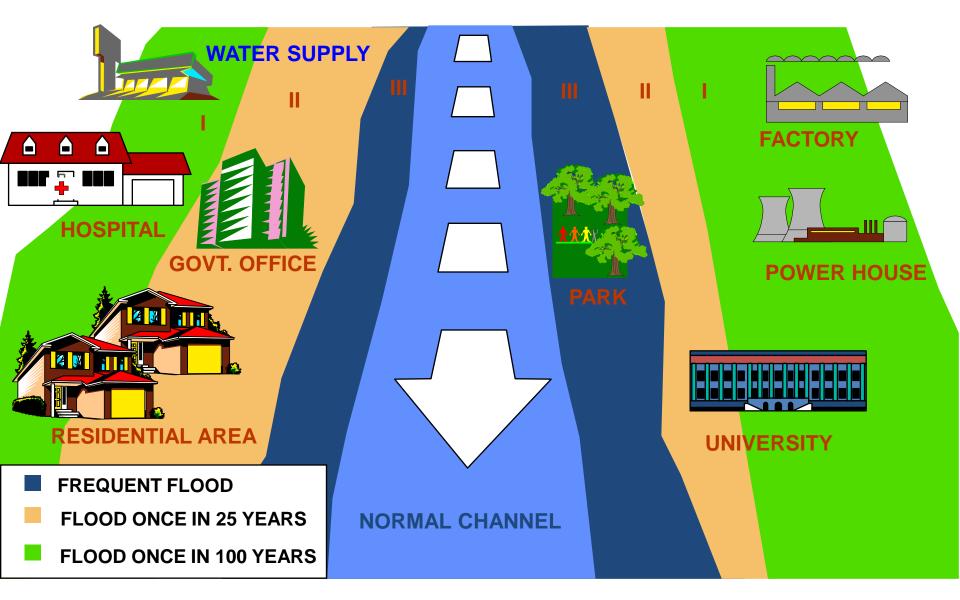
Figure 4: Flood Plain for 10, 50 and 100 year floods
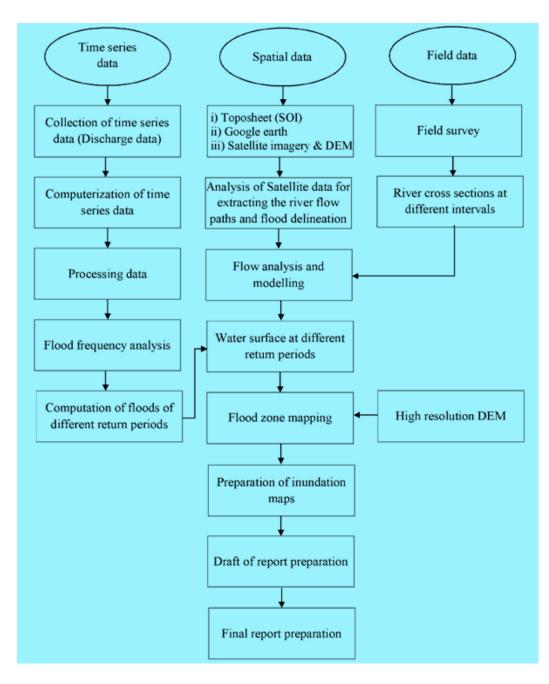
FLOOD PLAIN ZONING

Flood Zoning /Mapping at two stretches i.e.
River Bhagirathi at Uttarkashi and River Ganga from Haridwar to Lakshar
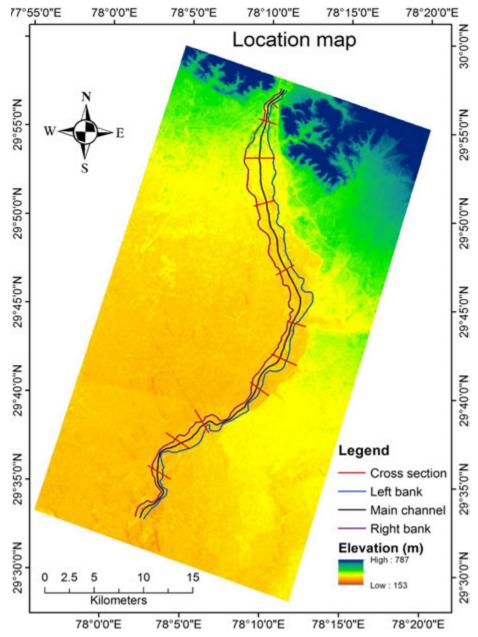
METHODOLOGY
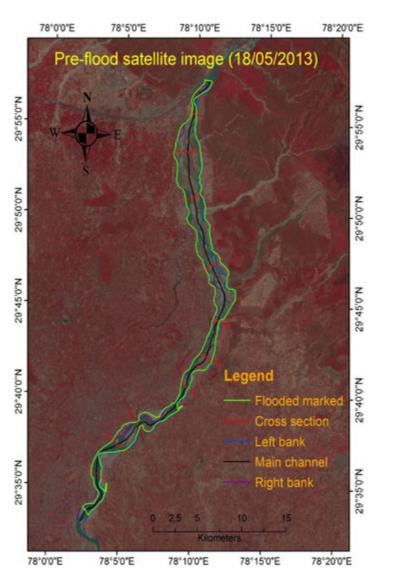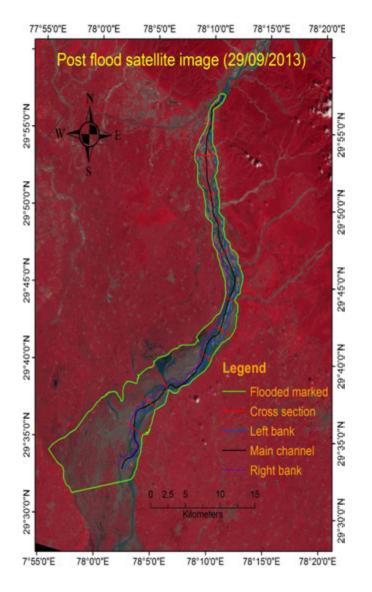
Location map (Haridwar stretch)

Flood extent as per Satellite data (Haridwar stretch)
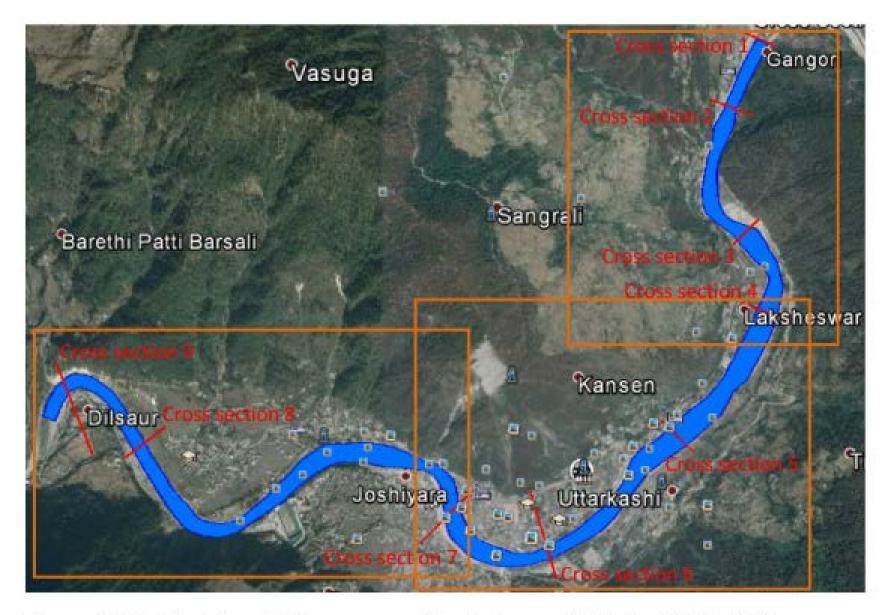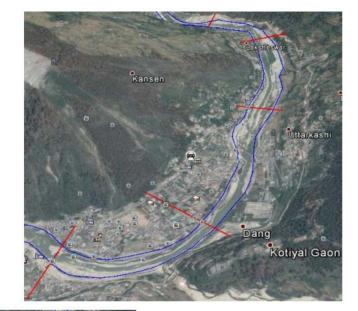
Figure 6.33: Flood inundation map on Google image (Uttarkashi Stretch)

