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Short Communication

Ocean Acidification, Climate and Health Hazard

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Abstract

Ocean acidification is a growing threat to marine life, ecosystems, and human health. Rising atmospheric carbon dioxide (CO2) emissions from human activities, primarily the burning of fossil fuels, are the main drivers of ocean acidification. As atmospheric CO2 levels continue to rise, the ocean's pH decreases, making it more acidic. This review examines the impacts of ocean acidification on climate and health hazards, focusing on the causes and consequences of acidification, as well as potential solutions. The review discusses how ocean acidification is affecting marine life, including shellfish, corals, and fish, and how this can lead to economic and ecological consequences. Additionally, it explores how ocean acidification is exacerbating climate change and contributing to the occurrence of extreme weather events. The review also examines the potential health hazards associated with ocean acidification, including the impact on human health through the consumption of contaminated seafood, and the impact on mental health due to the loss of natural resources. Furthermore, this review outlines potential solutions to address ocean acidification, such as reducing CO2 emissions, improving wastewater treatment, and implementing sustainable fishing practices. The review concludes that urgent action is needed to reduce greenhouse gas emissions and mitigate the impacts of ocean acidification. It highlights the need for interdisciplinary collaboration to address this issue and underscores the importance of developing sustainable solutions to preserve the health of our oceans and the well-being of human populations worldwide.

Introduction

The ocean plays a vital role in regulating the Earth's climate by absorbing Carbon Dioxide (CO_2) from the atmosphere. However, the rapid increase in atmospheric CO_2 levels resulting from human activities, primarily the burning of fossil fuels, has caused the ocean to become more acidic, a process known as ocean acidification. This is having significant impacts on marine life and ecosystems, as well as posing potential health hazards for human populations. The pH of the ocean has decreased by 0.1 units since pre-industrial times, which may not sound like a significant change, but it represents a 30% increase in acidity. This increase in acidity has far-reaching effects on marine organisms, particularly those that rely on calcium carbonate for their shells, such as corals and shellfish. The shells of these organisms' dissolve in more acidic conditions, leading to reduced growth rates and even mortality. This can have severe ecological and economic consequences, as these species are important sources of food and livelihood for many coastal communities [1] (Doney et al., 2009).

In addition to the impact on marine life, ocean acidification is also exacerbating climate change. The ocean acts as a carbon sink, absorbing around 25% of the CO_2 emissions produced by human activities. As the ocean becomes more acidic, it becomes less effective at absorbing CO_2, resulting in an increased concentration of CO_2 in the atmosphere. This contributes to the warming of the Earth's atmosphere and the occurrence of extreme weather events, such as hurricanes, floods, and droughts [2] (IPCC, 2019). The potential health hazards associated with ocean acidification are also a cause for concern. One of the main risks is the impact on human health through the consumption of contaminated seafood. As marine organisms are exposed to more acidic conditions, they absorb more heavy metals and other toxins from the water. This can lead to the accumulation of these toxins in the tissues of fish and shellfish, making them unsafe for human consumption. Additionally, the loss of natural resources due to ocean acidification can have a negative impact on mental health, particularly for communities that rely on the ocean for their livelihoods and cultural identity [3] (Cinner et al., 2018). In light of these challenges, it is clear that urgent action is needed to address ocean acidification and its associated impacts on climate and health hazards. This review examines the causes and consequences of ocean acidification, as well as potential solutions to mitigate its effects. It highlights the need for interdisciplinary collaboration and sustainable solutions to protect the health of our oceans and the well-being of human populations worldwide.

Impact on Marine Fisheries

Ocean acidification is having significant impacts on marine fisheries, which are important sources of food and livelihood for many coastal communities. As the pH of the ocean decreases, the survival and growth rates of commercially important fish species, such as salmon and tuna, are affected [4] (FAO, 2018). This can result in reduced catches and economic losses for fishermen and their communities. In addition to the direct impacts on fish, ocean acidification is also affecting the entire food web, from phytoplankton to top predators. The reduced availability of calcium carbonate, due to increased acidity, is affecting the growth and survival of shell-forming organisms, such as krill and pteropods, which are important food sources for many marine animals [5] (Berge et al., 2014). This can have cascading effects throughout the food web, ultimately impacting the abundance and distribution of fish populations. Furthermore, ocean acidification can also affect the sensory and behavioral responses of fish to their environment. Studies have shown that increased acidity can impair the olfactory and auditory systems of fish, making it harder for them to find food and avoid predators [6] (Munday et al., 2009). This can lead to reduced feeding and growth rates, as well as increased mortality. The implications of these impacts are significant. The loss of fish populations due to ocean acidification can have severe ecological and economic consequences, particularly for developing countries that rely heavily on fisheries for food security and economic growth [4] (FAO, 2018). In response to these challenges, it is essential to act to mitigate the effects of ocean acidification on marine fisheries.

