

# Flood Forecasting and Warning System



## FLOODS

- ✓ Natural Phenomena
- ✓ Heavy Losses
- ✓ Disrupt Normal Life
- ✓ In some river valleys, floods have been turned to economic advantage.
- ✓ Millions of People grow their rice, wheat, millet and corn on flood plains in India, China & Countries in the East where they are subjected to inundation and death.
- ✓ Competition between people and flood water for same land area

## FLOOD PROBLEM (INDIA)

- **Geographical Area** 329 mha
- **Total Flood Prone Area**
  - As Assessed by RBA 40 mha
  - As reported by the States to the Working Group on flood control programme for 10<sup>th</sup> five year plan 45.65 mha
- **Major Flood Prone States** Assam, Bihar, West Bengal, UP, Orissa, A.P.
- **Major Flood Prone Basins** Ganga, Brahmaputra & Mahanadi

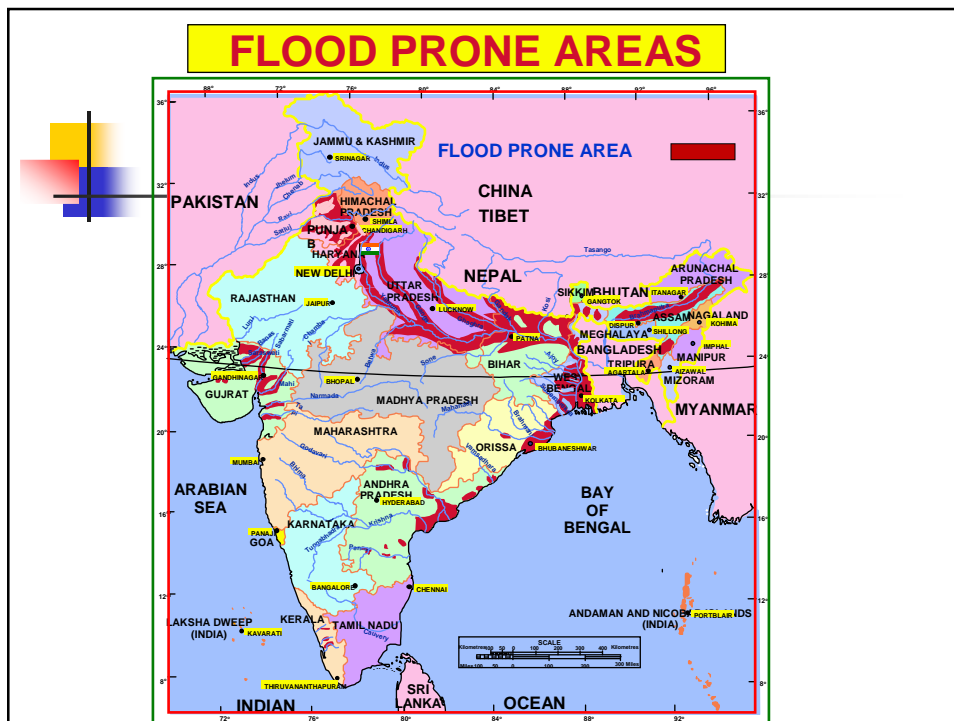
## FLOOD PROBLEMS

### Ganga, Brahmaputra & Mahanadi Basin

- **Brahmaputra basin**
  - Inundation
  - Bank erosion
  - Flash floods (including flows from Bhutan & China)
- **Ganga basin**
  - Inundation
  - Bank erosion
  - Water logging/drainage congestion
  - Floods from Nepal
- **Mahanadi basin**
  - Inundation
  - Water logging/drainage congestion

