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Effects of Human Induced Climate Change on Coral Reefs

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ABSTRACT

Current research displays that human behaviours within the past 200 years have been directly impacting flora and fauna species from the effects of having excess amounts of the byproducts of fossil fuel combustion. This paper explores the effects and possible future effects of human induced climate change. For example, as in coral reefs, which are highly sensitive to change in their environment, leading to the 'bleaching' of these creatures (losing all colour). Extinction/endangering of these species is highly probable if methods are not implemented to mitigate the effects of climate change. As evolutionary adaptations take extended periods of time, they would be longer than the time for climate change to take heavy negative impacts. The loss of coral reefs would be detrimental to the aquatic ecosystem as essential food, sanctum and begetting grounds for fish and other marine organisms would cease to exist, and biodiversity would greatly suffer as a consequence essential food, sanctum for fish and other marine organisms would cease to live.

Keywords: Climate change, biodiversity, coral reefs, bleaching.

Subject: Environmental Science.

INTRODUCTION

Recent human behaviours have been seen having large impacts on the surrounding environment, to both biotic and abiotic factors. Climate change is a major topic covered in a lot of scientific research in recent news, mainly due to its large effect on the surrounding world. However, behaviours such as burning of fossil fuels and large-scale production have emitted greenhouse gases into the atmosphere, polluting the air. These then lead to further refined consequences, such as ocean acidification and damage to large ecosystems such as coral reefs. Coral reefs provide to many different species, specifically the Great Barrier Reef, which is home to approximately 9000 known species alone (National Geographic, 2022).

In 2019 scientists assessed the reef in an aircraft and observed that 60% of the reef exhibited moderate to severe bleaching (Australian Government, 2019). According to recent research, the Great Barrier Reef has lost up to 50% of its coral cover in the last three decades as climate change has accelerated the damage. This is a single reef alone, meaning that similar damage has occurred to reefs globally such as the Red Sea Coral Reef, New Caledonia Barrier Reef and the Florida Reef. This damage to coral reefs mainly due to ocean acidification by human induced climate change is leading to a large decline in biodiversity in aquatic ecosystems.

LITERATURE REVIEW

In recent years there has been an increase in speculation and surge of interest in climate change and how human behaviour has influenced the surrounding environment. The recent climate patterns displayed is a thoroughly highlighted topic in academic research, however these studies are neglecting to shed how much of this research is truly impacted by human behaviours. This paper discusses the relationship between these two factors, through an analysis of quantitative second-hand data. The first review will draw on research conducted based on climate change and what climate sciences are from sources between 2010-2022.

The USEnvironmental Protection Agencydescribes that rising global average temperatures have been linked to significant shifts in weather patterns. According to their research, severe weather events such as heat waves and major storms are

predicted to become more common or more powerful as a result of human-caused climate change. The study also discusses more common extreme weather conditions linked towards human-induced climate change (US EPA, 2016). Fawzy et al. (2020) further adds to this concept by discussing future impacts of climate change and mitigation techniques and negative emission technologies. However, due to economic reasons, these ideas are unfeasible for the foreseeable future.

Yet within a substantial amount of these topics and coverages in climate science, biodiversity is brought up a numerous number of times. Biodiversity is a critical measure of an ecosystem's health. The WWF describes biodiversity as the natural resource upon which all living organisms depend on (WWF, 2020). As well as concluding from their own research that humans are using about 25% more natural resources than what we can sustain. Additionally, European Commission (2010) further discusses the idea about protecting biodiversity and how vital it is to support life itself, and are committed to maintaining biodiversity within Europe and halting the loss of biodiversity itself. Considering that the health of ecosystems is a key indication on soil, water and air purification, biodiversity declines in large ecosystems must be maintained. Rising atmospheric carbon dioxide (CO2), mostly from the combustion of fossil fuels, lowers ocean pH and causes significant changes in seawater carbonate chemistry. Ocean acidification is extensively proven in field data, and the pace will rise over the next century unless future CO2 emissions are drastically reduced (Doney et al., 2009). Hoegh-Guldberg et al (2007) discusses that by 2050 to 2100, atmospheric carbon dioxide concentrations are anticipated to approach 500 parts per million, and global temperatures to rise by at least 2°C, levels that will greatly exceed those of the previous 420,000 years, during which most existing marine creatures originated.

In particular, large self-sustaining ecosystems are taking severe damage, such as coral reefs. Coral reefs are among the world's most diversified ecosystems. Healthy coral reefs support around 25% of the ocean's fish population. In the various small spaces made by corals, fish and other species find shelter, food, reproduce, and rear their young (NOAA, 2019). By shielding coastlines from harmful impacts of tidal currents and tropical storms, coral reefs are a vital part to aquatic ecosystems. However, human actions are now seen negatively impacting the surrounding environment. Such as ocean acidification directly impacting Australia's Great Barrier Reef. As of 2022, 60% of the 1036 reefs assessed by scientists in an aircraft exhibited moderate or severe bleaching (Australian Government, 2019). Coral reefs throughout the world are experiencing the longest bleaching episode on record (from 2014 to at least 2022). Due to the remoteness of many of the world's reefs, there is little evidence on how previous temperature conditions impacted reef composition and contemporary stress responses. Using satellite temperature data from 1985 to 2012, researchers report the first study to quantify regional differences in warming trends, thermal stress events, and temperature variability at the reef-scale (4 km) for worldwide reef sites. During the research period, 97% of over 60,000 reef images worldwide showed positive SST trends, with 60% warming considerably (Heron et al., 2016).