Impact on Increase of Coastal Sea Levels

Ocean acidification is not the only impact of climate change on the oceans. The warming of the Earth's atmosphere also causes the melting of glaciers and ice caps, which contributes to rising sea levels. As sea levels rise, coastal communities around the world are increasingly at risk of flooding and erosion (IPCC, 2021) [7].

Rising sea levels can lead to a range of hazards and impacts on human health, including:

- Increased risk of coastal flooding, which can cause damage to homes and infrastructure, and displace communities (IPCC, 2021) [7].
- Increased erosion of coastal ecosystems, including beaches, dunes, and wetlands, which can reduce the natural protection provided against storms and flooding (Barbier et al., 2011).
- Contamination of coastal water and soil from seawater inundation, which can lead to the spread of waterborne diseases [8] (McMichael et al., 2013).
- Forced migration of coastal communities, which can lead to social and economic disruptions, and exacerbate poverty and inequality [9,10] (Adger et al., 2014).
- The effects of rising sea levels are not limited to coastal communities alone. They also have significant implications for the global economy, particularly for sectors that rely on coastal infrastructure, such as ports and tourism [11,12] (Hallegatte et al., 2013).
- To address the challenges posed by rising sea levels, it is necessary to act to reduce greenhouse gas emissions and slow the pace of climate change.

Impact on Earth's Climate System

Ocean acidification and climate change are interrelated phenomena that affect Earth's climate system in multiple ways. One of the most significant impacts of ocean acidification on Earth's climate system is its potential to accelerate climate change. As the ocean becomes more acidic, it can reduce the capacity of seawater to absorb carbon dioxide, which can result in more carbon dioxide remaining in the atmosphere and contributing to the greenhouse effect [7] (IPCC, 2021).

In addition, ocean acidification can alter marine ecosystems, leading to changes in the amount of carbon dioxide that is taken up or released by the ocean, and further impacting the global carbon cycle (Gattuso et al., 2015) [13]. Furthermore, climate change also affects the oceans in various ways. Rising temperatures lead to sea-level rise, increased storm intensity, and changes in ocean currents, which can impact marine ecosystems and their ability to absorb and store carbon dioxide [13] (Gattuso et al., 2015). Changes in ocean circulation patterns can also have impacts on global climate by affecting the distribution of heat and carbon dioxide between the atmosphere and the ocean [7] (IPCC, 2021). To mitigate the impacts of ocean acidification and climate change on Earth's climate system, it is crucial to reduce greenhouse gas emissions and implement measures to adapt to changing climate conditions.

Impact on Ocean as heat sink

Ocean acidification, climate change, and human health hazards are interconnected issues that are of great concern to scientists, policymakers, and the general public. One of the lesser-known impacts of ocean acidification and climate change is their effect on the ocean's role as a heat sink. The ocean absorbs a significant amount of the excess heat trapped by greenhouse gases in the atmosphere, which has a major impact on the planet's climate system [7] (IPCC, 2021). However, as the ocean becomes more acidic due to the absorption of carbon dioxide, its capacity to absorb heat is reduced, which can result in more heat remaining in the atmosphere and further exacerbating global warming [1] (Doney et al., 2012). The reduction in the ocean's heat-absorbing capacity also has other consequences, including increased sea surface temperatures, more frequent and severe heat waves, and changes in ocean currents that can lead to altered weather patterns [7] (IPCC, 2021). These changes in the ocean's heat dynamics can have profound impacts on marine ecosystems, including changes in the distribution and abundance of marine species, coral bleaching events, and altered nutrient cycles [1] (Doney et al., 2012). To address the impacts of ocean acidification, climate change, and their effect on the ocean's role as a heat sink, it is essential to reduce greenhouse gas emissions and promote adaptation strategies that protect marine ecosystems and human health [1] (Doney et al., 2012)

