

Forum: Environment Commission

Issue: Ocean acidification and its impact on ecosystems

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Introduction

The acidification of the ocean is caused by the absorption of the estimated 430 billion tons of carbon dioxide. This process of high concentrated atmospheric gas dissolving in the ocean is an ongoing cycle since the beginning of the industrial revolution. Though the absorption benefits humans as it minimizes global warming by reducing the levels of greenhouse gas present in the atmosphere, the pH of the surface water of the ocean has drastically decreased. Since carbonate ions are the chemical makeup of a large number of marine organisms such as but not limited to corals, skeletons, and shells, ocean acidification could potentially have a significant impact of the fundamental biological and geochemical cycles of the ocean. The issue on the acidification of the ocean raises ecological and socio-economical impacts from marine ecosystem to fishery businesses.

In a chemical standpoint, the carbon dioxide absorbed from the atmosphere chemically reacts to the seawater creating carbonic acid, which releases a bicarbonate and hydrogen ion. The hydrogen ion from the reaction reacts with the free carbonate ions in the ocean, which creates another bicarbonate ion. As the quantity of carbon dioxide absorbed by the ocean increases, the quantity of free carbonate ions for the production of calcium carbonate decreases. Thus, this decreases the capability of corals to produce skeletons, which will decrease its capability to create habitat. This effect is prevalent in the coral ecosystem in Australia's Great Barrier Reef, which its government predicted by 2100, the pH would fall from 8.2 to a slightly alkaline 7.8.

Japan is one of the countries heavily impacted by the issue on ocean acidification, which a recent research shows a reduction in coral distribution. Since corals have fundamental roles on reef ecosystems, the decline will affect ecosystem services and geomorphological features. In addition, due to the frequent bleaching by thermal stress and increase of temperature by global warming, there is a decrease of coverage of corals especially in subtropical regions of the country.

Definition of Key Terms

Ocean Acidification

It is the chemical reaction that occurs from the absorption of carbon dioxide by seawater that decreases its pH and concentration of carbonate ions. This is due to the hydrogen ions reacting with the natural carbonate ions found in the ocean which organisms utilize in creation of skeletons.

Exclusive Economic Zone (EEZ)

An exclusive economic zone is an area that is near or beyond the boundaries of a state's territorial sea and is under the rights and jurisdiction of its coastal State. The rights, jurisdiction and duties of the coastal State can be found under the article 56, part V of the United Nations Convention of the Law of the Sea.

Ecosystem

An ecosystem is considered a unit that is an ecological community comprised of biological, physical, chemical components such as organism. The effects from the issue on ocean acidification impacts ecosystems in the ocean through the chemical reaction between the gases present in the atmosphere the carbonate ions in the ocean water.

Ecosystem Services

Ecosystem services can be categorized into four classifications; provisioning services, regulating services, habitat or supporting services, and cultural services.

Provisioning services

Provisioning services are services by ecosystems focusing on the outputs such as food, water, and other resources. Food is produced by the conditions of ecosystems which primarily are from agro-ecosystems but marine systems also provide food. Ecosystems provide raw materials for fuel such as wood and biofuels. The global hydrological cycle is a process where ecosystems play an important role in terms of regulating flow and purification. For example, vegetation and forest affects water quantity. Plants provided by ecosystems and biodiversity are used in traditional medicines in the pharmaceutical industry.

Regulating services

Regulating services are what the name implies, services that maintain quality of air and soil. Local and regional rainfall and water availability are affected by ecosystems in terms of how trees function. Ecosystems have the ability to store greenhouse gases, which is a global climate regulator. In addition, ecosystems act as buffers against natural disasters such as but not limited to floods and storms. Human and animal wastes are filtered by ecosystems such as wetlands filter where pathogens are eliminated and level of pollution is reduced. Vegetation provides a

regulating service that prevents soil erosion, which is a key factor in land degradation and desertification.

Habitat or supporting services

Habitat or supporting services includes ecosystems providing different unique habitats for different animal species, which is a key element in the species' lifecycle. Different ecosystems maintain genetic diversity in species populations.

Cultural services

Cultural services are services that provides recreation, mental and physical health and tourism services. Furthermore, ecosystems provide aesthetic appreciation and inspiration for culture and spiritual experience services.

Background Information

Since the beginning of the Industrial Revolution, ocean acidity has increased by approximately 30%; the absorption of carbon dioxide the ocean is about 26% from the atmosphere every year. The high concentration of atmospheric carbon dioxide in the ocean corrode the shells of the countless marine organism; this also threatens plankton, a base in marine food chain, and is a significant factor in the survival of larger fishes. The issue on ocean acidification may provide hostility to biodiversity, shoreline protection, food security, affection tourism, and to coral reefs. Also, the denaturing of the ocean's ability and capacity to absorb carbon dioxide is greatly worsening its impact globally.

