SUNTEXT REVIEWS

SunText Review of Biotechnology
ISSN: 2766-5097

Open Access
Research Article
Volume 5:1

# Addressing the Impact of Ocean Acidification on Coral Reefs and Marine Life: A Risk Assessment for SDG 14 (Life below Water)

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**Received date:** 19 November 2024; **Accepted date:** 27 November 2024; **Published date:** 05 December 2024

**Citation:** Khan NT (2024) Addressing the Impact of Ocean Acidification on Coral Reefs and Marine Life: A Risk Assessment for SDG 14 (Life below Water). SunText Rev Biotechnol. 5(1): 152.

**DOI:** https://doi.org/10.51737/2766-5097.2024.052



## Abstract

One of the main issues emerging from environmental change with significant ramifications for marine life is Ocean acidification. It alludes to the cycle by which the sea turns out to be more acidic because of expansion in the concentration of carbon dioxide in the environment. As carbon dioxide levels ascend in climate a critical part is consumed by the sea which prompts a progression of redox responses that decline the pH of ocean water. This peculiarity has broad ramifications for marine life, especially for coral reefs, which are among the most miscellaneous and monetarily significant biological ecosystems in the world. The purpose of this review is to address and assess the impact of ocean acidification on coral reefs and marine life in order to conserve and sustain marine life below water thus fulfilling Sustainable Development Goal 14 (Life below water).

**Keywords:** Acidification; SDG14; Carbon dioxide; Calcium; Coral reefs

## Introduction

Ocean acidification is a global environmental issue affecting marine life and its associated ecological systems [1]. In this cycle the ocean turns out to be more acidic due to elevated release of carbon dioxide within the atmosphere [2]. This prompts an extraordinary danger to the marine biological system on global scale [3]. The key player that prompts the acidification of ocean is the combustion of fossil fuels that releases carbon dioxide into the air. Around 30% of this Carbon dioxide is absorbed by the world's ocean resulting in carbonic acid which then separates into bicarbonate and hydrogen ions thus lowering the pH of seawater. The typical pH of ocean water has diminished about by 0.1 units that addresses a 30% increment in acidity and it is predicted to be 150% more acidic before this century's over [4,5].

## Impact of Ocean Acidification on Coral Reefs in Pakistan

Coral reefs in Pakistan explicitly those in the Middle Eastern Ocean (Arabian Sea), for example, the reefs around Karachi and the Churna are encountering the impacts of ocean acidification [6]. Coral reefs are in peril because of the ocean acidification since they need calcium carbonate for building their skeletal construct [7]. Coral polyps, the small creatures which causes coral reefs to pull out calcium and carbonate particles from ocean water to assemble their hard skeletons [8]. The diminishing in carbonate particles because of acidification implies that corals need more energy to keep up with their skeletons which in outcome prompts the decreased development rates and debilitated structures [9].

Some of the impacts are as follows:

- **Calcium Carbonate Dissolution:** Coral reefs are essentially made out of calcium carbonate, additionally they extricate calcium carbonate from the ocean water to assemble and keep up with their skeletons [10]. Acidic conditions, for example,

can prompts the decrease in calcium carbonate ions which in outcome improves the dissolution of calcium carbonate [11]. This low accessibly of carbonate particles implies that corals need to burn through high effort to create their calcium carbonate skeletons. In outrageous circumstances this can prompt the more vulnerable and more slender skeletons which are at high gamble of breakage and least powerful while supporting the coral's construction [12,13].

