OPEN ACCESS

Manuscript ID: IJEBAMPSR-2024-010207

Volume: 1

Issue: 2

Month: December

Year: 2024

E-ISSN: 3065-9140

Submitted: 30-Oct-2024

Revised: 14-Nov-2024

Accepted: 06-Dec-2024

Published: 31-Dec-2024

DOI: 10.5281/zenodo.15005150

Address for correspondence: Dr. B. Lakshmi, Associate Professor, Department of Economics, Bharath Institute of Higher Education and Research, Chennai
Email: lakshmibaluchamy@gmail.com

Impact of Climate Change on Marine Ecosystem

Dr. B. Lakshmi
Associate Professor, Department of Economics,
Bharath Institute of Higher Education and Research, Chennai

Abstract

This paper deals with impact of climate change on marine ecosystem. It outlines the marine biological process and structure, physiological, population and community response consequent upon climate change. This paper makes a special note on marine ecosystem structure and functions, impact on coral reef system and key point of climate change impact on marine ecosystem. This paper concludes with some interesting findings along with future course of issues and actions to mitigate the impact of climate change on marine eco system. Climate change is affecting marine life. Warming oceans, rising sea levels, ocean acidification, droughts, and floods the productivity of our waters. Many of the marine species we work to conserve and protect, including endangered and threatened species, are already compromised. Rising sea levels mean bridges are lower in relation to the water, which can make it difficult for cargo ships to pass through and get to ports. As a result of rising sea levels, cargo ships have to be mindful of the height of the load they're transporting. Marine ecosystems contain. A diverse array of living organisms and biotic processes from massive marine mammals like whales to the tiny krill that form the bottom of the food chain, all life in the ocean is interconnected. Rising temperatures increase the risk of irreversible loss of marine and coastal ecosystems. Today, widespread changes have been observed, including damage to coral reefs and mangroves that support ocean life, and migration of species to higher latitudes and altitudes where the water could be cooler.

Keywords: *climate change; ecosystem; fisheries; ocean acidification; coral*

Introduction

Significant ocean physical changes are documented in the most recent IPCC assessment according to Bindoff et al. (2007). Levitus et al. (2009) report that upper-ocean heat content has grown substantially since the 1950s, with mean global sea-surface temperature increasing by approximately 0.4◦C during this interval. It is evident from the work of Ishii et al. (2006) that warming is not spatially uniform owing to ocean circulation, spatially variable changes in winds, and interaction with natural modes of climate variability such as El Ni˜ no/Southern Oscillation (ENSO) and the North Atlantic Oscillation.

As per the report by Boyer et al. (2005), upper-ocean salinity is trending fresher in low-salinity regions and saltier in high-salinity regions, patterns consistent with a warmer atmosphere and sea-surface temperatures driving elevated evaporation and precipitation rates, Broad-scale warming and mid- to high-latitude freshening increase water-column vertical stratification, which in turn alters ocean currents, mixing, and ventilation.

Biological Processes and Structure

Biological processes are those processes that are necessary for an organism to live and that shape its capacities for interacting with its environment. Biological processes are made of many chemical reactions or other events that are involved in the persistence and transformation of life forms. The definition of structure in biology is the components or parts that compose a living organism and how they are organized to function. . This includes the structure of biological components at different organization levels: bio molecules, organelles, cells, tissues, organs, organ systems, and organisms

How to Cite this Article:
Lakshmi, B. (2024). Impact of Climate Change on Marine Ecosystem. International Journal of Economic, Business, Accounting, Agriculture and Management Towards Paradigm Shift in Research, 1(2), 31–34. https://doi.org/10.5281/zenodo.15005150

