Role of Climate Change in Indian Monsoon

Why in news?

Research shows that Indian monsoon is likely to get much more dangerous as climate disruptions take a toll on the system in the subcontinent.

How about the picture of the current climate system?

- There is a complex mix of several factors which makes it difficult to understand the rainfall variability and how monsoon patterns have been behaving of late.
    - Persistence of intense La Nina conditions
    - Abnormal warming of East Indian Ocean
    - Negative Indian Ocean Dipole (IOD)
    - Southward movement of most of the monsoon depressions and lows
    - Pre-monsoon heating over the Himalayan region are melting glaciers
- **Change in monsoon pattern**- Since 1951, the monsoon circulation has weakened, especially in regions like the Western Ghats and the Indo-Gangetic plains.
- However, incidents of localised heavy rainfall have increased.
- The duration of dry spells between rainy days during the monsoon has also increased.

How climate change impacts summer monsoon rainfall?

> *The Indian Meteorological Department (IMD) has clearly sighted that 2022 has seen the second highest extreme events since 1902.*

- Alarming increase in floods and droughts provides direct evidence of how global warming has been impacting the Indian monsoon.
- **Changing area**- Most of the monsoon weather systems have been travelling across central parts of the country, changing the area of rainfall.
- **Excess and deficit**- Madhya Pradesh, Gujarat, Rajasthan and parts of Maharashtra have recorded excess rainfall this year.
- Back-to-back active monsoon systems in the Bay of Bengal in July led to excess rainfall to the tune of 8%.
- In contrast, West Bengal, Jharkhand and Bihar did not receive normal rains.
- **Variability-** While summer monsoon rainfall each year is unique, there has been a large regional and temporal variability in rainfall this year.
- **Role of GHG-** Climate models indicate that global warming is expected to increase monsoon rainfall by 14% by the end of the century if greenhouse gas (GHG) emissions remain high.

- **Rapid heating of global ocean**- The global ocean has absorbed 90% of the excess heat generated by man in the past 50 years due to which extreme rainfall events of the sort seen in Maharashtra would become very common.
- **Role of SST**- There is a strong relationship of the monsoon with sea surface temperature (SST).
- The weakening of the land-sea temperature gradient will result in drying of monsoon circulation.
- At the same time, there is a lot of moisture in the air because of an increase in SST.
- So even if the monsoon circulation is weak, in certain episodes, strong winds can bring in plenty of moisture from the Arabian Sea region which then falls over land in the form of extreme rainfall.
- **Case of South Asia**- Bangladesh, India and Pakistan have battled severe floods, while, China is reeling under massive drought conditions.

What are the impacts of change in monsoon?

- **Rice production**- Due to southward movement of majors, all main monsoon low pressure areas and depressions, rice producing States have been deficit by large margins.
- Bihar, West Bengal and Uttar Pradesh, which account for a third of the country's total rice production, have been highly deficit despite an active monsoon current in July and August.
- This would straight away have an impact on food security of the country.
- **Pest and disease incidence**- The uneven distribution rains along with increasing temperatures and humidity give rise to pest attacks and diseases.
- **Plant processes**- Very high temperatures (> 35°C) induce heat stress and affect plant physiological processes, leading to spikelet sterility, non-viable pollen and reduced grain quality.
- Drought reduces plant transpiration rates and may result in leaf rolling and drying, reduction in leaf expansion rates and plant biomass, immobilisation of solutes and increased heat stress of leaves.

Recent research indicates that monsoon rainfall became less frequent but more intense in India during the latter half of the 20th century.

References

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2. https://lifestyle.livemint.com/news/big-story/dark-clouds-ahead-how-climate-change-is-changing-the-indian-monsoon-111627637725104.html

Quick facts

- **La Nina**- La Nina refers to the periodic cooling of ocean surface temperatures in the central and east-central equatorial Pacific.
    - La Nina has been found to be helpful in bringing good rainfall to India.
- **Indian Ocean Dipole**- IOD is defined by the difference in sea surface temperature between the western pole in the Arabian Sea (western Indian Ocean) and an eastern pole in the eastern Indian Ocean south of Indonesia.
    - **Positive event**- Warmer sea surface temperatures in the western Indian Ocean relative to the east bringing more rainfall to India.
    - **Negative event**- Cooler sea surface temperatures in the western Indian Ocean relative to the east bringing less rainfall to India.

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