Flood inundation map on Google image (three sections, Uttarkashi stretch)

THANKS

BASIC CONCEPTS & FFRAMEWORK OF DISASTER MANAGEMENT AND DISASTER RISK REDUCTION IN FLOOD & DROUGHT RISK MANAGEMENT
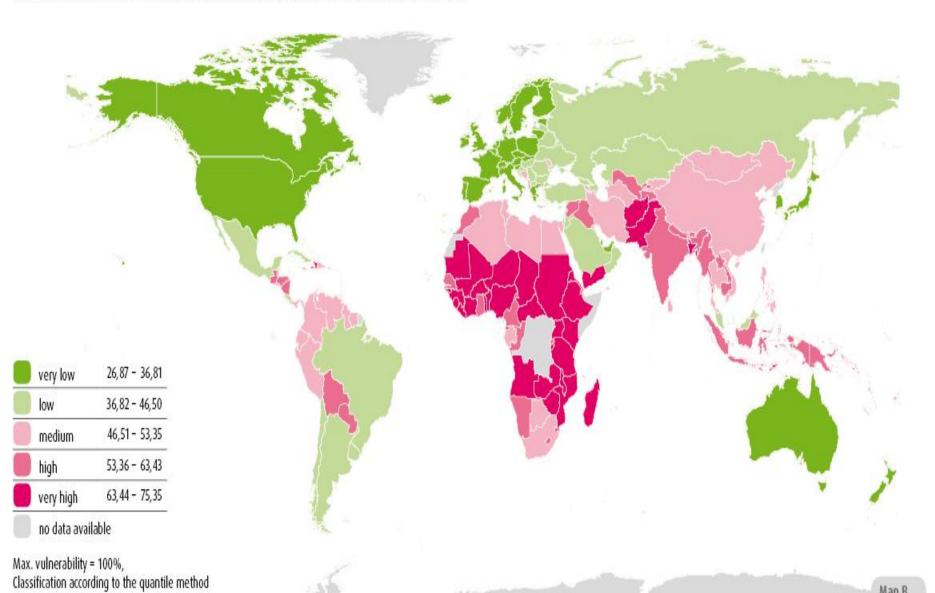
Dr. A.D. Kaushik, NIDM

www.nidm.gov.in

World Vulnerability to Disasters

Vulnerability

Vulnerability of society as the sum of susceptibility, lack of coping capacities and lack of adaptive capacities

	very low	26,87 – 36,81
	low	36,82 – 46,50
	medium	46,51 – 53,35
	high	53,36 – 63,43
	very high	63,44 – 75,35
	no data available	

Max. vulnerability = 100%,
Classification according to the quantile method

Map B

Increase in the number of reported natural disasters in 2015, mostly due to a higher number of Climatological disasters i.e. 45 in comparison to 2005-2014 annual average of 32 (an increase of 41%).
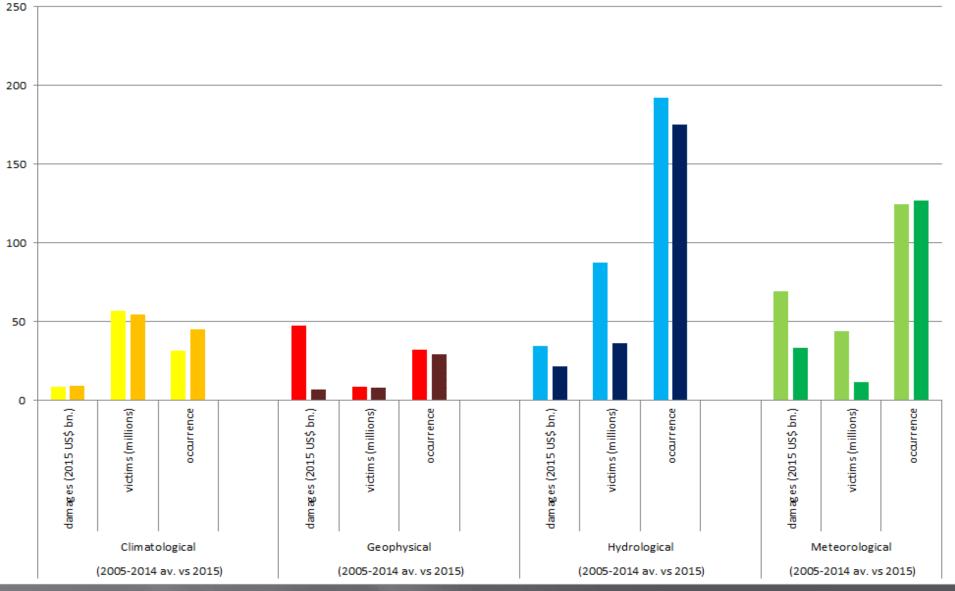
Number of Meteorological disasters (127) reported 2% above its decadal average (125) i.e. 2005-2014 while, inversely,

Number of Hydrological disasters (175) and of Geophysical disasters (29) were, both, 9% below their 2005-2014 annual average of, 192 and 32, respectively.
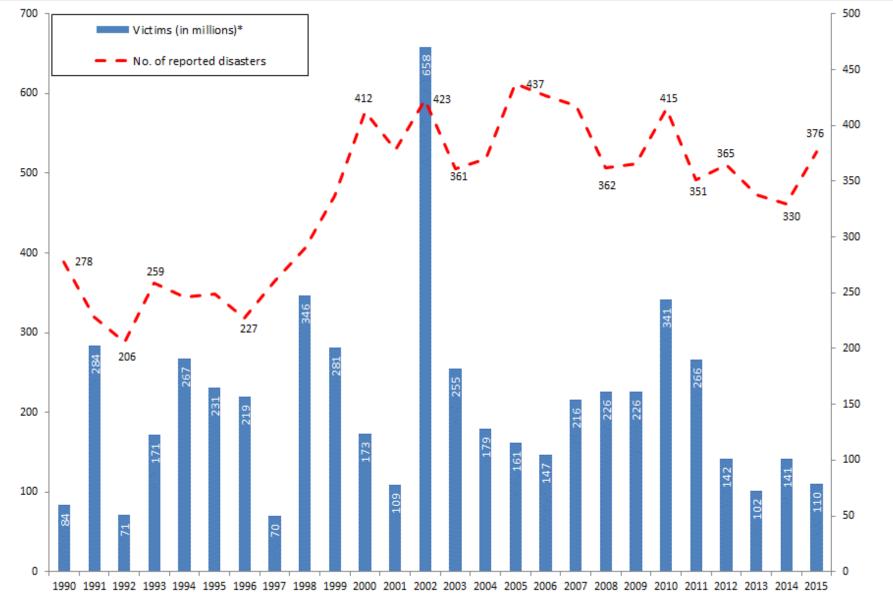
As each year since 2005, the number of Hydrological disasters still took by far the largest share in natural disaster occurrence in 2015 (46.5%, for a mean proportion of 50.6% for the period 2005-2014), followed by Meteorological disasters (33.8% versus a decadal mean proportion of 32.7%), while Climatological disasters (12% versus an annual mean proportion of 8.3%) over passed Geophysical disasters (7.7% for a 2005-2014 mean proportion of 8.4%).

