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Human disruption on the Great Barrier Reef ecosystem since 2000

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Abstract. The Great Barrier Reef is currently experiencing severe environmental pollution and extreme climate, which put the whole local ecosystem in danger. This literature review collects 10 journals (articles) from different scholars to discuss what impact did human put on the Great Barrier Reef ecosystem, and how do the animals of Great Barrier Reef ecosystem react. Various animals in the Great Barrier Reef ecosystem are classified and separately discussed, including coral reef, its symbiotic algae, fish species, and then the author sums up the ecosystem as a whole. While summarizing and analyzing the scholars' works, the Great Barrier Reef ecosystem needs to be protected through human intervention. Combining new ways of carbon-absorbing techniques to deal with extreme climate El Nino and pesticide control will be a potential solution of the Great Barrier ecosystem crisis.

Keywords: Great Barrier Reef, human disruption, ecosystem.

1. Introduction

The Great Barrier reef is under a harsh condition, while current research has not discovered far about what the Great Barrier Reef ecosystem suffered from. Due to human disruption (chemical run-off and garbage pollution) and extreme climates, the great barrier ecosystem is experiencing a downfall. The article will be mainly focused on how different floras and faunas react to those disruptions and a big picture of the ecosystem's future. The coral reef (fauna), its symbiotic algae (flora) and fish population (animals) are classified, and the Great Barrier Reef ecosystem is considered as a whole. This article aims to arouse public concerns for Great Barrier ecosystem. It also summarizes the environmental impacts on local ecosystem from multiple aspects, which develops the field further.

2. Human pollutions and climate effects on the Great Barrier Reef ecosystem

2.1. Land Run-offs and acidification

A significant factor of the Great Barrier pollution is human disruption and the following run-off acidification that human activities caused. The watershed area of the Great Barrier ecosystem contains 35 rivers, beside extensive planting areas and ranches that are over 319,700 square kilometers. Major run-offs in those rivers in the Great Barrier ecosystem include suspended solids, nutrient, pesticides and garbage [1]. As the water monitoring system becomes more and more advanced since 2003, a clearer overview of those pollutants is pictured. The suspended solids come mainly from hillslope, gully and streambank erosion [1]. After low-growing plants are consumed by the cows of the ranches, the soil lost

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the anchorage from the plant roots and get into waterbodies. The nutrients come mostly from the cultivation sites, where fertilizers leak into rivers, causing eutrophication. The chlorophyll a and nutrient concentrations level increases, leading to the quick reproduction of phytoplankton and destruction of ecological equilibrium [2]. Pesticides also originate from cultivation sites. After the leakage of it into water, aquatic animals will suffer from poisonous chemicals, enhancing their mortality. Garbage is mostly left by tourists with various forms, such as glass, as a common type.

2.2. Extreme climate

Australia is located in the Western Pacific, which is a location vulnerable to El Nino conditions. El Nino changes the trade wind direction in the tropic Pacific, heating up the sea surface temperature of the part of Pacific Ocean near Australia. Given the data of Hadley Center Global Sea Ice and Sea Surface Temperature, scholars have proven that the excessive greenhouse gases have given rise to El Nino effects [3]. Moreover, El Nino leads to less upwelling of oxygen-rich cold water in deep ocean, meaning marine animals will have to face difficulties to survive in warmer water, which will accelerate marine animals' death.

2.3. Affected marine animal flock analysis

As the most significant flock (more than 410 hard coral reef species) in the Great Barrier ecosystem, coral reefs are exposed to the environmental crisis to the most extent. The sea acidification and garbage deposits of the Great Barrier Reef prevented the coral reef community to sustain. Coral reefs need a slightly basic PH to maintain their backbone made of carbonates (also a base) healthy. However, as more and more waste acidic gas (mainly CO2) was emitted into the atmosphere, the coral reefs will get damaged severely. Carbonic acid reacting to carbonates will make their carbonate backbone weakened in a manner similar to osteoporosis affecting human bones. Coral reefs with damaged skeletons will not survive for a long time. In addition to acidification, global warming accelerated the collapse of coral reef community by raising oceanic temperature. In addition, garbage deposits can hurt the coral reefs in several ways. Sharp garbage such as edge of broken glasses may scratch the coral reefs. Scholars also conclude that the leakage of garbage like fertilizer will lead to overgrowth of algae and block the water surface, preventing coral reefs from absorbing light [3]. Also, run-offs of toxic chemicals will directly hurt the animals around the coral reefs, disrupting the niches of the local ecosystem.

Coral reefs can only live by maintaining commensalism with algae. As they cannot move, most of their nutrition is from photosynthesis with algae. They depend on algae to give them color and the ability to photosynthesis. However, if the temperature gets too high, the symbiotic algae will be sprayed out since they cannot stand heat. With the intensification of the El Niño phenomenon, the sea surface temperature of the Australian coast where the Great Barrier Reef is located has increased.