Physiological Impacts

Physiological impacts by ocean acidification include water-breathing animals such as fishes. The long-terms effect of the excess of carbon dioxide in organism includes effects on metabolic reproduction, growth, and functions, which concerns population of different species. The long-term effects include altered nervous system functions, blood circulation, respiration, and acid-base status. Furthermore, the high temperature in the ocean reduces the vertical mixing of nutrients. Essentially, changes in pH affect succession in coastal organism communities, species abundances, and growth rates. Primary productivity through is also an effect by ocean acidification in both coastal and open ocean environment.

Economic Impacts

The issue of ocean acidification impacts the economy in two ways, the fisheries and the ecosystem services by the coral reefs. According to a UN report, the *Global Biodiversity Outlook 4* by Convention on Biological Diversity, the issue of ocean acidification will annually cost the global economy up to \$1 trillion by the year 2100. Furthermore, mollusk fisheries stand to lose \$139 billion annually worldwide. Due to ocean acidification, larger fishes are now currently under

threat that affects fish markets globally. Similarly, the base of the food chain known as pteropods are also affected by the issue which is the food source of commercially caught, sold, and eaten fishes.

Coral reefs due to the acidification of the ocean are under threat and are declining. This affects the economy due to the ecosystem services by coral reefs provides source of food, protection of coastlines from natural disasters such as storms and erosion, produces habitat for economically significant fish, provides income to local economies and tourism.

Major Countries and Organizations Involved

United Nations of Education, Scientific and Cultural Organization (UNESCO)

UNESCO was formed at 1945 to address international affairs concerning education, intercultural agreement, scientific cooperation and freedom of expression. It is regarded by the United Nations also as the “intellectual” agency. UNESCO has a sub-organization called the Intergovernmental Oceanographic Commission that focuses on capacity development, climate change, small island developing states, and gender equality. The organization has 4 sections and programmes; capacity development, ocean observations and services, ocean sciences, and tsunamis. The Ocean and Climate 2015 platform is a recent platform by the Intergovernmental Oceanographic Commission that focuses on researching for solutions relating to the effects of climate change to the ocean.

Intergovernmental Oceanographic Commission of UNESCO (IOC-UNESCO)

Intergovernmental Oceanographic Commission of UNESCO was established in 1960 for the sole purpose of marine science. Its aim is to promote cooperation and coordination of international scale to create and execute research, services to understand the nature of marine science and apply for a sustainable development. Furthermore, it has been recognized the United Nations Convention on the Law of the Sea (UNCLOS) as an international organization that serves in the field of Marine Scientific Research.

Oceana

Oceana was established by a group of foundations such as The Pew Charitable Trusts, Oak Foundation, Marisla Foundation (formerly Homerland Foundation), and the Rockefeller Brothers Fund at 2001. The formation was a result after a commissioned study in 1999 resulted to the discovery of less than 0.5 percent of all resources spent by environment nonprofit organizations in the United States was directly to ocean advocacy. To solve this, the founders created Ocean, which is now an international organization that is solely designed for the advocacy of the ocean.

Japan

Japan is one of the six of the ten largest carbon dioxide emitters that are affected by ocean acidification. According to an analysis by *Oceana*, Japan is vulnerable to the impacts of ocean acidification due to the country's high levels of fish consumption and fishery economy. Due to the corals acting as topographic basement and has significant roles and impact on the reef ecosystem, the decline of corals is impacting fishery and tourism resources. Coral distribution in Japan will potentially be reduced under the ocean acidification: however, the rate of decrease and magnitude of loss of coral ecosystems and its habitat depend on the CO₂ emission scenarios in the future. A research by the Marine Ecology Research Institute and Institute of East China Sea Research, Nagasaki University in Japan emphasizes growth, reproduction, and behavior long-term sub lethal effects.

France

According to *Oceana*, France stands as the second nation most vulnerable of ocean acidification with similar reasoning to Japan such as high level of fish consumption and also catching large percentage of fish within their exclusive economic zone. Also, a large number of its country's coral reefs is a large percentage of its exclusive economic zone. According to a speech by Mrs. Catherine Chabaud, a delegate of France for marine and coastal ecosystem, France is in charge of a large area of maritime in the world. In September 2016, France joined the International Coalition Against Ocean Acidification.

United Kingdom

From the same source, the United Kingdom is ranked as the third country most vulnerable to ocean acidification due it's large portion of its catch is within its exclusive economic zone which is extremely acidified along with its coast. Currently, the United Kingdom is combatting the issue on the acidification of the ocean through programmes such as the United Kingdom Ocean acidification Research Programme (UKOA). The UKOA is working in coalition with international partner programmes in addressing the issue, which is led by Plymouth Marine Laboratory (PML).

Australia

Australia is the fifth most vulnerable nation according to *Oceana* due to similar reasons as the top 4 and due to it's significant portion of coral reefs are under highly acidified waters. Australia's Great Barrier Reef, largest coral ecosystem in the world, is an ecosystem heavily affected by the acidification of the ocean. Though the Great Barrier Reef is currently alkaline, pH of 8.2, it is predicted that by 2100 it will fall to 7.8 according to the Australian Government Great Barrier Reef Marine Park Authority.

