Ocean Acidification in the UAE: Causes and Potential Prevention

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Abstract

Unsustainable methods of transportation and electricity use in the UAE have contributed largely to local climate change. Consequently, oceans have suffered under extremely high temperatures, and through the absorption of greenhouse gases, caused two major oceanic problems: ocean acidification and coral bleaching. This induces destructive effects on one of the most diverse ecosystems in the world, coral reefs. As coral reefs provide many benefits to both marine and human life, their loss is detrimental to the environment. To counter the adversity of coral bleaching and ocean acidification, the bigger issue of climate change, which causes both of these phenomena, needs to be addressed. Several findings discussed in this paper reveal that by implementing sustainable alternatives, such as solar power and electric vehicles, the UAE would be able to decrease effects of climate change on ocean acidification and coral bleaching, potentially protecting coral reefs from further harm.

Keywords: ocean acidification, coral bleaching, climate change, coral reefs, United Arab Emirates

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Ocean acidification and coral bleaching are two major threats to both marine ecosystems and humans. Ocean acidification happens when excessive amounts of carbon dioxide that are present in the atmosphere get absorbed by oceans, lowering their pH levels (Branch et al., 2013, p. 1). According to the United States National Ocean and Atmospheric Administration's

(NOAA) National Ocean Service (2015), coral bleaching is the process by which corals turn completely white and are put at risk of mortality as a result of life-dependent algae leaving the site under stressed conditions such as warmer water and pollution. As oceans acidify due to increased CO_2 levels, chemical reactions in the water lead to a decrease in carbonate ions, which play a crucial role in helping coral reefs build their structures (Hoegh- Guldberg et al., 2017, p. 5).

Nowadays, one primary contributor to ocean acidification and coral bleaching is climate change. Looking at the United Arab Emirates, the state of corals and the acidity of oceans are not promising; the pH of the Arabian Sea is 6.4 as opposed to a normal pH of around 8.1, which indicates an acidic environment that negatively impacts local corals (El Khatib et al., 2012, p. 4). Due to excessive emissions from the high electricity demand for air conditioning and transportation methods that worsen climate change, oceans and corals of the UAE are being subjected to irreversible damage (Al- Badi & AlMubarak, 2019; El Khatib et al., 2012).

Due to such environmental stressors, this paper will explore ways in which we can reduce these effects of climate change to help lessen the amount of coral bleaching and ocean acidification in the UAE. In particular, I will argue that the UAE should adopt initiatives and strategies regarding the use of renewable energy, specifically highlighting the use of solar power for air conditioning and the promotion of electric vehicles as an alternative to high emission producing modes of transportation. This would not only reduce harmful emissions, but also help protect the local UAE culture, which is heavily reliant on fish and advocates for the safety of coral reefs.

The Threats of Climate Change to Coral Reefs in the UAE

Coral reefs are marine ecosystems comprised of massive structures held together by a molecule called calcium carbonate. They are considered some of the most important biologically diverse natural habitats of the planet since they provide shelter and food for many species of fish and other marine organisms such as oysters, crabs, and clams (Burt et al., 2019, p. 1). They are often described as “rainforests of the sea”; and although they are only present in around 1% of most oceans, they provide both shelter and food to nearly 25% of all ocean species, including ones that humans eat (NOAA Fisheries, 2022).

According to Ben-Romdhane et al. (2020), the UAE is host to relatively large coral reef areas of around 1,190 km^2 in size, most of which are located in Abu Dhabi waters (p. 2). This makes the UAE have the 38th largest reef size in the world, with over 34 different species of coral extending from the coasts of Abu Dhabi all the way up to Ras Al Khaimah (DiLeo, 2021). Coral reefs in the UAE affect the local culture through several benefits, such as: providing revenues to fishermen and fisheries, acting as tourist attractions for visitors, and protecting shorelines from coastal erosion and storms (Ibrahim, 2015). Furthermore, Ibrahim (2015) notes that coral reefs in the UAE also have a historical value as they were traditionally used in the construction of old houses in Dubai, based on the belief that they would help keep the houses cool in the hot environment. Unfortunately, however, over 90% of local coral reefs have been lost due to severe coral bleaching events caused by extreme water temperatures, both in the late 1990s and in 2017 (Tarmey, 2021). These events resulted in the bleaching of almost 95% of UAE corals, and the death of approximately 73% of them (Burt et al., 2019, p. 11). With the current rate of climate change, local coral reefs are subject to even more harm and distress; therefore, expeditious action needs to be taken to oppose this damage.