Natural disaster impacts by disaster sub-group: 2015 versus 2004-2015 annual average

Source: ADSR 2015, Centre for Research on the Epidemiology of Disasters

Trends in occurrence and victims
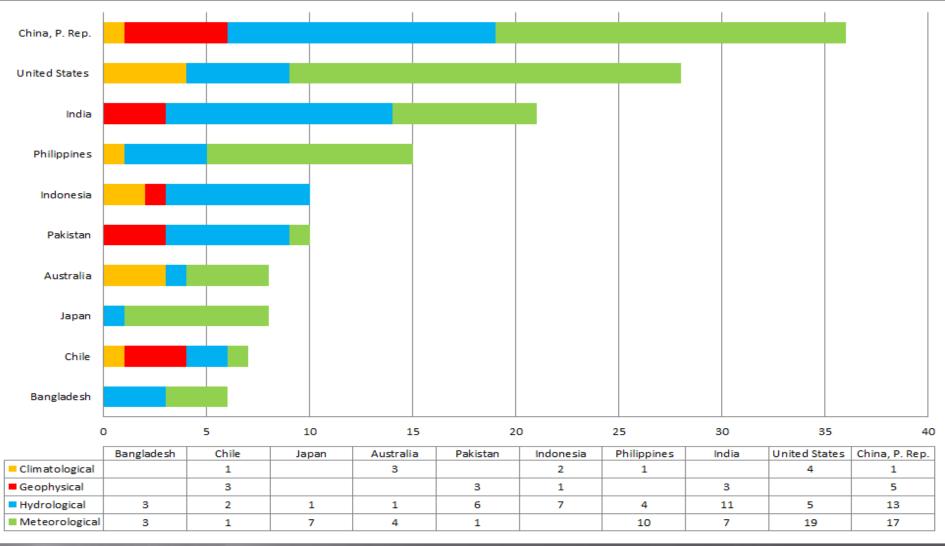
Source: ADSR 2015, Centre for Research on the Epidemiology of Disasters

Natural disaster subgroup classification

Geophysical	Hydrological	Meteorological	Climatological	Biological	Extra-terrestrial
Earthquake	Flood	Storm	Drought	Animal accident	Impact
Mass Movement (dry)	Landslide	Extreme temperature	Glacial lake outburst	Epidemic	Space weather
Volcanic activity	Wave action	Fog	Wildfire	Insect infestation	

Source: Annual Disaster Statistical Review 2015 – The numbers and trends

	Bangladesh	Chile	Japan	Australia	Pakistan	Indonesia	Philippines	India	United States	China, P. Rep.
Climatological		1		3		2	1		4	1
Geophysical		3			3	1		3		5
Hydrological	3	2	1	1	6	7	4	11	5	13
Meteorological	3	1	7	4	1		10	7	19	17

Top 10 countries by number of reported events in 2015

Source: Annual Disaster Statistical Review 2015 – The numbers and trends

When considering the countries of the top ten for the number of disasters, it appears that six of them experienced in 2015 a year among the worst since 2005. In Chile, the number of 7 disasters was the highest since the beginning of the period under review. In the USA (28 disasters) and Pakistan (10 disasters), 2015 was the second worst year since 2005. It was the third one in India (21 disasters), Australia (8 disasters) and Japan (8 disasters), while China (36 disasters) knew its fourth worst year. The number of disasters in Bangladesh was close to its 2005-2014 annual average, while the number of 15 disasters in the Philippines and of 10 in Indonesia were, respectively, the fifth and the second lowest since 2005.

Top 10 natural disasters by number of deaths in 2015

Event	Country	No. of deaths
Earthquake, April	Nepal	8,831
Heat wave, June	France	3,275
Heat wave, May	**India**	**2,248**
Heat wave, June	Pakistan	1,229
Heat wave, June	Belgium	410
Landslide, October	Guatemala	350
Flood, November	**India**	**325**
Riverine flood, July	**India**	**293**
Earthquake, October	Pakistan	280
Riverine flood, January	Malawi	278
	Total	**17,519**

Source: Annual Disaster Statistical Review 2015 – The numbers and trends

Four disasters killed more than 1000 people in 2015, accounting for 69.9% of all 2015 deaths: the Gorkha earthquake in Nepal, in April (8,831 deaths) and three heat waves in France (3,275 deaths), India (2,248 deaths) and Pakistan (1,229 deaths)

DEFINITION OF DISASTER

A serious disruption of the functioning of a society, causing wide spread human, material, or environmental losses which exceed the ability of the affected society to cope using only its own resources

The toll on us...

Contd...

The United Nation defines disaster as "the occurrence of a sudden or major misfortune which disrupts the basic fabric and normal functioning of a society (*community*)."

CONTD...

"Disaster" means a catastrophe, mishap, calamity or grave occurrence in any area, arising from natural or man made causes, or by accident or negligence which results in substantial loss of life or human suffering or damage to, and destruction of, property, or damage to, or degradation of, environment, and is of such a nature or magnitude as to be beyond the coping capacity of the community of the affected area (DM Act, 2005, 2 [d])

DEFINITION OF HAZARD

A rare or extreme natural event that threatens to adversely affect human life, property or activity to the extent of causing a disaster

or

Potentially damaging events loss of life/injury, Property damage social and economic disruption Environmental degradation

Examples are heavy rainfall, Earthquake, landslide, Forest fire, Tsunami etc.….

Hazard ....cont.

A natural hazard pertains *"to a natural phenomenon which occurs in proximity and poses a threat to people, structures and economic assets caused by biological, geological, seismic, hydrological or meteorological conditions or processes in the natural environment."*

There are four types of hazardous events that put societies at risk:
1. Those based in nature: earthquake, droughts, floods, etc.
2. Those based in violence: war, armed conflict, physical assaults, etc.
3. Those based in deterioration: environmental degradation declining health, education and other social services.
4. Those based in failing industrialized society: fire, gas leakage, transport collisions, etc.

The extent of damage from a disaster depends on:
1. The impact, intensity and characteristics of the phenomenon, and
2. How people, environment and infrastructure are affected by that phenomenon
The relationship between hazard and vulnerability is best represented as an equation:

Hazard > Disaster < Vulnerability
Or
Disaster Risk = Hazard + Vulnerability

HAZARD ASSESSMENT

•Identification of main hazards.
•Understanding their characteristics.
•Assessment of trends

Hazard assessment also determines the:
Geographical area affected by the hazard.
Season when the hazard is most likely to appear.
Any warning signs which precede its appearance etc.

Risk

Risk is a measure of the expected losses due to a hazard event of a particular magnitude occurring in a given area over a specific time period. The level of risk depends upon:

- Nature of the hazard.

- Vulnerability of affected elements.

- Economic value of affected elements

So Risk is a function of Threat (Hazard) and Exposure or weakness (Vulnerability)

Risk = Hazard x Vulnerability

RISK ASSESSMENT

Process to determine the nature and extent of risk by analysing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm to exposed people, property, services, livelihoods and the environment on which they depend".

RISK ASSESSMENT- METHODOLOGY

Step1: Consider the hazards

Step2: Identify elements at risk and assess their
vulnerabilities

Step 3: Evaluate the risks.

Step 4: Record your findings.

Step 5: Review your assessment periodically.

CAPACITY

The combination of all the strengths, attributes and resources available within a community, society or organization that can be used to achieve agreed goals. or

It may be defined as Identification of existing resources and resources to be acquired or created

Organization and training of personnel and coordination of such training for effective management of disasters

Capacity development: The process by which people, organizations and society systematically stimulate and develop their capacities over time to achieve social and economic goals, including through improvement of knowledge, skills, systems, and institutions.