## FLOOD DAMAGE (INDIA) DURING 1953-2005

ITEM	Average	Maximum(Year)
Area Affected (Million Hectare)	7.55	17.50(1978)
Crop Area Affected (Million Hectare)	3.54	10.15(1988)
Population Affected (crore)	3.286	7.045(1978)
Human Lives Lost (Nos.)	1,589	11,316(1977)
Cattle Lost (Nos.)	94,839	6,18,248(1979)
Houses Damaged (Nos.)	12,17,918	35,07,542(1978)
Value of damage to crops (crore)	710.63	4246.62(2000)
Value of damage to house (crore)	270.59	1307.89(1995)
Value of damage to public utilities (crore)	820.75	5604.46(2001)
Value of damage to crops, houses & public utilities (crore)	1805.18	8864.54(2000)





## ACHIEVEMENTS ON FLOOD CONTROL MEASURES (TILL MARCH 2005)

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•Embankments	35007 Km
•Drainage Channels	51678 Km
•Town Protection Works	2450 Nos
•Villages Raised	4721 Nos
•Area Benefited	17.77 Mha.



## FLOOD CONTROL MEASURES Non-Structural Measures

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•Flood Forecasting & Warning System. Plays significant role in reducing the loss of life and movable property during floods. CWC have a National Network of FF Stations on all Inter-State Rivers. CWC has 175 Forecasting sites on 70 Inter-State Rivers. About 6666 Nos. of Forecasts were issued during monsoon of 2006. Accuracy of forecast is about 95.8%.



## FLOOD FORECASTING NETWORK OF CWC

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- A network of flood forecasting stations established in major and inter state river basins
- Total Flood Forecasting Stations 175
  - Inflow 28
  - Stage 147



## Flood Forecasting Activities

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- Flood forecasting activities in India made a small beginning in November 1958 when the CWC created a Flood Forecasting Unit for flood forecasting for the river Yamuna at Delhi, the National Capital.
- The disastrous floods in 1968 in many parts of the country necessitated the setting up of forecasting centres on interstate rivers.

## Number of Flood Forecasting Stations in different years

<u>Year</u>	<u>No. of Forecasting Stations</u>
1958	1
1965	2
1970	43
1975	79
1980	84
1985	145
1990	157
2001	159
2004	172
2005	173
<u>2006</u>	<u>175*</u>

\*Out of 175 regular flood forecasting stations, 28 stations are inflow forecasting stations for reservoirs/barrages and rest 147 stations are level forecasting stations.

## River systems covered under flood forecasting network in India

<b>Name of River-systems</b>	<b>Level</b>	<b>Inflow</b>	<b>Total</b>
<b>Ganga &amp; Tributaries</b>	<b>77</b>	<b>10</b>	<b>87</b>
<b>Brhamaputra &amp; Tributaries</b>	<b>27</b>	<b>-</b>	<b>27</b>
<b>Barak-System</b>	<b>05</b>	<b>-</b>	<b>05</b>
<b>Eastern-Rivers</b>	<b>08</b>	<b>01</b>	<b>09</b>
<b>Mahanadi</b>	<b>03</b>	<b>01</b>	<b>04</b>
<b>Godavari</b>	<b>14</b>	<b>04</b>	<b>18</b>
<b>Krishna</b>	<b>03</b>	<b>06</b>	<b>09</b>
<b>West flowing Rivers</b>	<b>09</b>	<b>06</b>	<b>15</b>
<b>Pennar</b>	<b>01</b>	<b>-</b>	<b>01</b>
<b>Total</b>	<b>147</b>	<b>28</b>	<b>175</b>

## State-wise distribution of flood forecasting stations

<u>State</u>	<u>No. of Sites</u>	<u>State</u>	<u>No. of Sites</u>
Andhra Pradesh	16	Madhya Pradesh	3
Assam	24	Orissa	12
Bihar	33	Tripura	2
Chattisgarh	1	Uttar Pradesh	35
Gujarat	10	Uttaranchal	3
Haryana	1	West Bengal	14
Jharkhand	4	NCT Delhi	2
Karnataka	4	Dadra & Nagar Haveli	2
Marashtra	9		

**Total No.  
of Sites: 175**

## Methodology of Forecasting

- The data received from the site at the divisional headquarters through wireless, telemetry, telephone etc. is scrutinized and processed.
- Methods for formulation of forecast depend upon availability of data at the time of framing of forecast, physiographic characteristics of the watershed, warning time available, facilities/ infrastructure available and purpose of forecast.