The State of Ocean Acidification and Coral Bleaching

The current state of ocean pH in the UAE is detrimental to both marine and human life. The pH of coastal waters near the region of Jebel Ali in Dubai was measured within the last decade through direct testing of water quality, and it was found to be around 6.4, much lower than a regular pH of about 8 (ElKhatib et al., 2012, p. 4). This acidification of oceans was found to impair sensory and brain functions of fish, affecting things such as hearing, olfaction, and sight. Furthermore, the damage caused to their sensory and brain functions made some fish unable to control their predatory instincts, with some bigger fish incapable of finding their prey and some smaller fish involuntarily attracted to their predators (Branch et al., 2013, p. 3). Not only are coral reefs in the UAE dying due to ocean acidity, but corals in regions such as Dubai are suffering from irreversible damage due to human activities like pollution (Branch et al., 2013; ElKhatib et al., 2012). In addition, coral reefs in the Southern Persian/ Arabian Gulf are also at risk of permanent damage due to a recent 2017 bleaching event triggered by exceedingly high thermal limits in the country (Burt et al., 2019, p. 17).

Causes of Coral Bleaching and Ocean Acidification

There are many factors that contribute to coral bleaching and ocean acidification, but the main one that affects both is climate change. More specifically, the increase in temperature in the atmosphere alongside the increase of carbon dioxide and other greenhouse gasses in the air, such as nitrous oxide and hydrocarbons, negatively affect oceans and cause ocean acidification and coral bleaching (Veron, 2011, p. 2). Ocean acidification happens when the pH of ocean water lowers as a result of increasing atmospheric carbon dioxide that is absorbed by them; CO_2 molecules react with H_2O molecules to form carbonic acid, which breaks down and forms hydrogen ions that decrease seawater pH (Branch et al., 2013, p. 1). In turn, coral bleaching occurs as a result of ocean acidification; it happens when chemical reactions of the carbonate ion occur, hindering the ability of coral reefs to build their structure and survive (Hoegh-Guldberg et al., 2017, p. 5). Moreover, coral bleaching happens as a result of increasing carbon dioxide that gets trapped in the atmosphere and causes an increase in the global temperatures. These rising temperatures lead to coral bleaching due to the fact that, when oceans get too warm, corals expel the algae living in their tissues, which causes them to turn completely white (Dalton et al., 2020, p. 2). Ultimately, the causes of both ocean acidification and coral bleaching converge to the primary cause which is climate change that occurs as a result of anthropogenic activities.

Climate Change

Although this paper primarily discusses ocean acidification and coral bleaching in local water bodies around the UAE, it is important to note that climate change is a global issue. Accordingly, the overall increase in temperature all around the world, stemming from multiple countries at once, would inevitably affect oceans locally in the UAE. According to Law (2019), although climate change is an inescapable phenomenon in all countries, it is expected to impact certain countries more than others. Law shows that, due to its geographical location, one of these countries is the UAE, which faces climate change threats from neighboring and distant countries as well as from emissions within the UAE itself (Law, 2019). Nonetheless, the UAE does play a significant role in the contribution to climate change, which affects local

temperatures, and hence local oceans, considerably. For instance, Tiseo (2021) states that the UAE produced 203 million metric tons of carbon dioxide emissions, or approximately 15 metric tons per person, in 2020 alone, a year when the world was predominantly in COVID-19 lockdown. Comparatively, the United States, which has one of the highest carbon footprints globally, emitted 5,130 million metric tons of carbon dioxide in 2019, according to the U.S. Geological Survey (n.d.). Despite the fact that the UAE produced seemingly much lower emissions compared to the US, it should also be noted that the UAE is about 4.8 times smaller than the state of California alone (MyLifeElsewhere, n.d.). This comparison depicts that, although it produces lower emissions overall, the UAE still emits a significantly large amount of CO2 relative to its size, leading to an overall increase in climate change within the country itself. This demonstrates that, despite facing threats from other countries, the UAE should identify ways to mitigate local climate change threats as they have an immediate impact on local waters.