- **Reduced Coral Growth:** Calcium carbonate is the fundamental part in the development of corals, so the low amount and level of calcium carbonate present in ocean water implies that the corals will develop more leisurely additionally the corals will be unable to fabricate their skeletons [14]. Thus, this dials back the development of reefs and effects their capacity to recuperate from the damages. Moreover, slow development rate additionally influences the proliferation of the corals which in outcome can cause decline in the general coral populace [15, 16].
- **Impact on Coral Symbionts:** Most corals have a symbiotic mutualistic relationship with zooxanthellae, minuscule green algae that live inside the coral tissue and give them energy by the course of photosynthesis and pigments that contribute to the coral's colors [17,18]. Acidification in ocean water causes coral leaching in which the zooxanthellae remove themselves from the coral tissues [19]. This deficiency of green growth (zooxanthellae) influences the energy of coral as well as its pigmentation by making the coral to be seem white and powerless [20].
- **Disruption of Marine Food Webs:** Coral reefs contribute and upholds the extensive variety of marine life. Because of ocean acidification the coral wellbeing declines by which the whole biological system can be impacted [21]. Marine species that depend on solid coral reefs for sanctuary and food may likewise endure. Herbivorous fish that feeds on green algae will track down less food assuming coral populaces decline and predatory fish that go after herbivores can likewise be affected [22,23].
- **Altered Reef Structure:** Solid coral reefs typically build complex designs that give living space to a number of marine creatures [24]. At the point when corals dies it results in decreased habitat space. This likewise influences the species that relies on it for sanctuary, reproducing or scrounging, additionally these species might find less reasonable conditions as reefs debase [25,26].
- **Increase in Erosion:** Coral reefs act as natural barriers that provide protection to the shores from the wave activity, storm floods and disintegration [27]. Coral reefs scatter the wave energy and limit its effects on coastal areas. As coral reefs get debilitate, their capacity to safeguard shorelines decreases. This can prompt expanded waterfront disintegration, property harm, and loss of significant coastal lands [28,29].

## Effects of Ocean Acidification on Marine Life in Pakistan

In addition to corals, ocean acidification influences many marine species, especially those which incorporates calcium carbonate in their shells or skeletons like mollusks, scavengers and certain types of fish [30]. The results don't simply hurt the marine creatures, they likewise influence the whole marine environments.

A few critical impacts of ocean acidification on marine life are as per the following:

- **Calcifying Organisms:** Numerous marine life forms including corals, shellfish (like mollusks, clams, and snails) and some microscopic fish, that depends on calcium carbonate to construct their shells and skeletons are affected [31]. Acidification of ocean water lessens the accessibility of carbonate ions which are vital for calcium carbonate formation [32]. This can prompt more vulnerable shells and skeletons which makes these life forms more helpless against predation and natural pressure [33].
- **Impact on Shellfish and Mollusks:** Shellfish, including clams, mollusks and mussels, are exceptionally delicate to the progressions that happens in ocean [34]. Acidic waters diminish the accessibility of carbonate particles, disabling the capacity of these creatures to frame and keep up with their shells. This can prompt more fragile shells, expanded death rates, and diminished conceptive achievement [35]. Commercial shellfish enterprises are additionally in danger, with possible monetary ramifications for networks reliant upon these assets [36].
- **Effects on Crustaceans:** Most Crustaceans, for example, crabs and shrimp additionally depend on calcium carbonate for their exoskeletons [37]. Ocean acidification can influence their development and shedding processes which prompts the development of more slender exoskeletons and expanded weakness to predation [38,39]. Changes in shellfish populaces can have flowing impacts all through the marine food web which likewise influences the species that depend on them for food [40].
- **Marine Food Webs**: Ocean acidification can influence diversity of species and levels of marine food webs [41]. For instance, planktonic creatures like foraminifera and coccolithophores which are critical to the marine food chain, may compete to keep up with their calcium carbonate structures. This can influence the species that feed on them, including fish and bigger marine creatures [42,43].
- **Fish Behavior and Physiology** Ocean acidification can impact fish behavior and physiology. For instance, studies

have demonstrated the way that acidic conditions can influence fish tangible frameworks, fish olfaction, influencing their capacity to distinguish predators, find prey, and explore their surroundings [44]. These social changes can upset marine food networks and alter species biological interactions thus influencing their endurance and reproduction process [45].

- **Ecosystem Services**: Marine ecosystems offer many types of assistance to diverse marine species like coastal protections, food source and carbon sequestration etc [46]. Coastal territories, for example, coral reefs, mangroves and seagrass beds assumes a huge part as natural boundaries against tempests and disintegration, likewise protecting coastlines [47]. The sea gives a huge part of the world's food through fisheries and hydroponics which upholds the worldwide nourishment and economies [48]. Moreover, marine conditions sequester carbon dioxide which assumes a basic part in climate regulation [49]. The effects of ocean acidification on key species and biological systems can influences coastal communities and economies [50].
- **Interactions with Other Stressors**: Ocean acidification doesn't act in confinement yet cooperates with different stressors like elevated ocean temperatures and contamination [51]. The joined impacts of these stressors can intensify the adverse consequences on marine life by making it significantly more provoking for creatures to adjust and get by [52].