Impact on Carbon Dioxide absorption by Oceans

The ocean has been a critical sink for carbon dioxide (CO_2) for millions of years. However, human activities have significantly increased the amount of CO_2 in the atmosphere, leading to increased CO_2 absorption by the ocean and altering its chemistry, a process known as ocean acidification. The increase in ocean acidification has far-reaching impacts on the ocean's chemistry, ecology, and the health and well-being of humans. As the ocean absorbs more CO_2, the pH of the seawater decreases, making it more acidic. This process alters the chemical equilibrium of seawater, leading to a decrease in the availability of carbonate ions that marine organisms use to build shells and skeletons. This can lead to the breakdown of coral reefs, negatively impacting marine biodiversity. Moreover, ocean acidification can affect the behaviour and physiology of marine organisms, including fish, crabs, and other shellfish. This can lead to impaired growth and reproduction rates, altered predator-prey interactions, and reduced tolerance to other environmental stressors (Kroeker et al., 2013). This, in turn, can lead to significant economic losses for fishing and aquaculture industries and impact food security for millions of people worldwide [13] (Gattuso et al., 2020). Additionally, ocean acidification can alter the balance of the microbial communities that are essential for the production of oxygen and the cycling of nutrients in the ocean, potentially leading to harmful algal blooms and other toxic effects on human health [15] (Beman et al., 2012).

Impact on Health Aspects of Humans

The impacts of ocean acidification and climate change on human health are multifaceted and complex. Changes in the oceans' chemistry and ecosystems can have direct and indirect effects on human health, including:

Changes in seafood safety: As ocean chemistry changes, it can alter the growth and survival of marine organisms, which can lead to changes in the levels of toxins and contaminants in seafood. This can have significant implications for human health, as consumption of contaminated seafood can cause illnesses such as shellfish poisoning [7] (IPCC, 2021).

Increases in heat-related illnesses: As global temperatures rise, the incidence and severity of heat waves are increasing, which can lead to an increased risk of heat-related illnesses such as heat exhaustion and heat stroke [8] (McMichael et al., 2013)

Spread of waterborne diseases: Changes in ocean currents, temperatures, and chemistry can also influence the spread of waterborne diseases such as cholera and Vibrio infections [8] (McMichael et al., 2013).

Mental health impacts: Climate change and its impacts on the oceans can also have indirect impacts on human mental health, such as increased stress and anxiety related to the loss of traditional ways of life and changes in natural resources [7] (IPCC, 2021).

Impacts on vulnerable populations: Vulnerable populations such as low-income communities, indigenous peoples, and those with pre-existing health conditions are particularly at risk from the health impacts of climate change and ocean acidification [8] (McMichael et al., 2013).

Conclusion

In conclusion, ocean acidification, climate change, and related health hazards have significant impacts on marine ecosystems and human well-being. The ocean's role as a sink for carbon dioxide has led to increased absorption of CO_2, which has resulted in ocean acidification, threatening marine biodiversity, and ecosystem services. This, in turn, impacts the livelihoods of millions of people worldwide, particularly those who depend on fisheries and aquaculture for food and income. Moreover, ocean acidification can have harmful effects on human health, including through the consumption of contaminated seafood and the potential for harmful algal blooms. To mitigate these impacts, it is essential to reduce carbon emissions and promote adaptation strategies that protect marine ecosystems and the health and well-being of people worldwide. Conservation measures that could mitigate the impact of ocean acidification include reducing carbon emissions through the use of clean energy sources and sustainable development practices, protecting and restoring marine ecosystems such as coral reefs, and promoting sustainable fisheries and aquaculture practices.

Effective conservation measures require collaborative efforts between policymakers, scientists, stakeholders, and local communities. These measures should be based on a comprehensive understanding of the complex interactions between climate change, ocean acidification, and the health and well-being of people and the planet. By acting to reduce carbon emissions and protect marine ecosystems, we can mitigate the impact of ocean acidification, climate change, and related health hazards, and ensure a sustainable future for generations to come.

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