Causes of Climate Change in the UAE

One of the primary sources of carbon emissions in the UAE, and hence ocean acidification and coral bleaching, is road transportation. According to Saleh (2022), road transportation vehicles in the UAE emitted 40.7 million tons of carbon dioxide in 2017. Furthermore, a report published by the Environment Agency of Abu Dhabi in 2017 revealed that road vehicles accounted for approximately 97% of total greenhouse gas emissions of the transportation sector as a whole (as cited in Alzard, 2020, p. 2). Especially in recent times in the UAE, delivery services have increased, leading to a great dependence on fuel motorcycles and vastly increasing their use (The Sustainabilist, 2020). This reliance on petrol motorcycles leads to an accumulation of excessive greenhouse gasses in the atmosphere, such as hydrocarbons and nitrous oxide (Chen et al., 2003, p. 1). In contrast to these highly emissive petrol road vehicles, electric vehicles were found to produce less emissions than fuel-powered ones in 53/59 countries around the world (Knobloch et al., 2020, p. 5). Therefore, action needs to be taken in terms of the type of vehicles used, with more dependence leaning towards electric vehicles. By doing so, the amount of greenhouse gasses that contribute to ocean acidification and coral bleaching would decrease, lessening the damage being done to oceans.

Another major contributing factor to climate change in the UAE is the amount of electricity consumed, mainly to power the air conditioning systems in the country. According to Al-Badi and AlMubarak (2019), electricity consumption in GCC countries is one of the highest in the entire world, mainly because of inefficient cooling systems (p. 2). Furthermore, this inefficiency has caused the region's generated electricity to increase ten-fold between 1990 and 2015 (p. 3). With the United Arab Emirates' harsh climate, the energy demanded to power air conditioning systems is tremendously increased, with air conditioners accounting for 70% of annual electricity consumption in the country (Al-Badi & AlMubarak, 2019, p. 4).

As an alternative to electricity used for air conditioners, a solar energy cooling system was tested in an office-warehouse complex in Dubai, and was found to cut its total electricity consumption by 60% (Todorova, 2011). Therefore, since such renewable energy alternatives are an effective way to reduce electricity consumption, they should be considered as an alternative for more efficient use of energy in the country as a whole. Ultimately, this would reduce emissions from electricity and, ideally, lower the negative effects of it on ocean acidification and coral bleaching.

Possibilities to Mitigate Further Coral Reef Degradation

There are multiple solutions to help reduce climate change in the UAE, such as using renewable solar energy and switching to electric vehicles as a form of transportation instead of fuel-powered vehicles. Currently, the UAE has strategies and policies set to do this, such as their Net Zero by 2050 strategic initiative, which aims to reduce greenhouse gas emissions to levels in line with the COP21, or the Paris Agreement, that is, to levels that will keep the global temperature from increasing beyond 1.5°C (Emirates News Agency, 2021).

Moving in line with that initiative, the UAE has also approved plans to lower carbon emissions by 30% before the end of 2030 (Kamel, 2022). Though ambitious and optimistic, the Climate Action Tracker (2021) rated their plans and policies as "highly insufficient", stating that their policies require significant modifications in order to meet the temperature limit of 1.5°C (para. 1). Furthermore, they argue that this insufficiency is mainly due to the country's excessive need for electricity, and their continued dependence on fossil fuel-based energy (para. 3). In addition, they argue that if the current approaches are not improved, temperature rises would exceed not only 1.5°C target but 4°C (Climate Action Tracker, 2021, para. 5).

Following are some alternative, long-term shifts that could be taken to aid in meeting goals the UAE is already trying to achieve.

Long-term Renewable Energy Use

As previously mentioned, energy consumption in the UAE (and the GCC in general) is reported to be mainly due to the high electricity demand to power air conditioning systems (Al-Badi & AlMubarak, 2019). This high demand for efficient cooling systems stems from the effects of harsh temperatures within the GCC region, which are currently being aggravated as a result of climate change. Therefore, an alternative form of sustainable energy, such as the use of solar-powered air conditioners, is needed. One big problem with air conditioning, other than the fact that it releases carbon dioxide when energy is burned to power it, is that it also releases chlorofluorocarbon, which is a hydrocarbon that adds to global warming (Rahman et al., 2019, p. 1). Due to this, a sustainable performance enhancer for solar-powered air conditioners was developed and tested by Rahman et al. (2019); results showed that the workload of the compressor was reduced and the efficiency of cooling was improved (p. 6). Therefore, the implementation of this more renewable alternative, in addition to the performance enhancer, would help in reducing overall climate change effects on oceans, lowering the amount of ocean acidification and coral bleaching.