## Mitigation and Strategic Development to Overcome Ocean Acidification in Pakistan

To address the outcomes of ocean acidification it requires a complex methodology which requires both mitigation and smart strategic planning [53].

Some of the mitigation and strategic development are as follows:

- **Reducing $CO_2$ Emissions:** The prime contributors in ocean acidification is the expansion in degrees of carbon dioxide in the air [54]. Alleviating ocean acidification includes endeavors to diminish carbon dioxide emanations through alternative systems, for example**,** progressing to environmentally friendly renewable resources, further developing energy productivity and executing carbon capture and capacity innovations [55]. Environmental accords, which plans to restrict worldwide temperature rise and diminish ozone depleting substance discharges to alleviate the effects of acidification [56].
- **Marine Protected Areas:** Establishing and managing marine protected areas (MPAs) can assists with expanding the flexibility of coral reefs and marine biological systems with the impacts of ocean acidification [57]. Marine protected regions can give asylums to species and environments, support biodiversity and add to the wellbeing of biological ecosystem [58]. Compelling administration of marine safeguarded regions includes tending to extra stressors, for example, overfishing and contamination which can assist with beating the effects of ocean acidification [59].
- **Research and Monitoring:** Research and regulation assume an indispensable part while continuous exploration and observing are critical for figuring out the effects of ocean acidification and developing effective administration strategies [60]. Researchers are examining the physiological and biological reactions of marine species to acidic conditions, investigating potential transformation systems and evaluating the viability of relief measures [61]. Monitoring projects assist with following changes in ocean chemistry, coral reef wellbeing and marine biodiversity which gives significant information to decision makers [62].

**Restoration and Adaptation Efforts:** Coral reef reclamation exertion can be carried out, for example, coral planting and artificial reef creation, which can help and support the recuperation of debased reefs and improve their strength to ocean acidification [63]. Furthermore, variation methodologies, for example, particular rearing of coral species with more noteworthy resilience to acidic conditions which can add to long term and wellbeing of coral reefs [64] (Figures 1-3).

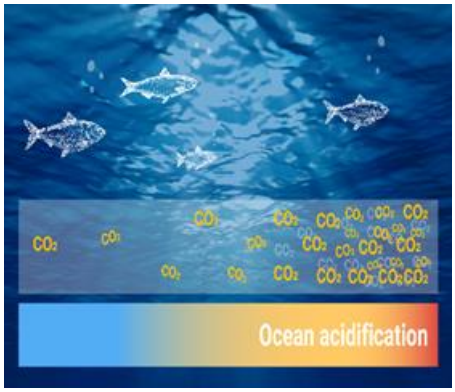


***Figure 1:*** *SDG goal 14 (Life below water) target 14.3 (Ocean Acidification).*


***Figure 2:*** *Impact of Ocean Acidification on Coral Reefs.*

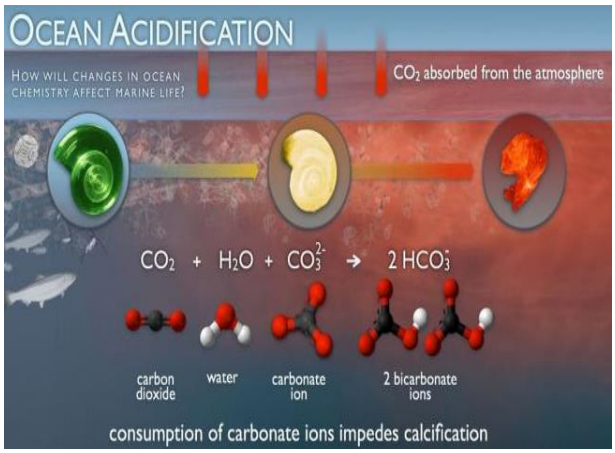


***Figure 3:*** *Impact of Ocean Acidification on Marine Life.*

## Conclusion

Ocean acidification represents an extraordinary danger to coral reefs and marine existence with extensive ramifications for environments. It influences the coral calcification, reef wellbeing, and marine species which features the dire and quick requirement for extensive activity to address this environmental challenge. Diminishing carbon dioxide discharges by executing marine safeguarded regions, supporting exploration and monitoring and pursuing restoration and adaptation efforts are essential for mitigating the effects of ocean acidification and making the surety of the resilience of marine ecosystems. By taking a proactive and collaborative approach we can work towards safeguarding the health and sustainability of our oceans for future generations.

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