Coping capacity: The ability of people, organizations and systems, using available skills and resources, to face and manage adverse conditions, emergencies or disasters.

Risk = H X V ÷ C

H = Hazards - *Potentiality* of a physical event that may cause loss of life or property

R = Risks - *Probability* of harmful losses or consequences

V = Vulnerabilities - *Factors or processes* - physical, social, economic, and environmental - which increase susceptibility of an area or a community to damage and loss

C = Capacities - *Strengths and resources* available within a community, society or organization

Vulnerability of India

Vulnerability defined as "The extent to which a community, structure, service or geographical area is likely to be damaged or disrupted by the impact of particular hazard, on the account of their nature, construction and proximity to hazardous terrain or a disaster prone area"

Indian sub-continent is amongst the world's most disaster vulnerable areas with:

- 59% area to earthquake.
- 28% to drought.
- 8% to cyclones and
- 12% to floods.
- 25% to landslides
- 50% forest area prone to forest fire

Types of Vulnerability

- **Physical Vulnerability** (infrastructure, buildings and agriculture)

- **Social Vulnerability** (identification of the vulnerable groups like poor, women, children, disabled person etc.)

- **Economic Vulnerability** (measures the risk of hazard causing losses to economic assets directly or indirectly)

VULNERABILITY

Capacity to Cope

	High	*Low*
High	*Low Vulnerability*	*High Vulnerability*
Exposure to Hazard		
Low	*Very Low Vulnerability*	*Low Vulnerability*

VULNERABILITY ASSESSMENT

The process of estimating the degree of weakness of "elements at risk" to various hazards and analysing root causes for damage and loss.

RELATIONSHIP BETWEEN HAZARD AND VULNERABILITY
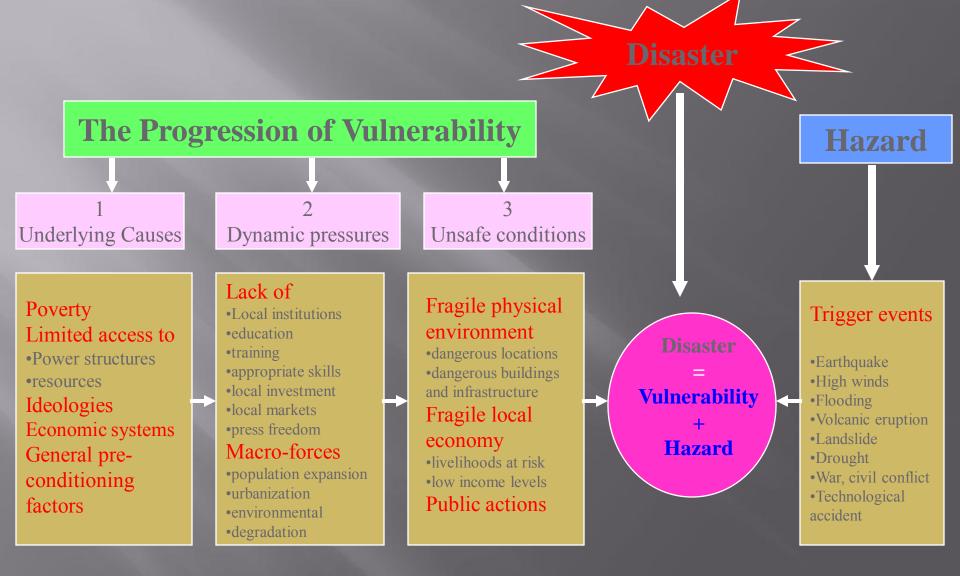
hazard x vulnerability = disaster

HAZARD x vulnerability = disaster

hazard x VULNERABILITY= disaster

HAZARD x VULNERABILITY= DISASTER

A DISASTER AS THE INTERFACE BETWEEN NATURAL HAZARDS AND VULNERABLE CONDITIONS

Disaster

The Progression of Vulnerability

Hazard

1 Underlying Causes	2 Dynamic pressures	3 Unsafe conditions

Poverty
Limited access to
- Power structures
- resources

Ideologies
Economic systems
General pre-conditioning factors

Lack of
- Local institutions
- education
- training
- appropriate skills
- local investment
- local markets
- press freedom

Macro-forces
- population expansion
- urbanization
- environmental
- degradation

Fragile physical environment
- dangerous locations
- dangerous buildings and infrastructure

Fragile local economy
- livelihoods at risk
- low income levels

Public actions

Disaster
=
Vulnerability
+
Hazard

Trigger events

- Earthquake
- High winds
- Flooding
- Volcanic eruption
- Landslide
- Drought
- War, civil conflict
- Technological accident

Disaster risk: The potential disaster losses, in lives, health status, livelihoods, assets and services, which could occur to a particular community or a society over some specified future time period.

Disaster risk management: The systematic process of using administrative directives, organizations, and operational skills and capacities to implement strategies, policies and improved coping capacities in order to lessen the adverse impacts of hazards and the possibility of disaster.

Disaster risk reduction: The concept and practice of reducing disaster risks through systematic efforts, to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events.
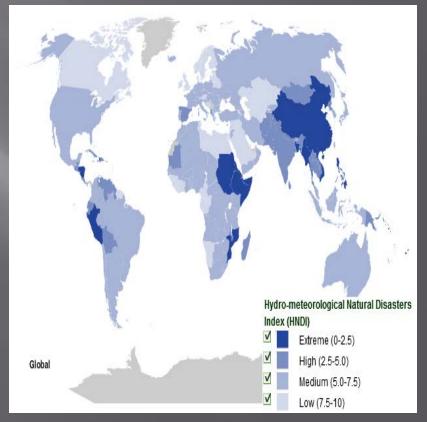
Early warning system: The set of capacities needed to generate and disseminate timely and meaningful warning information to enable individuals, communities and organizations threatened by a hazard to prepare and to act appropriately and in sufficient time to reduce the possibility of harm or loss.

Emergency management: The organization and management of resources and responsibilities for addressing all aspects of emergencies, in particular preparedness, response and initial recovery steps.

Type of Disasters

High Powered Committee (HPC) identified 32 disasters in the country, categorized into five sub groups:

- ▣ **Water and Climate related disasters.**
- ▣ **Geologically related disasters.**
- ▣ **Chemical, Industrial & Nuclear related disasters.**
- ▣ **Accident related disasters.**
- ▣ **Biologically related disasters.**

Hydro-meteorological Natural Disasters Index (HNDI)

☑ ■ Extreme (0-2.5)
☑ ■ High (2.5-5.0)
☑ ■ Medium (5.0-7.5)
☑ ■ Low (7.5-10)

Global

DISASTERS IDENTIFIED BY HPC

I.   WATER AND CLIMATE RELATED DISASTERS

1. Floods

2. Cyclones

3. Tornadoes

4. Hailstorm

5. Cloud Burst

6. Heat Wave and Cold Wave

7. Snow Avalanches

8. Droughts

9. Sea Erosion

10. Thunder and Lightning

11. Tsunami (added ?)

II. GEOLOGICALLY RELATED DISASTERS

1. Landslides and Mudflows
2. Earthquakes
3. Dam Failures/ Dam Bursts
4. Mine Fires

III. CHEMICAL, INDUSTRIAL AND NUCLEAR

- Chemical and Industrial Disasters
- Nuclear Disasters

IV. ACCIDENT RELATED DISASTERS

1. Forest Fires
2. Urban Fires
3. Mine Flooding
4. Oil Spill
5. Major Building Collapse
6. Serial Bomb Blasts
7. Festival related disasters
8. Electrical Disasters and Fires
9. Air, Road and Rail Accidents
10. Boat Capsizing
11. Village Fire

