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Popular Article

Ocean acidification: The hidden danger beneath the waves

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Abstract

Ocean acidification is one of the biggest hazards to marine ecosystems. The functioning of marine ecosystems may be impacted adversely by this phenomenon, which is brought on by the ocean's surface absorbing more CO_2. It is established that reducing CO_2 emissions is the most important step that has to be taken to prevent acidification. The present article discusses about the causes and impacts of ocean acidification. In this we look at mitigation and adaptation management techniques that can be used to increase the oceans' potential to continue being positive for human health even after they begin to acidify.

Keywords: Ocean acidification, Biodiversity, Resilience, Commercial fisheries

1. INTRODUCTION

The ocean acts as a vast CO_2 reservoir and has taken up roughly 31% of the emissions of CO_2 from the anthropogenic activities. As a result, the acidity of the ocean has significantly increased (Hall, et al., 2020). The term "ocean acidification" often refers to the decrease in pH of the ocean and related alterations in chemical speciation in dissolved inorganic carbon (DIC) that arise from the absorption of carbon dioxide from the atmosphere in ocean. When the ocean absorbs carbon dioxide, the following reaction takes place:

$$CO_2\,(aq)+H_2O \rightarrow H_2CO_3 \rightarrow HCO_3 + H^+ \rightarrow CO_3^{2-} + 2H^+$$

Reactions in this relationship are dynamic. This implies that either way could happen with these reactions. Carbonic acid is produced when carbon dioxide is dissolved in seawater. As carbonic acid is unstable therefore, it will dissociate into bicarbonate and hydrogen ions and as a result, the ocean's pH falls (Cui, et al., 2021). By reducing CO_2 concentrations in the atmosphere, the ocean carbon sink contributes to mitigating climate change. However, a shift in the ocean's chemical balance due to large quantities of dissolved CO_2 also implies that it will

eventually decrease its pH (Jiang et al., 2019). The phenomenon ocean acidification is also considered the "evil twin of global warming" (Pelejero, et al., 2010).

2. MAIN CAUSES OF OCEAN ACIDIFICATION

a. **Disposal of waste in the oceans**

The pH level of ocean water is affected by waste disposal, leading to acidification in the oceans. Not only domestic and industrial waste but sewage disposal and agricultural waste disposal also contribute to ocean acidification.

b. **The growing rate of industrialization**

Different industries are operating all over the world, releasing various pollutants into the atmosphere like carbon dioxide, nitrogen oxide, sulphur dioxide and so on. Later, these gases are entering the ocean in the form of acid rain, which increases the acidity of the ocean water.

c. Fossil fuels

For ocean acidification, fossil fuel may not harm the ocean water directly but contaminates the water indirectly. A significant quantity of carbon dioxide is released into the atmosphere during the burning of fossil fuels like coal, oil, etc. Acid rain or other direct methods are two ways that this carbon dioxide enters ocean water and increases the acidity.

d. **The growing rate of deforestation**

Carbon dioxide emissions are also caused by deforestation because trees absorb carbon dioxide from the atmosphere and store it. With decrease in the number of plants, the amount of carbon dioxide that were absorbed is decreasing and ultimately the burden is shared by oceans.

e. **Poor land management**

The main cause of the ocean acidification is agricultural activity. Through soil erosion and precipitation, the chemicals found in the pesticides and fertilizers find their way into the ocean. These substances acidify the water as they dissolve in ocean water, lowering the water's quality.

3. IMPACT OF OCEAN ACIDIFICATION

a. Crustaceans

To defend themselves against predators, marine organisms such as crustaceans, pteropods, snails have calcium carbonate-based shells. For the production and maintenance of hard shells and skeletons, shell-based animals require calcium and carbonate. But when human beings add more CO_2 to the atmosphere, the water becomes more acidic, and prevents organisms from building calcium carbonate shells,

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sometimes even dissolving shells and compromising their navigating ability.

b. Fish

As ocean acidification increases, the death rate of fishes rises (Baumann, et al., 2012). The acidification phenomenon affects the sense of smell and it creates a great impact on their behaviour. The increase in CO_2 affects the sensory organs of fish due to which they fail to distinguish the odors from predators and ultimately becoming a prey to them (Munday, et al., 2010).