Climate Change

It has been identified that over the past 250 years (beginning of industrial revolution) there has been an increased use of hydrocarbons as a source of energy via their combustion. The impact of these hydrocarbons is very negative on the environment not only due to their use as a fuel in the petro chemistry industry but also in the use of many polymers and plastics seen polluting the environment. High concentrations of CO2 in the atmosphere are now linked to the combustion of fossil fuels, as it is at a damaging spike at the moment (see Figure 1), displaying that carbon emissions from human activities are leading to critical amounts of carbon in the atmosphere.

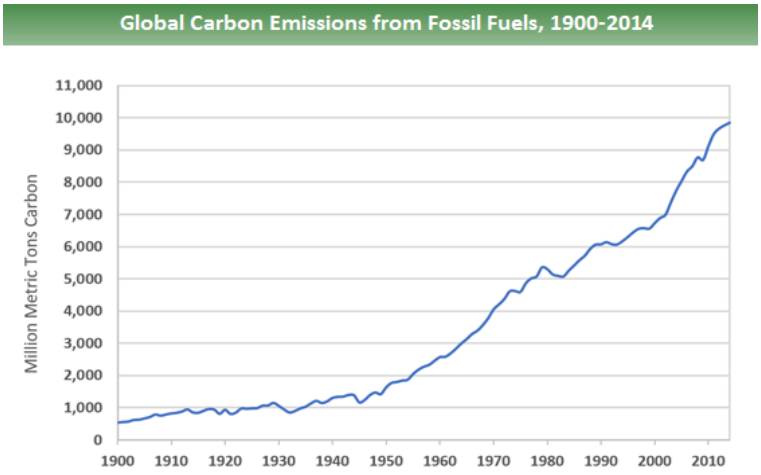

Figure 1: Graph of global carbon emissions from fossil fuels between 1900-2014. Displaying critical spiking amount of carbon emission. (United States Environmental Protection Agency, 2022)

Global warming is largely due to this mass combustion of hydrocarbons by humans for the last 200 years. Increased levels of human driven increased levels of carbon dioxide in the atmosphere leading to further carbon dioxide dissolving into the oceans. Fossil fuel use is the first-hand source of CO2. CO2 can also be released from direct human - induced effects on forestry and other land use. For example, as through deforestation, land clearing for farming, and declination of soils. Likewise, land can also remove CO2 from the atmosphere through reforestation, enhancement of soils, and other conditioning (United States Environmental Protection Agency, 2022).

Biodiversity Loss

Biodiversity is essential for a species' existence. If an environment changes and there is variety in the population, there is a potential that some of the organisms will have adapted to the change and so survive. Biodiversity is the key measure of the health of an ecosystem (WWF, 2020). Without biodiversity, i.e., if species are killed off in mass amounts, such species would become 'bottle necked' and be highly susceptible to disease and predators. Leading to the loss of key species in environments. Recent major biodiversity loss has been seen from human induced climate change, such key aspects include habitat destruction, ocean acidification and over harvesting of animals for food sources (Museum, 2010). Human-dominated marine ecosystems are now losing populations and species at an alarming rate, with predominantly unforeseen repercussions (Worm et al., 2006).

Coral Reefs

Coral reefs are a prominent example of loss of biodiversity due to human induced climate change. Rising CO2 levels in the atmosphere, primarily from the combustion of fossil fuels, reduce ocean pH and produce dramatic changes in seawater carbonate chemistry. Ocean acidification is well documented in field data, and it will accelerate over the next century unless future CO2 emissions are drastically reduced (Doney et al., 2009) (see Figure 2). Each decrease of pH is a ten-fold increase in acidity. They are also a vital supplier of nitrogen and other minerals for the marine food webs. As well as aid with carbon and nitrogen fixation and maintain equilibrium to aquatic environments (Museum, 2010).