V. BIOLOGICALLY RELATED DISASTERS

1. **Biological Disasters and Epidemics**
2. **Pest Attacks**
3. **Cattle Epidemics**
4. **Food Poisoning**

DISASTER MANAGEMENT - INTRODUCTION

According to DM Act,– DM defined as:

"Disaster Management" means a continuous and integrated process of planning, organising, coordinating and implementing measures which are necessary or expedient for:

(i) **Prevention** of danger or threat of any disaster

(ii) **Mitigation or reduction** of risk, impact or effects of any disaster or threatening disaster situation or its severity or consequences;

(iii) **Capacity building**;

(iv) **Preparedness** – the state of readiness to deal with any disaster, threatening situation or disaster and the effects thereof;

(v) **Prompt response** to any threatening disaster situation or disaster;

(vi) **Assessing the severity** or magnitude of effects of any disaster;

(vii) **Evacuation, rescue and relief**;

(viii) **Rehabilitation / reconstruction** means restoration of any property after a disaster;

(ix) **Resources** includes manpower, services, materials & provisions
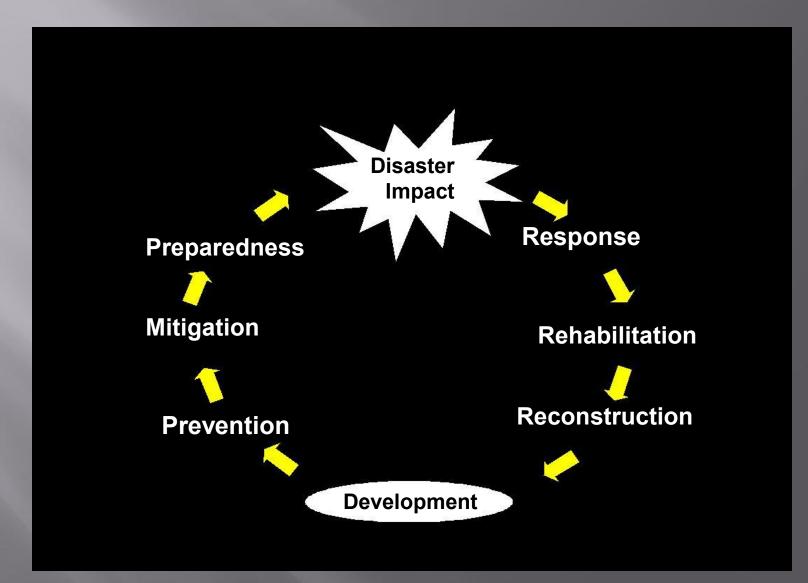
Key Stages of Disaster Management

Pre – Disaster: Before a disaster to reduce the potential for human, material or environmental losses caused by hazards and to ensure that these losses are minimised when the disaster actually strikes.

During Disaster: It is to ensure that the needs and provisions of victims are met to alleviate and minimise suffering.
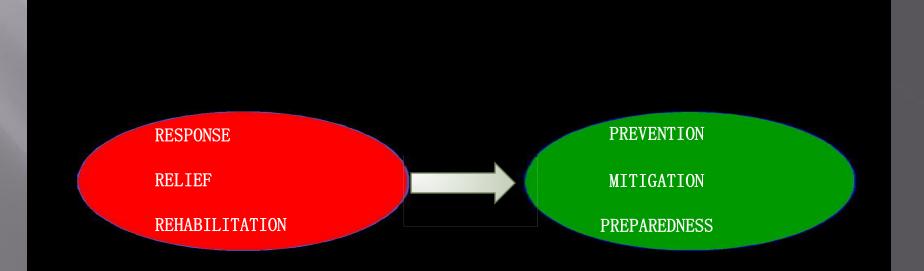
Post Disaster: After a disaster to achieve rapid and durable recovery which does not reproduce the original vulnerable conditions

The Disaster Management Cycle

DM POLICY FRAMEWORK: PARADIGM SHIFT (Yokohama 1994)

- Change from response & relief centric to mitigation & preparedness

- Multi dimensional , multi sectorial and Multi Tier approach with emphasis on incorporating risk reduction measures in development planning

RESPONSE

RELIEF

REHABILITATION

→

PREVENTION

MITIGATION

PREPAREDNESS

HYOGO FRAMEWORK FOR ACTION

- Three main Strategic Goals
  - Integration DRR in Sustainable Development
  - Capacity Building-Resilience to hazards
  - Systematic incorporation of risk reduction approaches in to the emergency preparedness, response and recovery programs

FIVE ACTION POINTS OF HFA (2005 – 2015)

- Make DRR a priority
- Know the risk and take action
- Build Understanding and Awareness
- Reduce Risk
- Be prepared and Ready to Act

DRR- Introduction

What is Disaster Risk Reduction?

The conceptual framework of elements considered with the possibilities to minimize vulnerabilities and disaster risks throughout a society, to avoid (prevention) or to limit (mitigation and preparedness) the adverse impacts of hazards, within the broad context of sustainable development (ISDR, 2004).

3ʳᵈ UN World Conference on DRR at Sendai (Japan) March 14-18, 2015

• Conference aims to agree on a new framework for disaster risk reduction to update the Hyogo Framework for Action adopted in Kobe, Japan, ten years ago.

• Global economic losses from disasters now exceed US$300 billion annually, said UN secretary-general Ban Ki-moon during the opening of the five-day conference in the city of Sendai.

• Actions are urgently needed to lower that figure and the money that will be saved should be invested in development to uplift people still mired in poverty, Ban added

• Cover the development of disaster-proof infrastructure, the promotion of global cooperation and training of government officials and leaders on disaster risk reduction.

3rd UN World Conference on DRR-Highlights

• **In the decade covered by the expiring Hyogo Framework for Action, more than 700,000 people lost their lives, and over 1.5 billion people were affected by disasters. Total economic losses topped $1.3 trillion.**

• **New Framework- The Sendai Framework for Disaster Risk Reduction, a 15-year plan, replaces the current 10-year blueprint.**

• **This opens a major new chapter in sustainable development as it outlines clear targets and priorities for action which will lead to a substantial reduction of disaster risk and losses in lives, livelihoods and health," said Margareta Wahlstrom, head of the U.N. Office for Disaster Risk Reduction (UNISDR).**

• **Implementation of the plan "will be vital to the achievement of future agreements on sustainable development goals and climate later this year", she added.**

•It aims to lower the global mortality rate from disasters between 2020 and 2030, compared to 2005 to 2015, and reduce the proportion of people affected.

• Another target is to reduce economic losses in relation to global GDP by 2030.

• The new agreement also includes targets to reduce damage to infrastructure and disruption to basic services, including health and education sectors, and to widen access to early warning systems and disaster risk information for the public.

• Need for greater efforts to protect those most at risk from extreme weather and other hazards. "Disasters, many of which are exacerbated by climate change and (are) increasing in frequency and intensity, significantly impede progress towards sustainable development," the Sendai framework said

CHART OF THE SENDAI FRAMEWORK FOR DISASTER RISK REDUCTION 2015-2030

Scope and purpose

The present framework will apply to the risk of small-scale and large-scale, frequent and infrequent, sudden and slow-onset disasters, caused by natural or manmade hazards as well as related environmental, technological and biological hazards and risks. It aims to guide the multi-hazard management of disaster risk in development at all levels as well as within and across all sectors.

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.

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.