c. Coral Reef

Corals are facing a number of challenges, such as the bleaching of corals that can lead to the loss of habitat for organisms. As the oceans become more acidic due to increased carbon dioxide absorption, the process of coral skeletal growth is impeded. This results in thinner and weaker skeletons that are more vulnerable to damage from various stressors like pounding waves and erosion by organisms. Due to the environment changes, such as temperature and pH, an alga called zooxanthellae will leave the corals, and then as a result the coral loses its colour. Research indicates that declines in coral skeletal density will occur, especially in the Indo-Pacific region, with up to 20% reductions in coral skeleton densities by 2100. The impact of ocean acidification on coral reefs is complex and intertwined with other stressors like ocean warming, highlighting the urgent need to understand and address these multiple threats to ensure the survival of these vital ecosystems.

d. Commercial fisheries

The acidification of the oceans may affect people through various social and economic links, potentially starting with reduced harvests of commercially important species. The harvesting of shellfish, their predators and coral reef habitats, as well as the decline in fishing income, directly affecting the livelihood of human beings.

e. Human impact

There are four possible ways that ocean acidification could affect human health: (1) through changing the amount and quality of food, leading to hunger and poisoning; (2) through lowering air quality, causing respiratory problems; (3) Modification of natural areas; (4) Loss of biodiversity results in a reduced opportunity to create and access medical resources that we are obtaining from marine organisms.

f. Boosting photosynthesis

By increasing the rate of photosynthesis, carbon dioxide may induce plant growth. Under the increased carbon dioxide levels, seagrass growth is higher. Seagrass provides a valuable habitat, yet if these plants grow too large, they dilute the biodiversity of the ecosystem.

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4. MITIGATION

a. The most obvious way to limit CO_2 emissions in the atmosphere and thus in the oceans is to reduce atmospheric CO_2 concentrations, which is the main driver of acidification.

b. Managing solar radiations- Techniques for managing solar radiation or removing non-CO_2 gases from the atmosphere may alleviate symptoms of climate change. Solar radiation management could be a feasible and affordable approach to supplement CO_2 removal and emissions reductions (Billé, et al., 2013).

c. Strengthening Ecosystem Resilience to Ocean Acidification- Improving marine ecosystem resilience to ocean acidification is a growing interest. Better management of fishing and nutrient pollution can enhance this resilience. Managing herbivores and nutrient pollution is necessary for improving the ecosystem's resilience.

d. Adapting Human Activities in Anticipation of or Reaction to Ocean Acidification - Adaptation and mitigation of climate change are complementary strategies. In the case of ocean acidification, it involves adapting natural or man-made systems to mitigate damage and exploit beneficial opportunities. A wide range of actions is possible, some of which must consider the effects of previous and subsequent CO_2 emissions.

e. Reducing Acidity Using Additives -The use of powdered alkaline rocks, like calcium carbonate, has been a long-standing solution to counteract acidification. These techniques accelerate the natural process of rock weathering that supplies alkaline substances through rivers and runoff.

f. Restoring Degraded Ecosystems- The recovery of oyster reefs, buffer acidification effects, and the establishment of habitat for other species can also be supported by the return of old shells to the extraction site. This approach increases pore water calcium carbonate saturation state, thus reducing dissolution risk (Waldbusser, et al., 2011).

Conclusion

Ocean acidification is a phenomenon resulting from the absorption of carbon dioxide from the atmosphere that leads to a decrease in ocean pH. This process, involves dynamic reactions and can produce hydrogen ions and carbonic acid, causing the ocean's pH to drop. While ocean acidification helps to reduce atmospheric CO_2 concentrations, it also leads to a shift in the ocean's chemical balance. The ocean acidification phenomenon is inevitable however, various measures can be taken to reduce its rate. For mitigation of this hazard the strategies than can be adapted are: control solar radiation, limit CO_2 emissions into the atmosphere and oceans, improve ecosystem resilience to ocean acidification, control over the anthropogenic activities, and rebuild damaged ecosystems to bring the ocean acidification to the minimum level.

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