Physiological Responses

Physiological performance is the principal determinant of a species' tolerance to environmental variability and change. As per the report by somero (2012) climate or other conditions shift, organisms initially respond based on physiological and behavioral adaptations molded through their evolutionary history. Physiological response refers to the measurable reaction of the human body. Such as change in heart rate or skin conductance, that can be used to understand a user's experience without relying on subjective assessments.ai generated definition based on: eye tracking in user experience design, 2014. physiological responses are a set of highly integrated changes including those related to heart rate, breathing, and stress hormones. By studying differences in children's physiological response, researchers are revealing the dynamic interplay between contextual adversity, biology, and behavioral adaptation.a psychological response refers to the emotional, cognitive, and behavioral reactions that individuals experience as a result of internal or external stimuli. These responses can vary greatly depending on the situation and individual. These responses are brought about by changes in activity in the sympathetic, parasympathetic, and enteric components of the visceral motor system, which govern smooth muscle, cardiac muscle, and glands throughout the body. Biological response types of physiological measurement can include tracking eye movements, reading facial expressions, and gauging skin conductance - a measure that focuses on the microscopic sweat-level of the skin, noting a participant's level of emotional response to a particular piece of media.

Population and Community Responses

Physiological responses to climate change will manifest at the population level as shifts in abundance, timing of annually recurring events, and the spatial organization of organisms. Suboptimal conditions and poor individual performance can cause reduced abundance and population productivity as well as reduced resilience to disturbance. Well-documented biological impacts from climate change include shifts in population range and distributions, which reflect the product of several interacting processes. As per the report by Bruno et al. (2003) the dispersal capacity of species from a regional species pool determines whether they will have the opportunity to invade or inhabit a site. Then, the range of abiotic environmental conditions that are physiologically tolerable to a species defines its fundamental niche, and thus niche boundaries can change as climate changes the ocean environment. Further, biological interactions predation, competition, and others may constrain, or in some cases expand, the habitable range of conditions or the realized niche of a species. A set of species with overlapping realized niches constitutes a community, and by affecting all of these processes, climate change can alter the composition and function of marine communities. One example of changes to dispersal patterns is that many boreal species currently restricted to either the North Atlantic or North Pacific are separated because of dispersal inhibition by harsh Arctic conditions. As this Arctic barrier weakens with warming and sea-ice retreat, large-scale trans-Arctic exchange between the two oceans seems likely over the coming decades, as has occurred in the past. Reid et al. (2007) note that the diatom Neodenticula seminae, a dominant primary producer in North Pacific pelagic ecosystems, became abundant in 1999 in the Atlantic for the first time in 800,000 years following an exceptional year of ice-free water in the Canadian Arctic.

Multiple factors beyond climate change influence changes in marine community composition and trophic structure, and synergistic effects may arise among climate, exploitation, and the introduction of invasive species. A survey of four well-studied marine regions found that invasions are shifting food webs toward domination by suspension and deposit feeders low in the food chain, presumably reflecting the widespread transport of small fouling organisms and the decline of large fishes caused by human harvesting. Geller et al's. (2010) molecular genetic techniques are emerging as powerful tools for deciphering the history of species invasions caused by human transport and may be equally valuable for understanding climate-driven shifts. Evidence from the Atlantic and Pacific coasts of North America indicates that nonnative species in fouling invertebrate communities are favored over native species in warmer waters. In this way, warming may tend to homogenize the composition of marine communities.

Ecosystem Structure and Function

Ecosystems integrate the responses of organism physiologies and ecological interactions to changes in climate and CO2. As a consequence, the mechanisms that link changes in populations and communities to alterations in ecosystem-level properties such as tropic structure, food-web dynamics, energy flow, and biogeochemical cycles are diverse. Disruptions of existing biological interactions can occur through asynchronous shifts in the seasonal phonologies of interacting predator and prey populations i.e., the match-mismatch hypothesis) biogeography reorganizations, leading to changes in community composition and biodiversity; and loss of functionally prominent species.

An ecosystem is a structural and funcuntion unit of ecology where the living organisms interact with each other and the surrounding environment. In other words, an ecosystem is a chain of interactions between organisms and their environment. Ecosystem functioning reflects the collective life activities of plants, animals, and microbes and the effects these activities (e.g., feeding, growing, moving, excreting waste) have on the physical and chemical conditions of their environment.