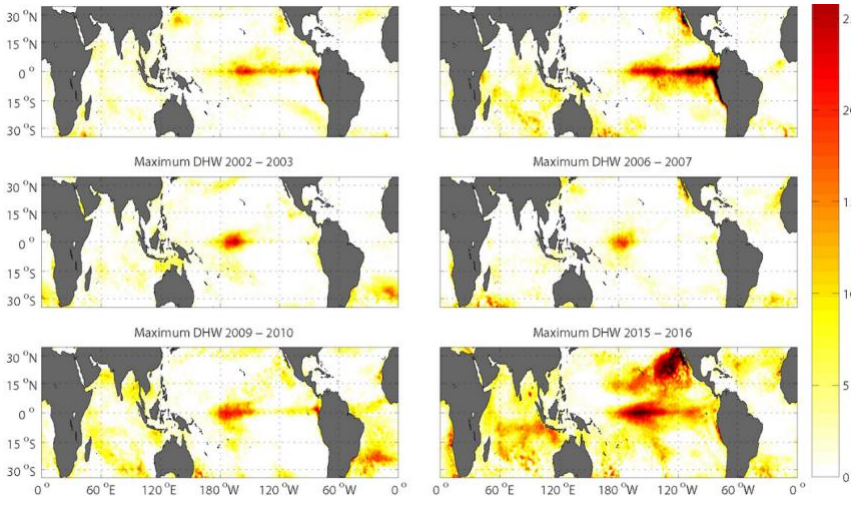

Figure 1. Heating Stress on Pacific in El Nino Years [4].

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The graph displays the maximum heat stress of tropical Pacific from the 6 previous El Nino, calculated at a 0.25° spatial resolution from AVHRR satellite data. It is shown that in 2015-2016, the temperature that rose along the Great Barrier Reef (eastern coast of Australia) is most severe. The temperature is positively combined with the bleaching rate of coral reefs. In 2002, only 18% coral reef in the global scale bleaches. By contrast, in March 2016, scientists checked 520 coral reefs along northernmost 1,000 km of the Great Barrier Reef and discovered that only 4 of them are not bleached [5]. What is more, the symbiotic algae will respond to the climate change of excessive carbon dioxide emission by pesticide production and garbage combustion. Human needs to get rid of these pollutants in ecosystems, but if not treated properly, these pollutants will remain their toxicity. The consequent carbon dioxide fertilization effect will boost up the symbiotics' productivity to produce more nutrients for coral reefs and consume atmospheric carbon dioxide more efficiently. Conversely, higher mortality rate of the symbiotic algae will be triggered as they work overload [6].

Fish is always an important fauna in any aquatic ecosystem. Not only because they are indicator species (tell if the ecosystem is qualified to sustain life by their sensitivity) of the water quality, but also because they make up the major part of the food chain, transmit the trophic in the water. The Great Barrier Reef Ecosystem owns more than 1620 fish species. Unfortunately, after 2000, the fish population in the Great Barrier Reef ecosystem suffered from water body pollution and heating processes. Overall, those fish that prefer cooler water temperature experienced a more profound population downfall, fish that feed on aquatic plants, especially. Take parrotfish as an example, they will eat algae that are not symbiotic to the coral reefs. If the water is heating, as the algae dies because of not bring capable to accept the temperature, parrotfish will die out [7]. For some fish that like warm water, the heating of fish seems to be a positive event in the short term, but it will not last too long, because the temperature rises faster than predicted. Moreover, keeping in touch with pesticides (heavy metals) for long term will cause "physiological disturbances, behavioral dysfunctions, histopathological damages, haematological alterations, biochemical changes, immune-suppression, hormone disruption, diminished intelligence, reproductive abnormalities and cancer" [8]. Skeletons and viscera of fishes will be harmed, accelerating their death. In addition, chemicals in the pesticides and garbage may give genetic mutations to the fishes. Genotoxins (which enters the DNA or RNA of fish population) include those mutants. Those mutation, cancer induced and negative impact in skeleton caused by toxins will be inherited by the next generations. Another noteworthy information for humans is that fish react to the toxins similar to higher vertebrates, indicating that human can actually suffer from those dire impacts, too.

The situation that the whole Great Barrier Reef Ecosystem (floras and faunas in 35 rivers, the grassland and the ranches) is facing represents a synthesis of the dire fact mentioned above. Those different floras and faunas interact (food chain), forming a much harder problem. For the herbivores like dugong and small fish, once the algae experiences eutrophication and carries large amount of chemicals (mainly phosphorous). For the predators, sea birds and reptiles in the system, for example, feed on fish. Unfortunately, due to the acidification and warming of the ocean caused by extreme weather (such as El Niño phenomenon), the local fish population continues to decline. Fish that prefer colder water temperature die out or migrate away, while those prefer warmer water suffer from highly concentrated chemical run-offs from ranches. Those predators have less suitable food to gain. If they choose to eat the small fish contaminated, the consequence will be miserable. According to the rule of trophic levels, the amount of energy transmitted is divided by 10 as it goes up to the top of the food chain. As the algae (producers) is contaminated, the small fish (primary consumers) have to consume 10 units of algae full of pesticides, garage particles, suspended solids, and nutrient. Accordingly, secondary consumers like sea birds and reptiles consumes 10 units of small fish, which equals to 100 units of contaminated algae [9]. Those predators in higher trophic levels take in more toxic matters, which leads to the quick collapse of food chain and local biodiversity. The Great Barrier Reef Ecosystem loses its vigor, letting death to invade it.

