MARINE HEAT WAVES - GS III MAINS

Q. In what ways do marine heat waves contribute to the increased intensity of extreme weather phenomena, and how can communities prepare for and adapt to the heightened risks associated with these events? (15 marks, 250 words)

News: *Large spread in marine heatwave assessments for Asia and the Indo-Pacific between sea-surface-temperature products*

What's in the news?

- Prolonged extremely warm ocean temperatures have great impacts on both natural ecosystems and human communities.
- Although differences in mean sea surface temperatures or their variances among datasets could not explain the abovementioned discrepancies, different sensors, procedures, and sea ice treatments in each dataset may contribute partially.

Marine Heat Waves (MHWs):

- A marine heat wave is an extreme weather event.
- A marine heatwave occurs when surface water temperatures are higher than 95 per cent (3 or 4 degree Celsius) of the values from the past 30 years for at least five consecutive days.
- MHWs can last for weeks, months or even years.

Causes of Marine Heat Waves:

1. Climate Change:

a. Greenhouse Gas Emissions:

- Increased levels of greenhouse gases, such as carbon dioxide, contribute to the greenhouse effect, trapping heat in the atmosphere and elevating sea surface temperatures.

b. Global Warming:

- The overall rise in global temperatures amplifies heat waves, affecting oceanic regions and giving rise to MHWs.

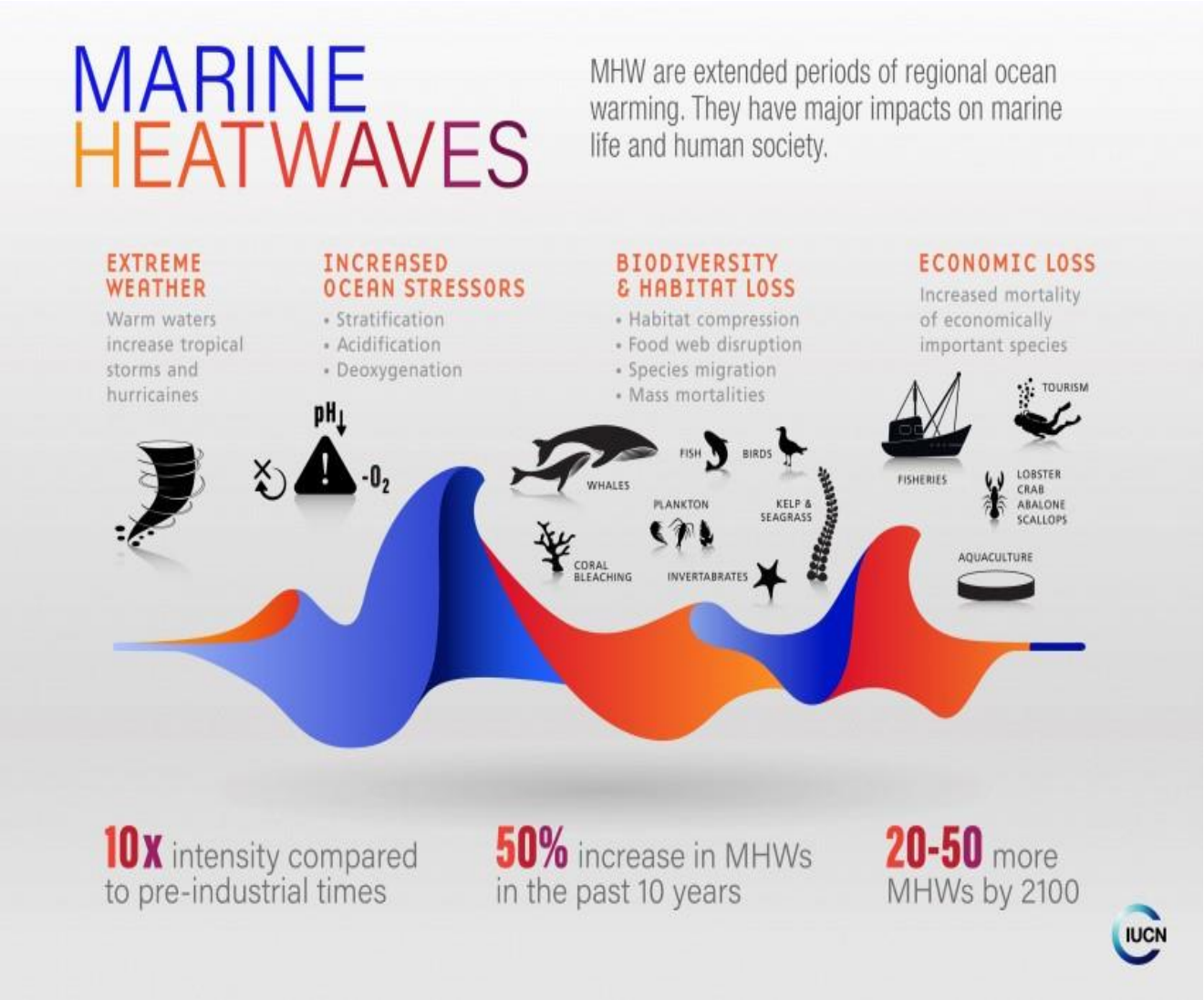
2. Atmospheric Conditions:

a. Persistent High-Pressure Systems:

- Stagnant high-pressure systems can lead to prolonged periods of calm weather, allowing the sun to intensify its heat on the ocean surface.

b. Weakening Winds:

- Reduced wind speeds impede the ocean's ability to cool down, promoting the accumulation of heat.



3. Ocean Currents and Circulation:

a. Ocean Current Anomalies:

- Changes in ocean currents, driven by natural variability or climate change, can create pockets of warmer water or impede the natural cooling process.

b. Stalled Circulation Patterns:

- Disruptions in typical ocean circulation patterns can result in the entrapment of warm water, fostering MHWs.

4. Underwater Heatwaves:

a. Underwater Geothermal Activity:

- Submarine volcanic activity and geothermal vents release heat into the ocean, creating localised warm zones.

b. Deep Ocean Processes:

- Natural processes deep within the ocean can influence temperature variations, contributing to the onset of MHWs.

5. El Niño and La Niña Events:

a. El Niño:

- The periodic warming of central and eastern Pacific waters during El Niño events can have cascading effects on global weather patterns, leading to MHWs.

b. La Niña:

- Conversely, La Niña events, characterised by cooler-than-average sea surface temperatures, can influence MHW occurrence in different ways.

6. Feedback Loops:

a. Ice-Albedo Feedback:

- Melting ice reduces the Earth's albedo, allowing more sunlight to be absorbed by the ocean, further increasing temperatures.

b. Positive Feedback Mechanisms:

- Interactions between warming ocean waters, atmospheric conditions, and other factors create self-reinforcing loops, sustaining MHWs.

Impacts of Marine Heat Waves:

1. Ecosystem Disruption:

- MHWs disrupt marine ecosystems, causing species distribution and composition shifts. Sensitive species, including corals and kelps, face bleaching and mortality.

2. Fisheries and Aquaculture:

- MHWs lead to altered fish migration patterns, affecting commercial and subsistence fisheries. Aquaculture operations face economic losses due to adverse conditions.

3. Biodiversity Loss:

- Increased stress on marine life leads to biodiversity loss, impacting overall ecosystem health. Vulnerable species face heightened extinction risks.

4. Coral Reefs:

- Coral bleaching occurs as elevated temperatures force symbiotic algae to leave coral tissues. Prolonged MHWs result in coral mortality and degradation of reef ecosystems.

5. Economic Ramifications:

- Fisheries, tourism, and coastal economies suffer as MHWs disrupt traditional livelihoods. Losses in revenue and employment opportunities exacerbate economic vulnerabilities.

6. Extreme Weather Events:

- Intensified storms and hurricanes result from warmer ocean temperatures associated with MHWs. Increased risk of destructive weather events poses threats to coastal communities.

Way Forward:

- Since the frequency, intensity, and area covered by the marine heatwaves are increasing, it is needed to enhance the ocean observational arrays to monitor these events accurately, and update our weather models to skillfully predict the challenges presented by a warming world.
- Effective responses to MHWs require action from a broad range of stakeholders: policymakers, researchers, the private sector (fisheries, aquaculture, ecotourism), conservationists, and civil society.
- Local management agencies should therefore raise awareness across all stakeholders and implement forecast systems to help achieve a coordinated response.
- National and sub-national governments should design and implement measures to protect communities and build regional ocean resilience.