Timeline of Events

Date	Description of event
May 10, 2004	First International Symposium, “The Ocean in a High-CO2 World”
June 30, 2005	The Royal Society of London Report
March 23, 2005	German Advisory Council on Global Change Releases Special Report
March 1, 2007	International Climate Science Coalition is formed
March 1, 2007	Intergovernmental Panel on Climate Change’s Fourth Assessment Report on Climate Change
July 16, 2007	Presentation of “The Myth of Dangerous Human Caused Climate Change”
March 1, 2008	First International Conferences on Climate Change
October, 6, 2008	Second International Symposium, “The Ocean in a High-CO2 World”
January 31, 2009	Monaco Declaration issued by 155 recognized scientist
June 1, 2009	IAP releases a statement confirming the existence of ocean acidification as environmental concern
November 23, 2009	The think-tank The Global Warming Policy Foundation is launched
October 13, 2010	National Science Foundation Awards grants to study ocean acidification
April 11, 2012	Research published the Journal of Limnology and Oceanography

Relevant UN Treaties and Events

- Nineteenth session of the (IOC) Assembly, Paris, 2-18 July 1997: adopted resolutions. *Publ: 1997; IOC/XIX/3/ANNEX II; SC.97/CONF.216/CLD.20.*
- IOC. Assembly; 19th; Paris; 1997 Executive summary of the fourth session of the IOC Regional Committee for the Co-operative Investigation in the North and Central Western Indian Ocean (IOCINCWIO-IV) and related draft resolution. *Publ: 1997; IOCINCWIO/IV/3S.*
- IOC. Assembly; 19th; Paris; 1997 Executive summary of the second session of the IOC Regional Committee for the Central Indian Ocean (IOCINDIO-II) and related draft resolution. *Publ: 1997; (7 p. in various pagings); IOCINDIO/II/3S.*
- IOC Intergovernmental Panel on Harmful Algal Blooms (IPHAB-IV); 4th; Vigo, Spain; 1997 Executive summary of the fourth session of the IOC Intergovernmental Panel on Harmful Algal Blooms (IPHAB-IV) and related draft resolution. *Publ: 1997; IOC/IPHAB/IV/3S.*
- Joint IOC/WMO Committee for the Integrated Global Ocean Services System (IGOSS); 7th session; Paris; 1995 Draft resolution to be submitted to the next session of the IOC Executive Council *Publ: 1995; 3 p.; IOC/WMO/IGOSS.VII/INF.13.*
- UNESCO. General Conference; 39th; 2017 International Decade of Ocean Science for Sustainable Development (2021-2030) *Publ: 2017; 6 p.; 39 C/52.*
- UNESCO. General Conference; 39th; 2017 UNESCO Strategy for Action on Climate Change

- *Tsunami Exercise NEAMWave 17: a tsunami warning and communication exercise for the North-eastern Atlantic, the Mediterranean, and Connected Seas Region, 31 October-3 November 2017, volume 1: Exercise instructions IOC. Technical series; 134 Publ: 2017; IOC/2017/TS/134VOL.1 REV.*

Previous Attempts to solve the Issue

One of the recent actions plans that target the issue on the acidification of the ocean is The Monaco Ocean Acidification Action Plan. It has ten priorities of address; the first one includes shifting to emphasizing the importance of scientific research from individual species to ecosystem; second is creating long-term experimental studies; third is considering real world factors in the research; fourth targets and reduces CO₂ emission; fifth is to invest and manage plans of protecting ocean genetic diversity and fascinating ecosystem resilience; sixth is to connect ocean acidification observational development to the needs of different nations; seventh is to maintain and sustain international cooperation and coordination in supporting research, eight affects new stakeholders and identifying and developing relationships; ninth is support more research on mapping current economic impacts; and tenth is to invest internationally on education and communication regarding about the issue.

Possible Solutions

Currently, there are a lot of organizations worldwide that focuses on research regarding about the acidification of the ocean. The next course of action should be to create more programs that act and execute physical solutions. This can even include integrating action plans into our education since this issue cannot be solved in a short period of time. The accumulation of CO₂ over time has lead to international issues such as the acidification of the ocean thus it will take a considerable amount of time to solve this issue and it can start from the source. CO₂ is a major concern and not only internationally knowing how to resolve the extensive amount of CO₂ in the atmosphere but an international cooperation of shifting to a better source is imperative. An international cooperation and coordination can include more economically developed countries aiding less economically developed countries in terms of finance. Shifting to a better energy source affects factors such as unemployment and these must be taken into consideration. However, research on the issue of ocean acidification is imperative and is currently at the works and it must remain so. Another solution is to maintain, regulate, and update research, which can be executed flawlessly through international cooperation.

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