SFWDRR: TARGETS

Substantially reduce global disaster mortality by 2030, aiming to lower average per 100,000 global mortality between 2020-2030 compared to 2005-2015	Substantially reduce the number of affected people globally by 2030, aiming to lower the average global figure per 100,000 between 2020-2030 compared to 2005-2015	Reduce direct disaster economic loss in relation to global gross domestic product (GDP) by 2030	Substantially reduce disaster damage to critical infrastructure and disruption of basic services, among them health and educational facilities, including through developing their resilience by 2030	Substantially increase the number of countries with national and local disaster risk reduction strategies by 2020	Substantially enhance international cooperation to developing countries through adequate and sustainable support to complement their national actions for implementation of this framework by 2030	Substantially increase the availability of and access to multihazard early warning systems and disaster risk information and assessments to people by 2030

SFWDRR: PRIORITIES FOR ACTION

There is a need for focused action within and across sectors by States at local, national, regional and global levels in the following four priority areas.

Priority 1	Priority 2	Priority 3	Priority 4
Understanding disaster risk	**Strengthening disaster risk governance to manage disaster risk**	**Investing in disaster risk reduction for resilience**	**Enhancing disaster preparedness for effective response, and to «Build Back Better» in recovery, rehabilitation and reconstruction**
Disaster risk management needs to be based on an understanding of disaster risk in all its dimensions of vulnerability, capacity, exposure of persons and assets, hazard characteristics and the environment	Disaster risk governance at the national, regional and global levels is vital to the management of disaster risk reduction in all sectors and ensuring the coherence of national and local frameworks of laws, regulations and public policies that, by defining roles and responsibilities, guide, encourage and incentivize the public and private sectors to take action and address disaster risk	Public and private investment in disaster risk prevention and reduction through structural and non-structural measures are essential to enhance the economic, social, health and cultural resilience of persons, communities, countries and their assets, as well as the environment. These can be drivers of innovation, growth and job creation. Such measures are cost effective and instrumental to save lives, prevent and reduce losses and ensure effective recovery and rehabilitation	Experience indicates that disaster preparedness needs to be strengthened for more effective response and ensure capacities are in place for effective recovery. Disasters have also demonstrated that the recovery, rehabilitation and reconstruction phase, which needs to be prepared ahead of the disaster, is an opportunity to «Build Back Better» through integrating disaster risk reduction measures. Women and persons with disabilities should publicly lead and promote gender-equitable and universally accessible approaches during the response and reconstruction phases

SFWDRR: Guiding Principles

Primary responsibility of States to prevent and reduce disaster risk, including through cooperation	Shared responsibility between central Government and national authorities, sectors and stakeholders as appropriate to national circumstances	Protection of persons and their assets while promoting and protecting all human rights including the right to development	Engagement from all of society	Full engagement of all State institutions of an executive and legislative nature at national and local levels	Empowerment of local authorities and communities through resources, incentives and decision-making responsibilities as appropriate	Decision-making to be inclusive and risk informed while using a multi-hazard approach

Coherence of disaster risk reduction and sustainable development policies, plans, practices and mechanisms, across different sectors	Accounting of local and specific characteristics of disaster risks when determining measures to reduce risk	Addressing underlying risk factors cost-effectively through investment versus relying primarily on post disaster response and recovery	«Build Back Better» for preventing the creation of, and reducing existing, disaster risk	The quality of global partnership and international cooperation to be effective, meaningful and strong	Support from developed countries and partners to developing countries to be tailored according to needs and priorities as identified by them

Preparedness- Activities and measures taken in advance to ensure effective response to the impact of hazards, including the issuance of timely and effective early warnings and the temporary evacuation of people and property from threatened locations (ISDR, 2004).

Prevention- Activities to provide outright avoidance of the adverse impact of hazards and the means to minimize related environmental, technological and biological disasters (ISDR, 2004).

Mitigation - Structural and non-structural measures undertaken to limit the adverse impact of natural hazards, environmental degradation and technological hazards (ISDR, 2004).

ELEMENTS OF DISASTER MANAGEMENT

- **Disaster preparedness planning**
    - Vulnerability and risk assessment

- **Disaster response**
    - Disaster assessment

- **Rehabilitation & reconstruction**

- **Disaster mitigation**

SHIFT TOWARDS PREPAREDNESS

- Vulnerability and Risk Assessment.

- Disaster Management Plan at National, State & District Level.

- Early Warning System.

- Community Awareness and Public Education

DISASTER PREPAREDNESS : RECENT TRENDS

Gradual shift from Relief to Preparedness

- Awareness Generation
- Community Training
- Vulnerability Assessments
- Retrofitting
- Use of Space Technology
- Information Systems
- Traditional Practices
- Better Coordination

DISASTER PREPAREDNESS FRAMEWORK

Vulnerability Assessment	**Planning**	**Institutional Framework**
Information Systems	**Resource Base**	**Warning Systems**
Response Mechanisms	**Public Education and Training**	**Rehearsals**

PLANNING

A PLAN MUST :

•Have a clearly stated objective or set of objectives

•Reflect a systematic sequence of activities in a logical and clear manner

•Assign specific tasks and responsibilities

•Integrate its activities, tasks and responsibilities to enable the overall objective or series of objectives to be achieved

Importance

- **Risk reduction reduces vulnerability**
- **Reduced vulnerability reduces impact of future hazardous events**
- **Reduced impact means quicker recovery**
- **Quicker recovery allows return to development activities**

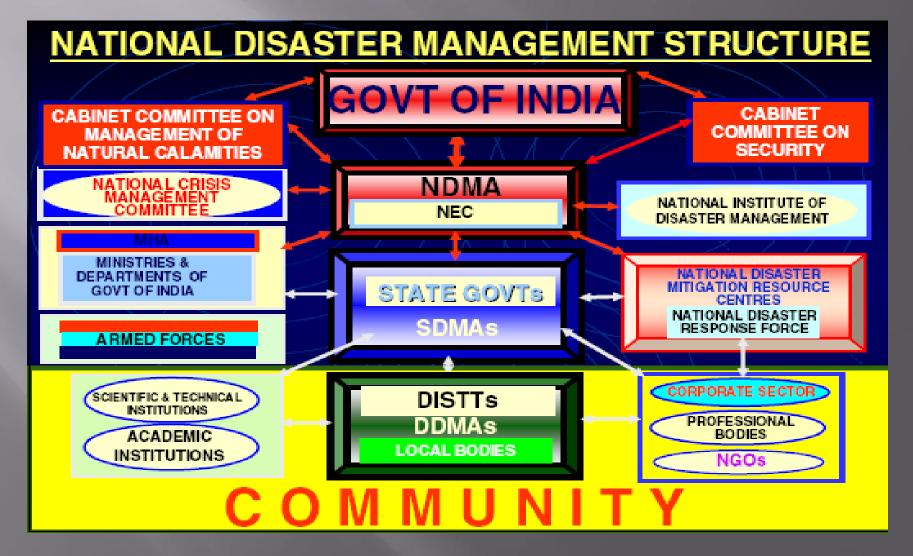| Before Disaster	During Disaster
To check readiness of facilities for quick response. To take decisions to minimize losses. To conduct school safety audit	To quickly respond to a disaster situation, record damage, mobilization to support for evacuation
Non-disaster time	**After Disaster**
Initiative to reduce structural and non-structural vulnerability of school buildings To take up activities for reducing disaster effects. To increase disaster management skills, to regularly carry out drills in schools, to raise awareness of students and staff.	To manage the safety and care of evacuees, sending students back to their homes in safe manner

TARGET GROUP

Who must be involved?

• Multi-sectoral, multidisciplinary strategic users which include a broad range of Disaster Risk Management stakeholders.

• Governmental and nongovernmental organizations at Community, National and Regional levels,

• National Disaster Organisations

• Professional Associations.

