Ocean Acidification

July 2, 2019
Manifest pedagogy

Ocean acidification as a topic could be asked at the mains stage. Global warming has a profound effect on functioning of oceanosphere. The process along with geographical illustrations would be highly recommended for the above topic

In news

A new study has suggested that Ocean acidification could have serious consequences for the millions of people globally whose lives depend on coastal protection, fisheries and aquaculture.

Placing it in syllabus

- Changes in critical geographical features

Static dimensions

- What is Ocean acidification
- Causes for Ocean acidification

Current dimensions

- Global warming and Ocean acidification
- Impact on marine biodiversity
- What can be done

Content

Ocean acidification refers to a **reduction in the pH of the ocean over an extended period of time, caused primarily by uptake of carbon dioxide (CO2) from the atmosphere.** For more than 200 years, or since the industrial revolution, the concentration of carbon dioxide (CO2) in the atmosphere has increased due to the burning of fossil fuels and land use change. The ocean absorbs about 30 percent of the CO2 that is released in the atmosphere, and as levels of atmospheric CO_2 increase, so do the levels in the ocean.

When CO_2 is absorbed by seawater, a series of chemical reactions occur resulting in the increased concentration of hydrogen ions. This increase causes the seawater to become more acidic and causes carbonate ions to be relatively less abundant.

Causes for ocean acidification

In the past, ocean acidification occurred naturally but over much longer periods of time.

However the Industrial Revolution of the 1800s triggered an escalation of carbon dioxide levels in the atmosphere, which has continued to climb ever since. The gas is being produced faster than nature can remove it, meaning increasing amounts are being absorbed by the ocean. Ocean acidification is now thought to occur faster than it has been in the last 20 million years.

- Main culprit is the burning of fossil fuels such as coal, oil and gas.
- Deforestation results in fewer trees to absorb the gas. Also, when plants are cut down and burnt or left to rot, the carbon that makes up their organic tissue is released as carbon dioxide.
- Some parts of the ocean are naturally acidic, such as at underwater hydrothermal vents and cold seeps. These openings occur on the sea floor and are caused by underground volcanic activity.
- Other industrial processes also contribute to atmospheric carbon dioxide levels. Eg. Cement production accounted for around 8% of the gas released globally in 2015.

- In coastal areas, logging can also displace acidic soil into waterways, gradually contributing to the lowering pH in the ocean.

Global warming's evil twin – Ocean acidification

Ninety-seven percent of the Earth's water is in the ocean. And the ocean covers more than 70 percent of the planet's surface. Ocean acidification is happening in parallel with other climate-related stressors, including ocean warming and deoxygenation. This completes the set of climate change pressures on the marine environment – **heat, acidity and oxygen loss** – often referred to as the '**deadly trio**'. The Great Barrier Reef is bleaching rapidly due to climate change and ocean acidification, with only 7 percent of the reef unaffected by the most recent mass bleaching event.

As humans burn more and more fossil fuels, the concentration of carbon dioxide in our atmosphere continues to rise, driving climate change and making both air and sea temperatures hotter and hotter. With more and more carbon dioxide in the atmosphere, oceans absorb more of it, becoming more and more acidic. This is happening at an unprecedented rate and will continue unabated if we don't stop burning fossil fuels.

Impact on marine biodiversity

As a consequence of acidification, marine life face a two-fold challenge **decreased carbonate availability and increased acidity.** Studies have suggested that changing ocean chemistry will

1) Harm life forms that rely on carbonate-based shells and skeletons,

2) Harm organisms sensitive to acidity

3) Harm organisms higher up the food chain that feed on these sensitive organisms.

Many ocean plants and animals build shells and skeletons by combining two chemicals that exist in seawater, calcium and carbonate. Increased acidity slows the growth of calcium carbonate structures, and under severe conditions, can dissolve structures faster than they form.

Organisms can often compensate when faced with increased acidity, but this comes at the expense of using energy to grow critical body parts like muscle or shell. For example, scientists have found that mussels, sea urchins, and crabs start to dissolve their protective shells to counter elevated acidity in their body fluids. So even if an organism can adjust to survive increasing acidity its overall health can be impaired.

Many marine fish and invertebrates have complex life cycles. They spend their early lives as larvae which is distinct, immature life stage of animals prior to metamorphosis into the adult life stage. Larvae are very small, which makes them especially vulnerable to increased acidity. For example Oyster larvae will not develop properly when acidity is increased, fish larvae lose their ability to smell and avoid predators. The vulnerability of larvae means that while organisms may be able to reproduce, their offspring may not reach adulthood.

Changes in species growth and reproduction, as well as structural and functional alterations in ecosystems, will threaten food security, harm fishing industries and decrease natural shoreline protection. They will also increase the risk of inundation and erosion in low-lying areas, thereby hampering climate change adaptation and disaster risk reduction efforts.

Coral reefs are considered to be the most biodiverse ecosystem on the planet. Coral bleaching occurs when the living organisms that make up coral reefs expel the colourful, photosynthetic algae that normally live inside their bodies, and provide them with food and becomes white in colour. These algae disappear when the reefs are exposed to stressful climatic conditions, such as temperatures even a few degrees higher than normal. The role of coral reefs in buffering coastal communities from storm waves and erosion, and in supporting income generation (fisheries and tourism) for local communities and commercial businesses, is jeopardised. The potential recovery of such bleaching events is hampered due to the declining calcification rates on reefs caused by ocean acidification.

What can be done?

Halting ocean acidification is practically impossible. The objective of the United Nations Framework Convention on Climate Change (UNFCCC) to achieve 'stabilisation of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system' cannot be encapsulated by a single 'one-size-fits-all' climate indicator. The current emissions targets need significant tightening if they are to tackle the issue of ocean acidification and ocean warming. Limiting the global average temperature increase to well below 2°C, (**Paris climate agreemen**t) rather than a lower level, will significantly harm the ocean life on which we all depend in some form or another.

Sustainable management, conservation and restoration of the ocean are needed. At the IUCN World Conservation Congress 2016, IUCN Members approved a resolution calling for the protection of 30% of the planet's ocean by 2030. Other initiatives such as the **Ocean Acidification international Reference User Group (OAiRUG),** composed of scientists and various stakeholders, need to be engaged as a key means of conveying scientific results. Long-term observations and relevant experiments need to be carried out to achieve the target **14.3 of Sustainable Development Goal 14,** which asks to "minimize and address the impacts of ocean acidification".