



## Flooding in North India

This editorial is based on [Why North India is facing unusually heavy rains](#) which was published in Hindustan Times on 10/07/2023. It talks about reasons of floodings in North India and issues related to floodings.

**For Prelims:** [Food Security](#), [Malnutrition](#), [Poverty](#), [Floods](#), [Monsoon](#), [Western Disturbance](#), [El Nino-Southern Oscillation](#) [Indian Ocean Dipole](#), [Climate Change](#) [National Disaster Management Plan](#), [National Disaster Management Authority](#), [India Meteorological Department](#), [Central Water Commission](#)

**For Mains:** Causes of Heavy Rainfall in North India, Factors Affecting the Rainfall in India

India is experiencing a **series of extreme rainfall** events that **have caused widespread destruction, landslides, flash floods and deaths** in several parts of the country.

The **rainfall distribution and intensity** have been influenced by various factors, such as the [monsoon](#), the [western disturbance](#), the [El Nino-Southern Oscillation](#) (ENSO), the [Indian Ocean Dipole](#) (IOD) and [climate change](#).

### What are Causes of Heavy Rainfall in North India?

- **Interaction between Western Disturbance and the Monsoon Trough:**
  - The heavy rainfall in North India is **primarily due to the interaction between a western disturbance** (a low-pressure system originating from the Mediterranean region) and **the monsoon trough** (a low-pressure zone along the monsoon wind belt).
  - This interaction **leads to intense rainfall** over regions like **Himachal Pradesh, Uttarakhand, Punjab, and Haryana**.
- **Excess Rainfall and Deficient Distribution:**
  - After experiencing a **10% deficiency in rainfall until the end of June**, North India has **witnessed a surge in monsoon activity**, resulting in a **2% excess rainfall** over the country.
  - Specifically, **there is a 59% excess rainfall over northwest India**, while **peninsular India and east/northeast India** have faced **rainfall deficiencies of 23% and 17%, respectively**.
- **Synoptic Conditions and Climate Change:**
  - The recent **heavy rainfall and flash floods in Himachal Pradesh** have been attributed to synoptic conditions similar to the 2013 Uttarakhand floods.
    - These conditions **involve an active monsoon with strong low-level easterly winds bringing ample moisture**, coupled with **upper-level divergence** caused by an eastward-moving trough.
  - Climate change also plays a role, as **it leads to increased heavy rainfall** in hilly areas

and surroundings **due to extra moisture and orographic lifting.**

- In hilly areas like the Himalayan foothills and the Western Ghats, increased extreme rains occur due to orographic lifting.
- The **hills obstruct the moisture flow**, causing it to accumulate and result in heavy downpours.

▪ **Flash Floods and Cloudbursts:**

- Flash floods caused by cloudbursts and extreme rainfall events are challenging to predict.
- Monitoring and forecasting such events require radar systems and close observation of areas prone to flash floods.
- Land use changes and development activities may aggravate the severity of flash floods.

## What are the Factors Affecting the Rainfall in India?

▪ **Monsoon Affecting Rainfall:**

- The monsoon **is a seasonal reversal of winds that brings a humid climate** and torrential rainfall to India.
  - The monsoon **typically lasts from June to September**, with peak rainfall occurring in July and August.
  - The Indian Monsoon is **caused by a difference in air pressure between the Bay of Bengal and the Arabian Sea.**
  - The rainfall distribution in India is **impacted by the Thar desert and the Himalayas**, as well as **temperature and pressure changes** over the **Indian Ocean, the Arabian Sea, the Bay of Bengal** and the southern part of the **Pacific Ocean.**

▪ **Western Disturbance Affecting Rainfall:**

- The western disturbance **is a low-pressure system that originates over the Mediterranean Sea** or West Asia and moves eastward towards India.
  - It usually affects northwestern India during winter (December to February) and brings snowfall to the Himalayan regions and rainfall to the plains.
  - However, **sometimes it can also interact with the monsoon trough during summer** (June to September) and bring heavy rainfall to northern India.
- The western disturbance **can enhance or suppress the monsoon activity** depending on its location, intensity and timing.
  - When it is **located over northwestern India or Pakistan**, it can **enhance the monsoon** activity by providing moisture and instability to the atmosphere.
  - When it is **located over central or eastern India**, it **can suppress the monsoon activity** by creating a high-pressure system that blocks the monsoon winds.