• Lending Institutions

• Insurance Companies

• Educational bodies from Primary Schools onwards

NATIONAL DISASTER MANAGEMENT STRUCTURE

IFW : NODAL MINISTRIES

- Natural Disaster (Flood, Tsunami, Cyclone, Earthquake etc.)- Ministry of Home Affairs
- Drought-Ministry of Agriculture
- Biological Disasters-Ministry of Health and Family Welfare
- Chemical Disasters-Ministry of Environment & Forests
- Nuclear Disasters-Ministry of Atomic Energy
- Air Accidents-Ministry of Civil Aviation
- Railway Accidents-Ministry of Railways….

THE DISASTER MANAGEMENT ACT 2005

•The Disaster Management Act was enacted on 23rd December,2005. The Act provides for establishment of
  ➢NDMA (National Disaster Management Authority)
  ➢SDMA (State Disaster Management Authority)
  ➢DDMA (District Disaster Management Authority)

•Act provides for constitution of Disaster Response Fund and Disaster Mitigation Fund at National, State and District level.

•Establishment of NIDM and NDRF.

•Provides penalties for obstruction, false claims, misappropriation etc.

•There shall be no discrimination on the ground of sex, caste, community, descent or religion in providing compensation and relief.

NATIONAL DISASTER MANAGEMENT AUTHORITY (NDMA)

➢National Disaster Management Authority (NDMA) headed by the Prime Minister with up to a maximum of nine members nominated by Prime Minister.

➢The Authority may constitute an Advisory Committee consisting of experts in the field of disaster management.

➢The Authority shall be assisted by a National Executive Committee of Secretaries to be constituted by Central Government.

➢National Disaster Management Authority (NDMA) headed by the Prime Minister with up to a maximum of nine members nominated by Prime Minister.

➢The Authority may constitute an Advisory Committee consisting of experts in the field of disaster management.

➢The Authority shall be assisted by a National Executive Committee of Secretaries to be constituted by Central Government.

•Lay down the policies, plans and guidelines for disaster management.
•The National Executive Committee shall prepare a National Disaster Management Plan in consultation with the State Governments.
•The National Plan shall include measures for prevention and mitigation of disasters, integration of mitigation measures in the plans, preparedness and capacity building.
•NDMA shall recommend guidelines for the minimum standards of relief provided to persons affected by disaster

National Executive Committee (NEC)

• A National Executive Committee is constituted under Section 8 of DM Act, 2005 to assist the National Authority in the performance of its functions. NEC consists of Home Secretary as its Chairperson, *ex-officio*, with other Secretaries to the Government of India in the Ministries or Departments having administrative control of the agriculture, atomic energy, defence, drinking water supply, environment and forest, finance (expenditure), health, power, rural development science and technology, space, telecommunication, urban development, water resources. The Chief of Integrated Defence Staff of the Chiefs of Staff Committee, *ex-officio*, is also its Members.

• NEC may as and when it considers necessary constitute one or more sub-committees for the efficient discharge of its functions. For the conduct of NEC, Disaster Management National Executive Committee (Procedure and Allowances) Rules, 2006 has been issued which may be visited at www.mha.nic.in. NEC has been given the responsibility to act as the coordinating and monitoring body for disaster management, to prepare a National Plan, monitor the implementation of National Policy etc. vide section 10 of the DM Act.

STATE DISASTER MANAGEMENT AUTHORITY (SDMA)

➢ SDMA with eight members to be nominated by the Chief Minister and the Chairperson of the State Executive Committee.

➢ One of the members may be designated as the Vice-Chairperson of the State Authority by the Chief Minister.

➢ SDMA may constitute an Advisory Committee of experts, as and when necessary.

DISTRICT DISASTER MANAGEMENT AUTHORITY (DDMA)

➢ **The State Government shall establish a District Disaster Management Authority (DDMA) in each district.**

➢ **The District Authority will be headed by District Magistrate and shall consist of members, not exceeding seven, as may be prescribed by the State Government.**

➢ **The District Authority shall act as the district planning, coordinating and implementing body for disaster management.**

The District Authority is responsible for planning, coordination and implementation of disaster management and to take such measures for disaster management as provided in the guidelines. The District Authority also has the power to examine the construction in any area in the district to enforce the safety standards and also to arrange for relief measures and respond to the disaster at the district level.

NATIONAL INSTITUTE OF DISASTER MANAGEMENT (NIDM)

The Central Government shall constitute the National Institute of Disaster Management (NIDM) , Chapter 7 of DM Act 2005
NIDM shall:
- plan and promote training and research in disaster management
- Start documentation, development of national level information base of disaster management policies, prevention mechanisms, mitigation measures.
- Networking

NATIONAL DISASTER RESPONSE FORCE (NDRF)

➢A National Disaster Response Force shall be constituted for specially response.

➢The general superintendence and direction of the Force shall be vested in and exercised by the National Authority.

➢Command and supervision of the Force shall vest in an officer to be appointed by the Central Government as the Director General of the NDRF

➢Biological and Chemical Disasters 10 Battalion (10x 1149) of National Response Force raised . 02 more Battalion approved by GoI.

➢Each battalion consist of 18 specialist response team besides other supporting staff

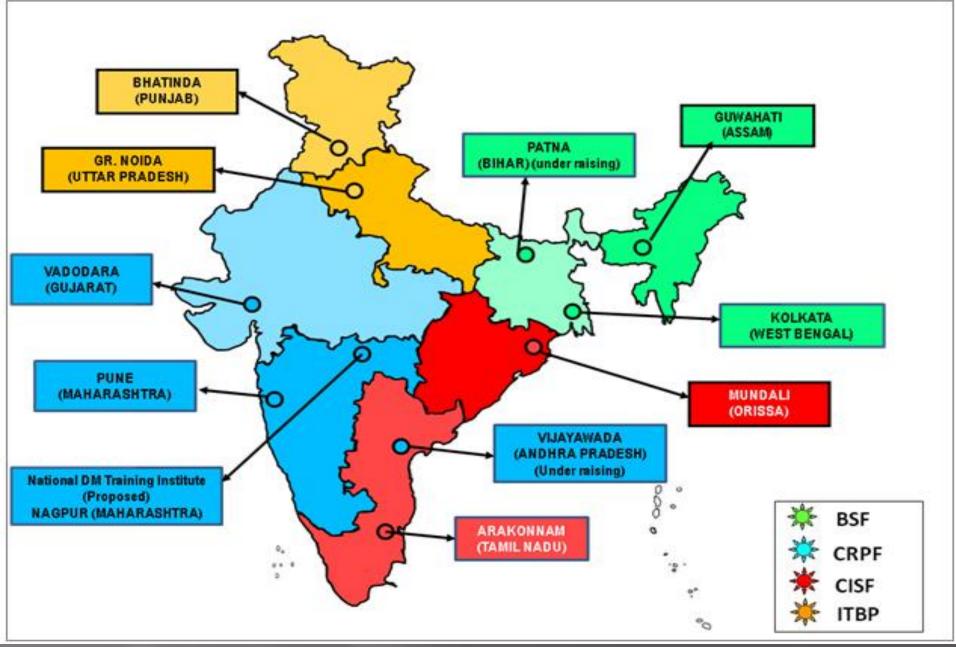➢Each Specialist Response Team of 45 persons comprising

