Monsoon and its impact

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Manifest pedagogy

Monsoon as climatic phenomenon and dependency of south Asia economy on it have been asked earlier in mains. The topic has been repeated with different dimensions at mains in different years. Thorough preparation of the topic is a must both at prelims and mains.

In news

The arrival of Indian Monsoon

Placing it in the syllabus

Important geographical phenomena

Static dimensions

- Definition Monsoons
- The physical mechanism of monsoons

Current dimensions

- Factors influencing the variability of Indian monsoons
- Monsoons and climate change
- Monsoons and the Indian economy

Content

Definition of Monsoon

The term monsoon refers to the **seasonal reversal of the prevailing surface winds**, notably in the Indian Ocean, tropical Asia, Australia, and Africa.

The term also increasingly refers to regions where there is a clear alternation between winter dry and summer rainy seasons. The monsoon region is distributed globally overall tropical

continents, and in the tropical oceans in the western North Pacific, eastern North Pacific, and the southern Indian Ocean(but called in different names). Monsoon systems represent the dominant variation in the climate of the tropics with profound local, regional, and global impacts.

The planetary-scale monsoon can be considered to have these fundamental Mechanisms:

- The seasonal oscillation of solar heating with net heating in the summer hemisphere, which leads to migration of the equatorial trough and the tropical convergence zones.
- The differential heating between the land and ocean and the resulting pressure gradient

The planetary-scale monsoon can be considered to have these fundamental mechanisms:

- The curvature of the winds due to the rotation of the Earth
- Moisture processes and convection

The physical mechanism of Monsoon

The giant sea breeze:

- Heated air over the warm surface expands vertically. Surfaces of equal pressure at height slope downward towards the cooler surface, with the pressure gradient force(PGF) accelerating air from the warm zone to the cool at this height.
- As soon as this happens, there is a smaller mass of air over the warm surface and surface pressures there drop. Now a PGF acts on air near the surface to accelerate air from the cool zone to the warm.
- To maintain continuity, a full circulation develops with an ascent over the warm surface and descent over the

cool one.

The Coriolis force

- Air moving across the equator from high to low pressure is deflected by the Coriolis force.
- The Coriolis force is an apparent force, arising from the rotation of the planet, and acts to the left for motion in the Southern Hemisphere, and to the right in the Northern Hemisphere

The availability of moist convection processes

- Moist convection provides latent heating of the atmosphere, which further promotes the large scale “giant sea breeze” circulation.

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The South Asian (Indian) monsoon is strongly forced by north-south temperature gradient and enhanced heating over the Tibetan Plateau

Factors influencing the variability of Indian monsoons

Following are the factors that influence Indian Monsoon;

Tropospheric Biennial Oscillation (TBO)

- The TBO is a major mode of interannual variability of the Asian-Australian monsoon
- The tendency is for a relatively strong Indian or Australian monsoon to be followed by a relatively weak one, and vice versa.

- Asian-Australian monsoon intensity is modulated by both the TBO and ENSO.

El Niño-Southern Oscillation (ENSO)

- The dominant driver of Asian-Australian monsoon changes from year to year is El Niño warming and La Niña cooling in the equatorial Pacific Ocean.
- For example, El Niño during 2002 significantly contributed to the failed monsoon that year, thereby resulting in the largest ever decline in Asian (and worldwide) annual rice production. More recently in 2009, El Niño resulted in late onset of the monsoon and a patchy progression of the rainy season over India, while in 2010 (a La Niña year) Pakistan and China suffered severe floods.
- **The impacts of El Niño and La Niña on the monsoon are potentially predictable** because the sea surface temperature changes associated with them are slow and are themselves predictable to some extent. Even so, seasonal predictions of the Asian- Australian Monsoon remain very difficult, especially over land during the northern hemisphere summer. **It is the main factor which affects around 20% of the Indian monsoon.** Along with that, it is also a major affecting other regional monsoons in the world.

Indian Ocean Dipole

- It is sustained variations in the difference between tropical western and eastern Indian Ocean surface temperatures are referred to as the Indian Ocean Dipole or IOD.
- It is also known as the Indian Niño, is an irregular sea – surface temperature oscillation in which the western Indian Ocean alternately becomes warmer and colder than the eastern part of the ocean.
- It has positive, neutral and Negative phases, **During**

negative phase westerly winds intensify along the equator, allowing the concentration of warmer waters near Australia. This creates a temperature difference across the tropical Indian Ocean, with warmer than normal water in the east and cooler than normal water in the west. This event **obstructs the progression of monsoon over India.**

Madden Julian Oscillation

- It is an oceanic-atmospheric phenomenon which affects weather activities across the globe. It brings major fluctuation in tropical weather on weekly to monthly timescales.
- In other words, the MJO can be defined as an eastward moving ‘pulse’ of clouds, rainfall, winds, and pressure near the equator that typically recurs every 30 to 60 days. It’s a traversing phenomenon and is most prominent over the Indian and Pacific Oceans.

- The improved precipitation period of the MJO can bring the onset of the Monsoon seasons around the world. On the other hand, the suppressed convection stage can delay the beginning of the Monsoon season
- There is proof that the MJO impacts the El Nino Southern Oscillation (ENSO) cycle. It doesn’t cause El Nino or La Nina, however, it can add to the speed of advancement and force of El Nino and La Nina scenes. The MJO appears to be more active during and weak ENSO years.

Active-break cycles:

- A prominent feature of the monsoon and one which is most felt by society is its variation within a season, known colloquially as active-break cycles. These intraseasonal

variations occur with a typical period between active phases of between 20 and 50 days.
- During the active phase, copious rainfall occurs, while during the break phase little or no rainfall occurs.
- The Indian/Asian monsoon can, in fact, be viewed as a series of active-break cycles, which often originate over the equatorial Indian Ocean that spread polewards over land and eastward over the tropical ocean.

Prediction of the intraseasonal rainfall variations is of prime importance as these variations can have dramatic impacts, affecting the timing of crop planting and crop selection, and the management of water resources in the affected regions.

Indian Monsoon and Atlantic Zonal Mode (AZM)

Much like the dreaded El Nino which involves unusual warming (or cooling) of the Pacific Ocean, the Atlantic Zonal Mode – more popular as Atlantic Nino – is unusual warming (or cooling) of the Atlantic Ocean.

Atlantic Zonal Mode (AZM) and Indian summer monsoon rainfall are known to have an inverse relationship, which means that the cold (warm) phases of AZM result in strong monsoonal rainfall, while a warmer AZM phase has resulted in weaker rains.

Monsoons and the Indian economy

- The monsoon is the lifeblood for India's farm-dependent $2 trillion economy, as at least half the farmlands are rain-fed. The country gets about 70% of annual rainfall in the June-September monsoon season, making it crucial for many farmers.
- About 800 million people live in villages and depend on agriculture, which accounts for about 15% of India's gross domestic product (GDP) and a failed monsoon can have a rippling effect on the country's growth and

economy.

- Whereas, a normal to above-normal and well-distributed monsoon boost farm output and farmers’ income, thereby increasing the demand for consumer and automotive products in rural markets. A deficit monsoon could also lead to a drought-like situation, thereby affecting the rural household incomes, consumption, and economic growth. A poor monsoon not only leads to weak demand for fast-moving consumer goods, two-wheelers, tractors and rural housing sectors but also increases the imports of essential food staples and forces the government to take measures like farm loan waivers, thereby putting pressure on finances. Whereas a normal monsoon results in a good harvest, which in turn lifts rural incomes and boosts spending on consumer goods
- The hydel power generation, groundwater availability and its recharge are nearly entirely dictated by monsoon rains.