Climate Impacts on Ecosystem Services from the Sea

Climate change puts at risk many of nature's benefits, or ecosystem services, that humans derive from the sea. These impacts will have repercussions for society's dependence on the ocean for wild-caught and farmed food, recreation, nutrient cycling, waste processing, protection from natural hazards, climate regulation, and other services. For example, climate-induced sea-level rise could put added pressure on coastal infrastructure and thus the health and safety of human communities. Natural habitats such as wetlands, mangroves, coral and oyster reefs, and sea grasses buffer coastlines from erosion and inundation, providing important protective services. One of the many advantages of nature-based protection is that those same habitats also provide other benefits, including nursery grounds for commercial and recreationally valued species, filtration of sediment and pollutants, and carbon storage and sequestration.

The social values of these services are broad and include those reflected in markets, avoided damage costs, maintenance of human health and livelihoods, and cultural and aesthetic sustenance. Understanding how human activities and a changing climate are likely to interact to affect the delivery of these ecosystem services is of the utmost importance as we make decisions now that affect the health of marine and coastal systems and their ability to sustain future generations.

Coral Reef Systems

Because one-quarter of all marine species associate with coral reefs, the ecological impacts of changing climates and chemistry on overall marine biodiversity are potentially severe and widespread. The ability of the coral animal to create massive and complex reef structures, on which the rest of the ecosystem depends, is sensitive to relatively small changes in temperature and pH. Because the effects of climate change are already apparent on coral reefs, this ecosystem is often called the canary in the coal mine for warming and acidification. Concerns about reefs are heightened by the fact that most coral reefs today are also severely impacted by multiple stressors such as overfishing, destructive fishing, pollution, sedimentation, nutrient over enrichment, and invasive species.

Donner (2009) notes that warming of as little as 1◦C causes coral bleaching, a state in which the tissues of the coral become colorless because of the loss of the zooxanthellae the symbiotic din flagellates that through their photosynthesis fuel the growth of their coral hosts. Moderate bleaching results in stress that causes reduced growth rates and reproductive output, whereas severe bleaching results in coral death. Bleaching also appears to make corals more vulnerable to disease, so that some death occurs after a time lag.

Ocean acidification makes it more difficult for corals to secrete and maintain their skeletons. Some coral species lose their skeletons altogether, and skeletal growth of recent recruits can be disrupted. Growth rates of adult corals may be reduced, or their skeletons may be less dense which would make storm damage more serious. However, as with zooxanthellae and temperature, some coral species are likely to be more resistant to the effects of low pH.

Many other reef organisms can also be negatively affected by changing temperatures and pH. A particularly worrying possibility is the reduction of cover by coralline algae, which are preferred recruitment surfaces for coral larvae but are highly sensitive to low pH because of the chemical composition of their calcareous skeletons. Ocean acidification also disrupts the sensory abilities of coral reef fishes and likely has reproductive impacts on external spawners. The impact that seemingly countless small changes in the fitness of many individual species have on the function of entire coral reef ecosystems is currently impossible to estimate, but potentially substantial.

Key Points of Climate Change Impact on Marine Ecosystem

1. Rising atmosphericCO2 is causing increasing atmosphere and ocean temperatures, which in turn drive rising sea levels, increased vertical stratification, retreating sea ice, and altered precipitation, runoff, and wind patterns. Warming and altered ocean circulation reduces subsurface oxygen concentrations, and rising atmospheric CO2 leads to ocean acidification.
2. Regional pressures on ocean ecosystems arise from runoff from intensive fertilizer use, coastal and benthic habitat degradation, fish stock overexploitation, growing aquaculture production, and invasive species. These factors interact in complex and sometimes synergistic ways such that these multiple stressors on marine ecosystems—both CO2 and non-CO2 related—must be considered in total, not as independent issues.
3. Climate and CO2 changes influence many levels of ocean biological organization and function.