    4 SAR Team
    1 Medical Support Team
    1 Technical Support Team
    1 Dog Squad

➢Each battalion to have 1 diving and 1 Water Rescue Team

➢Four of these battalion to specialize on Nuclear

Map showing NDRF Bns locations and their respective area of responsibility
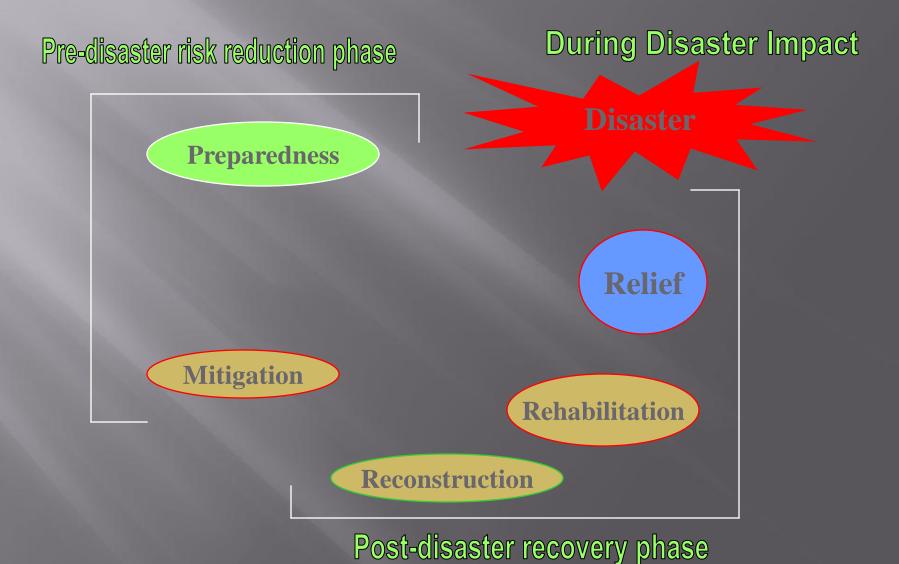
NATIONAL POLICY ON DISASTER MANAGEMENT (2009)

▪The National Policy on Disaster Management has been finalized and approved by Home Minister.

▪Inter-Ministerial consultation process has been completed.

▪The Policy is now under consideration of NDMA.

▪Draft Policy lays down the roadmap/direction for all Government endeavors.

MAJOR PHASES OF DISASTER MANAGEMENT CYCLE

Pre-disaster risk reduction phase

During Disaster Impact

Disaster

Preparedness

Relief

Mitigation

Rehabilitation

Reconstruction

Post-disaster recovery phase

Flood Preparedness

- 175 Flood forecasting stations in which 18 in AP including Telangana (4 Inflow & 14 Level)
- 96% accuracy in forecasting
- Flood forecasts are issued by CWC at 175 stations (147 Level Forecast Stations + 28 Inflow Forecast Stations)
- Annually, about 6000 flood forecasts are issued by CWC during floods.
- Average 1464 deaths and 86288 heads of cattle dead annually because of floods in India
- Warning system
- Community involvement in warning dissemination

Importance of Level Forecasting

Flood Forecasting has been recognized as the most important, reliable and cost effective non-structural measures for flood mitigation and reduction of :

- ➢ Damages to roads, railways, communications
- ➢ Loss of movable properties
- ➢ Loss of cattle, other pet animals
- ➢ Loss of human lives
- ➢ Loss of immovable properties like houses, heavy personal effects

Importance of Inflow Forecasting

Inflow Forecasting essential for :

➢ Accounting the flow at Reservoir/ Barrage/ station, or reach of river.
➢ Estimation of added flows/ extraction between any given reach, during any given duration.
➢ Optimum reservoir regulation
➢ Flood moderation
➢ Evaluation of reservoir regulation methodology.

Karnataka State Natural Disaster Monitoring Centre
24 HOURS DAILY RAINFALL DURING 8:30 AM OF 19-08-2018 TO 8:30 AM OF 20-08-2018
(Based on data from all GP's Telemetric Raingauges)

UNDERSTANDING DROUGHT

Drought is a temporary aberration unlike aridity, which is a permanent feature of climate. Seasonal aridity (i.e. a well-defined dry season) also needs to be distinguished from drought. Thus drought is a normal, recurrent feature of climate and occurs in all climatic regimes and is usually characterized in terms of its spatial extension, intensity and duration. Conditions of drought appear when the rainfall is deficient in relation to the statistical multi-year average for a region, over an extended period of a season or year, or even more.

Drought differs from other natural hazards such as cyclones, floods, earthquakes, volcanic eruptions, and tsunamis.

IMPACTS OF DROUGHT

Direct impacts or primary impacts are usually physical / material and include reduced agricultural production; increased fire hazard; depleted water levels; higher livestock and wildlife mortality rates; and damage to wildlife and fish habitats.

Indirect impacts When direct impacts have multiplier effects through the economy and society, they are referred to as indirect impacts. These include a reduction in agricultural production that may result in reduced income for farmers and agribusiness, increased prices for food and timber, unemployment, reduced purchasing capacity and demand for consumption, default on agricultural loans, rural unrest, and reduction in agricultural employment leading to migration and drought relief programmes.

TYPES OF DROUGHT IMPACT

- **Economic:** production losses in agriculture and related sectors, especially forestry and fisheries

- **Environmental:** lower water levels in reservoirs, lakes and ponds as well as reduced flows from springs and streams would reduce the availability of feed and drinking water and adversely affect fish and wildlife habitat, loss of forest cover & migration of wildlife and their greater mortality

- **Social:** lack of income causing out migration of the population from the drought-affected areas. People in India withdraw their children from schools, postpone daughters' marriages, and sell their assets such as land or cattle.

CLASSIFICATION OF DROUGHT

In the literature, droughts have been classified into three categories in terms of impact:

- **Meteorological drought**
- **Hydrological drought**
- **Agricultural drought**

Marathwada and Vidarbha regions of Maharashtra due to deficient rainfall and excess use of water for sugarcane cultivation Sept.2018

Rain-deficit 23 districts in Karnataka declared drought-hit
The state departments concerned will conduct a joint survey of the drought-hit districts and submit a report to the Centre for grants Sept.2018

राष्ट्रीय मौसम पूर्वानुमान केन्द्र
भारत मौसम विज्ञान विभाग
पृथ्वी विज्ञान मंत्रालय

National Weather Forecasting Centre
India Meteorological Department
Ministry of Earth Sciences

South India
Date: 29 JUNE 2017
(MORNING)

Met-Sub Division	TODAY (29 JUNE 2017)	TOMORROW 30 JUNE 2017)	01 JULY 2017	02 JULY 2017	03 JULY 2017
Coastal Andhra Pradesh	NIL	NIL	NIL	Heavy rain very likely at Isolated places	Heavy rain very likely at Isolated places
Telangana	NIL	NIL	NIL	NIL	NIL
Rayalaseema	NIL	NIL	NIL	NIL	NIL
Tamilnadu & Puducherry	NIL	NIL	NIL	NIL	NIL
Coastal Karnataka	Heavy rain very likely at Isolated places	Heavy rain very likely at Isolated places	Heavy to very heavy rain very likely at Isolated places	Heavy to very heavy rain very likely at Isolated places	Heavy to very heavy rain very likely at Isolated places
North Interior Karnataka	NIL	NIL	NIL	NIL	NIL
South Interior Karnataka	NIL	NIL	NIL	NIL	NIL
Kerala	Heavy rain very likely at Isolated places	Heavy rain very likely at Isolated places	Heavy rain very likely at Isolated places	NIL	NIL
Lakshadweep	NIL	NIL	NIL	NIL	NIL

Sustainable communities

- Able to weigh up natural risks and balance them successfully against other goals, and they are communities that can survive and prosper in the face of exposure to forest fire

- Ones which identify and pursue strategies designed to reduce their member's vulnerability by addressing social, economic and political inequities and by giving all within their communities access to resources to forest fire exposure and vulnerability (Beatley, 1998)

DRR Message

Community must share their learnings based on information and knowledge of disasters and their management to all the components/ units of a society.

EDUCATION IS KEY

- *"...*although knowledge does not guarantee power over natural catastrophe, it is a prime requisite of disaster prevention.*"* (Alexander 2000)

- *"* Human history becomes more and more a race between education and catastrophe.*"* (H.G. Wells)

THANK YOU

adkaushik@gmail.com