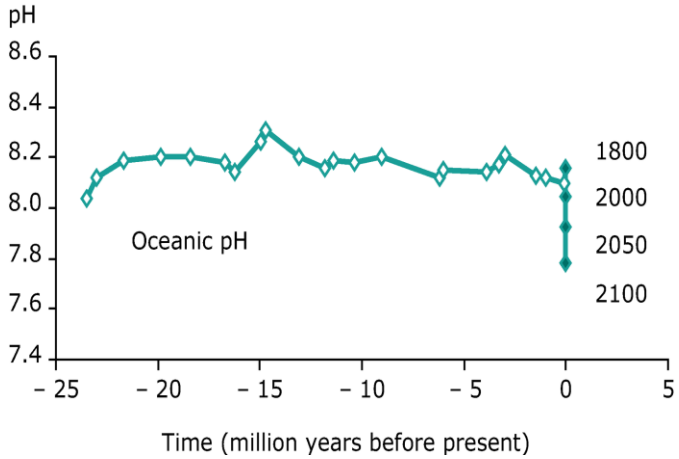

Figure 2: Graph of declining ocean pH due to high amounts of carbon dioxide in the atmosphere dissolving into the ocean, as well as expected pH in the future. **(EEA, n.d.)**

Coral reefs are very important to aquatic ecosystems; however, they are very sensitive to changes in the surrounding environment. They are mainly composed of calcium carbonate, which slowly dissolves in more acidic environments. However, once some parts of the coral die the whole organism dies - it loses all colour and becomes white in colour, which is where the term coral bleaching comes from. Coral reefs are home to an abundance of species, meaning that if these reefs die off the species living in the reefs also decrease in population.

The Great Barrier Reef, which stretches over 2,300 kilometers (1429 miles) along Australia's northeastern coast, is home to over 9,000 recognized species. There are new discoveries being made on a regular basis, such as a new species of branching coral identified in 2017 (Kleypas, n.d.).

If coral reefs perished, fish and other marine animals would lose vital food, shelter, and breeding grounds, and biodiversity would suffer significantly as a result. Marine food webs would be severely disrupted, and many profitable species would become extinct (NOAA, 2019).

CONCLUSION

In conclusion, the connection between coral reef disruption and human induced climate change is quite clearly implied. Especially when displayed the relationship between emission of fossil fuel combustions and ocean acidification through increased carbon dioxide in the atmosphere. Such that the coral is very vulnerable to change in their environment, i.e., the pH of the ocean decreases and becomes more acidic than what the corals are used to. Thus, leading to the conclusion that if this human behaviour continues then the risk of these corals becoming extinct/endangered is imminent as species like this are unable to adapt at such rapid speeds before they all die off. This change would then disrupt the whole ocean ecosystem as coral are relied on by a multitude of species for hiding, general habitats and breeding purposes, leaving this prey out of a home would then leave them vulnerable to predators or disrupt other species from their own habitats.

BIBLIOGRAPHY

[1]. US EPA 2016, *Climate Change Indicators: Weather and Climate*, US EPA. https://www.epa.gov/climate-indicators/weather-climate#:~:text=Rising%20global%20average%20temperature%20is
[2]. National Geographic. (2022, May 20). *Great Barrier Reef | National Geographic Society*. Education.nationalgeographic.org. https://education.nationalgeographic.org/resource/great-barrier-reef
[3]. Australian Government. (2019). *Coral bleaching 101 | gbrmpa*. Gbrmpa.gov.au. https://www2.gbrmpa.gov.au/learn-reef-health/coral-bleaching-101#:~:text=Of%20the%201036%20reefs%20surveyed
[4]. United States Environmental Protection Agency. (2022, February 25). *Global Greenhouse Gas Emissions Data*. US Environmental Protection Agency. https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data
[5]. United States Environmental Protection Agency 2022, Global Greenhouse Gas Emissions Data, US Environmental Protection Agency. WWF 2020, How does Biodiversity loss affect me and everyone else?, Panda.org.
[6]. Museum, c=AU; co=Queensland G ou=Queensland 2010, Biodiversity research, www.qm.qld.gov.au.
[7]. Worm, B., Barbier, E. B., Beaumont, N., Duffy, J. E., Folke, C., Halpern, B. S., Jackson, J. B. C., Lotze, H. K., Micheli, F., Palumbi, S. R., Sala, E., Selkoe, K. A., Stachowicz, J. J., & Watson, R. (2006). Impacts of Biodiversity Loss on Ocean Ecosystem Services. *Science*, *314*(5800), 787–790. https://doi.org/10.1126/science.1132294
[8]. Doney, S. C., Fabry, V. J., Feely, R. A., & Kleypas, J. A. (2009). Ocean acidification: the Other CO2 Problem. *Annual Review of Marine Science*, *1*(1), 169–192. https://doi.org/10.1146/annurev.marine.010908.163834
[9]. EEA. (n.d.). *Ocean acidity over the past 25 million years and projected to 2100 — European Environment Agency*. Www.eea.europa.eu. https://www.eea.europa.eu/data-and-maps/figures/ocean-acidity-over-the-past
[10]. Kleypas, J. (n.d.). *2. CorAl reefs And ClimAte ChAnge: susCeptiBility And ConsequenCes*. https://www.coris.noaa.gov/activities/caribbean_rpt/SCRBH2005_02.pdf
[11]. NOAA. (2019, February 1). *Coral reef ecosystems | National Oceanic and Atmospheric Administration*. Www.noaa.gov.
[12]. https://www.noaa.gov/education/resource-collections/marine-life/coral-reef-ecosystems#:~:text=Coral%20reefs%20protect%20coastlines%20from