Direct temperature and chemical effects alter organism physiology and behavior, leading to population-level impacts such as poleward shifts in spatial ranges as well as changes in population size, population growth rates, and seasonal variation.

4. Community-level impacts of climate change stem from altered physiology that translates to changing interactions among species such as competition, grazing, predation, and disease dynamics. Together with local climate-driven invasion and extinction, these processes result in altered community structure and diversity, including emergence of novel ecosystems.

5. No ecosystem is unaffected by the diverse effects of rising CO2 levels. The effects of climate change are particularly striking for the poles and the tropics, because of the sensitivity of polar ecosystems to sea-ice retreat and poleward species migration as well as the sensitivity of coral-algal symbiosis to minor increases in temperature. Ocean acidification may hasten the decline of tropical coral ecosystems.

Future Issues

1. To what extent will climate change be expressed through changes in the temporal variability and amplitude of key modes of natural ocean climate cycles?

2. What effects will interactions between natural climate cycles and anthropogenic climate change have on marine ecosystem structure and function?

3. How will the possible emergence of ecosystem states with no analog in the past impact our ability to forecast future dynamics of marine ecosystems?

4. How will marine ecosystems respond to the interactions between climate-dependent and climate-independent stressors?

5. How do ecosystem tipping points scale from physiological-, population-, and community-level processes? What information is critical for predicting approaching tipping points?

Conclusion

It could be seen clearly from the above discussion that marine ecosystem is vulnerable to climate change. Climate change affects the marine living organisms, coral reefs, phytoplantation, and fish species and so on. Hence, there is a need to mitigate the impact of climate change on marine ecosystem. In this context, efforts should be taken to control anthropogenic activities ton coastal environment.

Acknowledgments

Nil.

Financial support and sponsorship

Nil.

Conflicts of interest

There are no conflicts of interest.

References

1. Bindoff NL, Willebrand J, Artale V, Cazenave A, Gregory JM, et al. 2007. Observations: oceanic climate change and sea level. In Climate Change 2007: The Physical Science Basis: Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, ed. S Solomon, D Qin, M Manning, Z Chen, M Marquis, et al., pp. 385–432. Cambridge: Cambridge Univ. Press
2. Levitus S, Antonov JI, Boyer TP, Locarnini RA, Garcia HE, Mishonov AV. 2009. Global ocean heat content 1955–2008 in light of recently revealed instrumentation problems. Geophys. Res. Lett. 36:L07608
3. Ishii M, Kimoto M, Sakamoto K, Iwasaki SI. 2006. Steric sea level changes estimated from historical ocean subsurface temperature and salinity analyses. J. Oceanogr. 62:155–70
4. Boyer TP, Levitus S, Antonov JI, Locarnini RA, Garcia HE. 2005. Linear trends in salinity for the World Ocean, 1955–1998. Geophys. Res. Lett. 32:L01604
5. Stroeve J, Holland MM, Meier W, Scambos T, Serreze M. 2007. Arctic sea ice decline: faster than forecast.
6. Geophys. Res. Lett. 34:L09501. Polyakov IV,TimokhovLA, Alexeev VA,Bacon S, Dmitrenko IA, et al. 2010. Arctic oceanwarming contributes to reduced polar ice cap. J. Phys. Oceanogr. 40:2743–56
7. Holland MM, Serreze MC, Stroeve J. 2008. The sea ice mass budget of the Arctic and its future change as simulated by coupled climate models. Clim. Dyn. 34:185–200
8. Cazenave A, Lombard A, Llovel W. 2008. Present-day sea level rise: a synthesis. C. R. Geosci. 340:761–70
9. Somero G. 2012. The physiology of global change: linking patterns to mechanisms. Annu. Rev. Mar. Sci. 4:39–61
10. Bruno JF, Stachowicz JJ, Bertness MD. 2003. Inclusion of facilitation into ecological theory. Trends Ecol. Evol. 18:119–25