▪ **ENSO Affecting Rainfall:**

- ENSO is a **periodic fluctuation of sea surface temperature (SST)** and atmospheric pressure **over the equatorial Pacific Ocean.**
- ENSO can affect the rainfall in India **by altering the atmospheric circulation** patterns over the Indian Ocean, the Arabian Sea, the Bay of Bengal and the southern part of the Pacific Ocean.
  - El Nino **tends to weaken or delay the onset of the monsoon** by creating a high-pressure system over India that blocks the moisture-laden winds from reaching India.
  - La Nina **tends to strengthen or advance the onset of the monsoon** by creating a low-pressure system over India that attracts the moisture-laden winds from reaching India.

▪ **IOD Affecting Rainfall:**

- IOD can **affect the rainfall in India by modulating the moisture transport and convection over the Indian Ocean**, the Arabian Sea and the Bay of Bengal.
- IOD can also affect different regions of India differently depending on its strength, duration and timing.
  - Positive IOD can **increase rainfall over northwestern India** in summer and central India in autumn.
  - Negative IOD can **decrease rainfall over northwestern India** in summer and increase rainfall over peninsular India in autumn.

### ▪ **Climate Change:**

- Climate change can affect the rainfall in India **by altering the temperature, humidity, pressure, wind and cloud patterns** over various scales of time and space.
- Climate change can affect the monsoon by changing its onset, duration, intensity and spatial distribution. Some studies suggest that -
  - Climate change **can delay the onset of the monsoon by increasing the land-sea temperature contrast**, which inhibits the northward movement of the monsoon winds.
  - **Climate change can advance the onset of the monsoon by increasing the SSTs** over the Indian Ocean, which enhances the moisture supply to the atmosphere.
  - Climate change can increase the frequency and intensity of El Nino events, which can reduce Indian summer monsoon rainfall (ISMR) and increase droughts.
  - Climate change can increase the frequency and intensity of La Nina events, which can increase ISMR and floods.
- Climate change can also **affect the orographic rainfall in India by changing the snow cover, glacier melt and soil moisture** over the Himalayas and the Western Ghats.

## **What are the Implications of Heavy Rainfall in India?**

### ▪ **Agriculture:**

- Heavy rainfall and floods **can damage crops, soil fertility, irrigation infrastructure and livestock.**
- They can also affect crop sowing, harvesting, storage and distribution.
  - This can **lead to [food insecurity](#), [malnutrition](#), [poverty](#) and distress migration** among farmers.

### ▪ **Water resources:**

- Heavy rainfall and floods **can replenish groundwater, surface water and soil moisture levels.**
- They can also improve water quality by flushing out pollutants.
  - However, they **can also cause waterlogging, erosion, sedimentation, landslides, dam breaches and contamination** of water sources.
  - This can lead to **water scarcity, water conflicts, waterborne diseases and displacement of people.**

### ▪ **Energy:**

- Heavy rainfall and floods **can increase hydropower generation by increasing river flows** and reservoir levels.
- They can also reduce thermal power generation by affecting coal supply and cooling systems.
  - However, they **can also damage power plants, transmission lines, substations and distribution networks.**
  - This can lead to **power outages, blackouts, losses and accidents.**

### ▪ **Transportation:**

- Heavy rainfall and floods can **improve navigation by increasing water levels** in rivers and lakes.
  - However, they can also **disrupt road, rail, air and water transport** by causing landslides, floods, traffic jams, delays, cancellations, accidents and fatalities.