2.4. Future plannings

The Great Barrier Reef is currently in danger.

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		Listed threatened species	
	Number of species recorded on the GBR*	Australia's environment protection and biodiversity conservation act 1999	Global red list index (critically endangered, endangered or vulnerable)
Sponges#	2,500	0	Not assessed
Jellyfish#	100	0	Not assessed
Soft corals and sea pens#	150	0	Not assessed
Ascidians/tunicates#	720	0	Not assessed
Bryozoans#	950	0	Not assessed
Anemones#	40	0	Not assessed
Hard corals#	450	0	88
Echinoderms#	630	0	10
Crustaceans#	1,300	0	Not assessed
Molluscs#	3,000	0	2
Insects and arachnids#	25	0	Not assessed
Worms#	500	0	Not assessed
Bony fishes	1,625	1	5
Sharks and rays~	136	9	21
Breeding sea snakes	14	0	0
Marine turtles	6	6	5
Whales and dolphins	30	6	4
Dugong	1	1	1
Total	**12,177**	**23**	**136**

Notes:
The number of animal species known to occur on the GBR contrasted with the number listed on national and global threatened species lists. Adapted from the 2014 Outlook Report (*GBRMPA, 2014a*) and the 2016 IUCN Red List.
* Excludes crocodile, nesting seabirds, shorebirds, plankton and marine flora.
# Best available estimate.
~ A. Chin, 2016, unpublished data.

Figure 2. Protection of Great Barrier Reef biodiversity [10].

The graph above displays data of biodiversity in the Great Barrier Reef, how they are protected and whether they are in the global red list index in the beginning of the 21st century. A few species are in danger, while most of species are not evaluated. However, scientists now predict the biodiversity of the Great Barrier Reef will continuously to decrease. The worst prediction is that human will lose 95% of local biodiversity in the end of this century.

As ocean acidification and global warming have led to coral reef weakening and bleaching at an unprecedented rate, people have to review their environmentally unfriendly behavior and develop effective solutions to deal with the coral reef crisis. Other local organisms such as algae and fish are also chained with the fate of coral reefs. In order to solve this environmental issue timely, government should focus on proposing new carbon-absorbing manners and safer fishing styles.

Carbon pollution causes acidification in the Great Barrier Reef ecosystem. Regarding to oceanic acidification, coral reefs die out since they require basic PH to grow. Given this circumstance, an increase in phytoplankton density is required. Any artificial carbon absorption device used in the ocean will bring risks to the marine community because they may cause pollution. However, the biological method brings much less risk- as long as the phytoplankton do not cover the whole ocean surface and block the sunlight, it is effective and safe. Phytoplankton can also increase the oxygen level in the water by conducting photosynthesis, helping supporting more fish population, which is a win-win strategy.

Scraping herbivores are important in revitalizing the productivity of coral reefs in the Great Barrier Reef. Due to eutrophication, some algae will overgrow over the coral reefs, preventing the coral reef to get nutrients from their symbiotic algae. Nevertheless, scraping algae-fed fish can help revitalize those coral reefs by eating the algae up [11]. It is noticeable that common fishing methods are not environmentally friendly enough. Popular ones like trawlers, purse-seine fishing and drift net fishing can cause ocean bottom habitat destruction or bycatches. To improve so, catching a part of the fish to build aquaculture farming will help. With the meat production from farming, less frequent fishing activities will be hold, protecting both the fish population and the coral reef population.

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3. Conclusions

This articles focuses on how the Great Barrier Reef Ecosystem suffered from human disruptions and extreme climates since 2000. Because of so, the major faunas and floras are all negatively affected by them, reducing the resilience, inertia and biodiversity of the Great Barrier Ecosystem. Viewing the Great Barrier Reef Ecosystem as a whole is even worse as the pollutants and unhealthiness are transmitted in the whole food chain, accelerating the collapse of the whole ecosystem. Protecting phytoplankton and scrapping algae-eating fish by developing aquaculture farming and less frequent fishing activities will help improve the dilemma that the Great Barrier Reef is facing. Due to lack of field measurement, some data used in the article is not fully updated. What is more, the article is a summary of journals of scientists about an existing problem. Data misuses could appear in this article, which further affects the improvement advices proposed.

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