## Methodology of Forecasting

- While simple **statistical correlations using gauge to gauge, gauge & discharge data** are being used for some forecasting sites; **multiple coaxial correlations using gauge, rainfall, Antecedent Precipitation Index (API) data** are being used for other stations.
- **Mathematical models/ rainfall runoff models** like MIKE-11 FF are also in use for some of the sites in **Damodar Basin, Godavari Basin, Mahanadi Basin & Chambal Basin.**




## Forecasting Schedule

- **Major rivers (Travel time >24 hours)**  
Forecasts are being formulated based on 0800 hrs/ 0900 hrs water level data and issued once in a day at 1000 hrs with advance warning time from 24 hrs to 36 hrs
- **Medium rivers (Travel time 12-24 hours)**  
Forecasts are being formulated based on 0600 hrs and 1800 hrs water level data and issued twice in a day at 0700 hrs and 1900 hrs with advance warning time from 12 hrs to 24 hrs
- **Flashy rivers (Travel time < 12 hours)**  
Forecasts are being formulated based on any main hr water level data and issued multiple times (more than twice) in a day with advance warning time less than 12 hrs




## Dissemination of Forecast



Dissemination of forecasts to the users agencies, such as civil/ engineering authorities of concerned States, defence, railways/ highways authorities, industrial and other important establishments located in the flood prone areas through telephone/ fax/ e-mail/ special messenger for taking advance action for flood fighting & evacuating population to safer places.

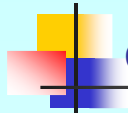
- Forecasts being given to Radio, Television and News Agencies for the benefit of the likely flood affected population.
- Daily flood bulletins hosted on the website [www.india-water.com](http://www.india-water.com) for quick dissemination.

## Co-operation with Nepal



Under the bilateral Flood Forecasting and warning system on rivers common to India & Nepal, Hydro-meteorological stations have been set up in Nepal and India for exchange of data on real time basis

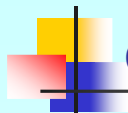
- 42 hydro-meteorological stations in Nepal territory. Data received by CWC are shared with Bihar & U.P.
- 18 stations in Indian territory
- Joint Task Force (JTF) and Committee on Flood Forecasting (CFF) recommended 47 stations against 42 existing stations for improving the existing flood forecasting scheme.



## Co-operation with Bangladesh

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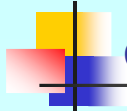
- **Transmission of water level, discharge of rivers and rainfall data from India to Bangladesh during monsoon season since 1972**
- **Water level, weather report and discharge data of Farakka on Ganga and Pandu on Brahmaputra twice daily (0800 hrs. and 2000 hrs).For Farakka on Ganga Forecast level is also transmitted.**
- **Water level, Weather report and Forecast levels of Goalpara & Dhubri on river Brahmaputra river, Silchar on Barak river and Tista on Damohani river twice daily (0800 hrs. and 2000 hrs)**



## Co-operation with Bangladesh – Contd.

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- **Rainfall data at Jalpaiguri, Coochbehar, Siliguri, Dhubri, Goalpara, Silchar, Tura and Agartalla at 0800 hrs**
- **Water level at Kailashahar on Manu river, Amarpur on Gumti river, Badarpurghat on Barak river, Gazaldoba on Tista river, NH-31 on Jaldhaka (Dharla) and Ghughumari on Torsa (Dudkhkumar) thrice a day at 0900, 1300 and 1800 hrs throughout flood season**



## Co-operation with China

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- **Data of 3 stations namely Yanghen, Nugesha and Nuxia on Siang river located in China are being received twice a day at 0530 hrs. and 1730 hrs. since 2002.**
- **Historical data of last ten years received from China are being used for development of flood forecasting model.**
- **Data are used for formulation of flood forecast and shared with the Govt. of Arunachal Pradesh & Assam.**