### ▪ **Health:**

- Heavy rainfall and floods can reduce air pollution by washing away dust particles and aerosols.
- They can also reduce heat stress by lowering temperatures and humidity.
  - However, they can also increase vector-borne diseases.

## **What are the Government Initiatives to Tackle Flooding?**

### ▪ **National Flood Risk Mitigation Project (NFRMP):**

- It **aims at ensuring that arrangements** are in place to mobilise the resources and capability for **relief, rehabilitation, reconstruction and recovery from disasters**

besides creating awareness among vulnerable communities.

- **National Disaster Management Plan (NDMP):**
  - It provides a **framework and direction for all phases of disaster management cycle**, such as prevention, mitigation, preparedness, response, recovery and reconstruction.
- **National Disaster Management Authority (NDMA):**
  - It is the apex body for disaster management in India, under the chairmanship of the Prime Minister.
  - It lays down policies, plans and guidelines for disaster management and coordinates their implementation.
- **India Meteorological Department (IMD):**
  - It provides rainfall or cyclonic event forecast which is used by all the agencies for preparedness to deal with the floods.
  - It also issues warnings and advisories for heavy rainfall, flash floods, landslides and cloudbursts.
- **Central Water Commission (CWC):**
  - It monitors the water levels of major rivers and reservoirs and issues flood forecasts and inflow forecasts.
  - It also conducts flood damage assessment and flood plain zoning. It also provides technical guidance and assistance to state governments for flood management.
- **National Remote Sensing Centre (NRSC):**
  - It provides satellite-based information for flood monitoring, mapping, damage assessment and relief planning.
  - It also develops flood inundation models and flood risk maps.

## What Should be the Way Forward?

- **Strengthening the Institutional and Legal Framework:**
  - Strengthening the institutional and legal framework for flood and landslide management **at the national, state and local levels.**
  - This includes **establishing dedicated agencies or departments for flood and landslide management, enhancing coordination and collaboration among various stakeholders**, enforcing regulations and standards for land use, construction, mining, etc., and ensuring accountability and transparency in disaster management activities.
- **Enhancing the Scientific and Technical Capabilities:**
  - This **includes conducting hazard, vulnerability and risk assessment, mapping and zoning of flood** and landslide prone areas, developing early warning systems and forecasting models, implementing structural and non-structural mitigation measures, promoting research and innovation, and building human resources and capacities.
- **Improving the Disaster Preparedness:**
  - **Short Term Measures:**
    - Establishing emergency control rooms and communication networks
    - Conducting drills and mock exercises
    - Deploying rapid response teams and relief materials
    - Ensuring timely evacuation and rescue operations
  - **Long Term Measures:**
    - Developing disaster management plans at various levels
    - Allocating funds and resources
    - Mobilising community participation and awareness

### **Drishti Mains Question:**

Analyse the causes and implications of the recent heavy rainfall and flooding in North India.

## UPSC Civil Services Examination Previous Year's Question (PYQs)

### **Prelims:**

**Q. La Nina is suspected to have caused recent floods in Australia. How is La Nina different from El Nino? (2011)**

1. La Nina is characterised by an usually cold ocean temperature in the equatorial Indian Ocean whereas El Nino is characterised by unusually warm ocean temperature in the equatorial Pacific Ocean.
2. El Nino has an adverse effect on the south-west monsoon of India but La Nina has no effect on the monsoon climate.

**Which of the statements given above is/are correct?**

- (a) 1 only
- (b) 2 only
- (c) Both 1 and 2
- (d) Neither 1 nor 2

**Ans: (d)**

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**Mains**

**Q.** With reference to the National Disaster Management Authority (NDMA) guidelines, discuss the measures to be adopted to mitigate the impact of recent incidents of cloudbursts in many places of Uttarakhand. **(2016)**

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