Atmospheric Rivers

Why in news?

Recently atmospheric river has put millions at risk in California.

What is an atmospheric river?

- A relatively narrow plume of moisture that forms over an ocean and can produce intense rainfall or snowfall when it reaches land.
- **Concentrated water vapour**-It produce intense rainfall or snowfall when it encounters mountains or local atmospheric dynamics.
- **River in the sky**- Atmospheric river is the weather phenomenon can produce torrential amounts of rain.
- **Occurrence-** It occur all over the world, most commonly in the mid-latitudes, they can be over 1,600 kilometres long.
- **Formation-** They form when large-scale weather patterns align to create narrow channels, or filaments, of intense moisture transport.
- These start over ***warm water***, typically tropical oceans, and are guided toward the coast by low-level jet streams ahead of cold fronts of extratropical cyclones.

- **Pineapple Express**- It is a type of atmospheric river that originates near *Hawaii* and brings warm and moist air to the US West Coast, especially California.
- **Pacific Ocean**- Along US West Coast the Pacific Ocean serves as the reservoir of moisture for the storm, and the mountain ranges act as barriers, which is why the western sides of the coastal ranges and Sierra Nevada see so much rain and snow.
- **Atmospheric River (AR) families**- It is caused by Madden-Julian Oscillation which results in consecutive atmospheric rivers that can lead to significant flooding.

What causes atmospheric river?

- **Warm tropical air masses**- In tropical regions, warm temperatures cause ocean water to evaporate and rise into the atmosphere. Strong winds then help carry this water vapour through the atmosphere.
- **Cold air masses**- When cold air masses interact with warm, moist air, they create a high concentration of moisture in the atmosphere.This moisture-laden air becomes part of the atmospheric river.
- **Orographic conditions-** They occur when air is lifted over geographic features such as mountain ranges. Atmospheric rivers often form along the boundaries between large areas of divergent surface air flow, including some frontal zones associated with extratropical cyclones** over oceans.
- These orographic features enhance water vapour transport and contribute to the

narrow bands of enhanced moisture characteristic of atmospheric rivers.

- **Precipitation-** Atmospheric river can carry an immense amount of water vapour, when this moisture-laden air encounters topographical features, it leads to significant precipitation.

On average, atmospheric rivers have about twice the regular flow of the Amazon River.

- **Climate change**- As global temperatures rise, atmospheric rivers are expected to become more intense, frequent and variable, leading to more extreme precipitation events and seasonal shifts.
- **Madden–Julian oscillation**- It is an *eastward moving* disturbance of clouds, rainfall, winds, and pressure that traverses the planet in the tropics and returns to its initial starting point in 30 to 60 days, on average.

An active MJO shift occurred during the early 2023 events, tilting the odds toward increased atmospheric river activity over California.

What are the impacts of atmospheric river?

Postive impact	Negative impact
Water supply enhancement- It serve as essential contributors to water supply in drought prone-areas like California. They bring substantial moisture replenishing reservoirs, rivers and groundwater.	**Extreme Flooding**- This can lead to extreme flooding, disrupting travel, causing mudslides, and posing a threat to life and property
Quenching wildfires- Intense rainfall reduces fire risk by saturating the landscape and providing much-needed moisture.	**Debris flows**- When atmospheric rivers combine with saturated soil, they can trigger debris flows. These fast-moving mixtures of water, mud, and debris can be highly destructive.
Snowpack accumulation- The moisture they bring falls as snow at higher elevations, which gradually melts and feeds rivers during spring and summer.	**Economic impact**- They cause an average of 1.1 billion dollars in flood damages yearly in western US.
End droughts- When an atmospheric river delivers substantial precipitation it can end prolonged droughts, these events paly crucial role in maintaining ecological balance and sustaining ecosystems.	**Disrupt normal life**- Flooded roads, power outages, and property damage impact communities

References

1. BBC- Atmospheric Rivers

2. PBS- What is atmospheric river?