## Co-operation with Bhutan.

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- **A scheme to carry out Hydro-meteorological observations in Bhutan on the rivers common to India and Bhutan since 1955**
- **A network 35 nos. of hydro-meteorological / meteorological stations maintained by Royal Govt. of Bhutan**
- **A Joint Expert Team (JET) consisting of officials from the Government of India and Royal Government of Bhutan has been constituted to review the progress and other requirements of the scheme**



## Co-operation with Pakistan.

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- **Exchange of flood data between India and Pakistan for rivers in India Water Treaty of 1960**
    - Ropar below, Harike below and Ferozepur below on the Sutlej Main
    - Madhopur below on the Ravi Main
    - Inflows, outflows and levels of Pong reservoir on the Beas, and Bhakra reservoir on the Sutlej main
- A flood warning cell is operated round the clock in the Indus wing during monsoon. The frequency of flood warning messages varies as hourly/ 3 hourly/ 6 hourly etc. depending on the magnitude of floods



## Evaluation of Flood Forecast Performance

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- On an average, 6000 forecasts at various places in the country are issued during the monsoon season every year.
- A level forecast is considered reasonably accurate if the difference between the forecast and the corresponding actual observed river level lies within +/- 15 cm.
- Inflow forecast – variation of inflow volume within +/- 20% is considered acceptable.
- Level forecast reliable to an extent of 95%
- Inflow forecast reliable to an extent of 96%



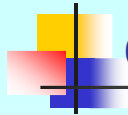
## FLOOD FORECASTING MODERNISATION

<b>Data Collection:</b>	<b>By Using Automatic Sensors</b>
<b>Data Transmission:</b>	<b>Using Modern Automatic Data Transmission Technique e.g. Satellite, VSAT, Internet/Email, Mobile Phones etc</b>
<b>Forecast Formulation:</b>	<b>Using Computer Based Comprehensive Catchment Models.</b>
<b>Forecast Dissemination:</b>	<b>By Using Computer Network and Satellite e.g. Internet, E-mail etc.</b>



## INUNDATION FORECAST

- Level forecast by CWC doesn't directly indicate area likely to be flooded
- Authorities involved in relief and rehabilitation need potential areas (villages/ abadis) likely to be flooded corresponding to level forecast
- Inundation forecast will save time in assessing areas and facilitate quick action
- As a pilot project for flood forecasting & Management in Mahanadi basin the models would be developed under USAID to increase advance warning time and give forecast of the area likely to be inundated.



## Ongoing scheme for modernisation

- **TELEMETRY SYSTEM AVAILABLE**

Mahanadi basin – 35 stations

Chambal basin – 20 stations

- **TELEMETRY SYSTEM UNDER INSTALLATION**

Godavari basins - 63 no.

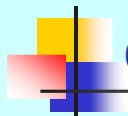
Krishna basin - 41 no.

Brahmaputra basin - 21 no.

Damodar basin - 20 no.

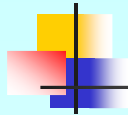
Yamuna basin - 15 no.

Mahanadi basin - 8 no.



## Ongoing scheme for modernisation

- Installation of 11 modeling centres at Dibrugarh, Assansol, New Delhi, Agra, Hyderabad (2), Kurnool, Bhadrachalam, Guwahati, Bhubaneswar and Maithon to receive data from existing earth stations at Jaipur and Burla
- Installation of MIKE11 (HD, NAM, FF and GIS) Software for Inflow as well as level forecast at 12 places
- Installation of Arc View GIS based for flood inundation map



## Future Programme

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- Up gradation & modernization of equipment at remaining stations (about 787) including telemetry system in order to improve accuracy in data collection, lead-time in flood forecasting by way of installing sensor & data logger based instrumentation like Automatic Rain Gauges/Weather stations, Automatic Water Level Recorder with latest available technology
- Integration with State Network of Flood Forecasting and Hydrological sites



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# THANK YOU