Another solution could be to build more solar power plants instead of nuclear ones in the UAE. Currently, the UAE is in the process of building the world's largest solar power plant in Abu Dhabi, and it is expected to be completed by the end of 2022 (UAE's Government Portal, n.d.). The government claims that this plant will provide electricity to 160,000 homes around Abu Dhabi, among other benefits. Since the UAE receives abundant amounts of sunlight almost all year round, this plant could be an effective solution to the excessive electricity use that the country faces, and the government should consider building more of them in other regions in the country. Although the process may be lengthy and expensive, the benefits received from lower emissions, as well as less climate change overall, would ultimately outweigh the costs by serving as a long-term solution.

Switching to Sustainable Transportation Methods

This next solution aims to combat the negative environmental effects that transportation has on the climate and oceans. Not only do transportation vehicles release carbon dioxide, but they also release other greenhouse gasses such as methane, nitrous oxide, and hydrocarbons (Fan et al., 2018, p. 1). These emissions contribute to global warming and cause oceans to get warmer, leading to coral bleaching and ocean acidification. Therefore, a more sustainable substitute could be used instead of fuel-powered vehicles and motorcycles, such as electric cars and motorbikes. Although electric vehicles would still require electricity to run, a study by Knobloch et al. (2020) revealed that the emissions produced from using this electricity would still be lower than those released by petrol cars, making electric vehicles a plausible alternative in the long run (p. 2). Furthermore, as mentioned earlier, the UAE is already building a solar power plant which could be considered as a solution to the electricity problem in this case as well, making the shift to electric vehicles even more reasonable. Ultimately, the use of electric cars as an alternative mode of transportation would reduce climate change through lower emissions, and eventually decrease the amount of ocean acidification and coral bleaching.

The Urgency for Change

With the current state of oceans in terms of ocean acidity and coral bleaching, if no action is taken towards reducing the damage being done, things are only projected to get worse. However, if solutions such as the ones discussed above were implemented, it would benefit oceans through less ocean acidification and reduced coral bleaching due to lower effects of climate change.

Why Should We Care?

With the present rate at which climate change in the UAE is increasing, temperatures of oceans are expected to increase further, causing more ocean acidification and coral bleaching. This would not only be detrimental to marine life, but also to people in the UAE. The eradication of corals would mean that over 1 million marine species would lose their habitats, leading to a substantial decrease in their chances of survival. Eventually, these millions of species that numerous humans eat, such as different types of fish, clams, crabs, oysters, shrimp, and many more, would disappear (The Reef-World Foundation, 2021). This would not only cause a massive disruption in the marine food-chain, but would also lead to the loss of a vital source of protein for many humans, especially with the recent rise in seafood demand due to population growth in the UAE (FishingUAE, 2020). Furthermore, the UAE culture would also suffer immensely as many fishermen would lose their jobs, leading to a decline in the fishing industry, which is a very important traditional industry in the local culture (FishingUAE, 2020). In addition, tourism economies in the country would deteriorate as a result of dying corals since many visitors of the UAE come to enjoy snorkeling and scuba diving activities at coral reefs sites around Dubai, Abu Dhabi, and Ras al Khaimah (Ibrahim, 2015). Furthermore, coastal areas in the UAE, such as the Palm Islands in Dubai, would be put at risk of erosion, floods, and storms without the protection of coral reefs that act as a barrier from these natural disasters (Carilli, 2013).

What Would Happen if Solutions are Implemented?

By shifting the current highly emissive road transportation vehicles to electric ones, the emissions produced by the transportation sector as a result of petrol vehicles would be considerably reduced. Moreover, by switching to more renewable sources through the use of solar energy, emissions caused by the over-exploitation of electricity to power current air conditioning systems could be reduced. If the UAE proves that the solar power plant that is currently being built can be a promising alternative to non-renewable electricity sources, the excessive burning of fossil fuels in the country can be significantly decreased. In addition, this solar energy could also eventually be implemented to account for the electricity used to power electric vehicles, which would lead to overall environmental benefits in the long run. These solutions would ultimately lower the effects that climate change has on oceans and corals including lower ocean acidification due to the decreased absorption of greenhouse gasses by oceans and less coral bleaching as a result of both cooler water temperatures and reduced ocean acidity. Consequently, fish would not be endangered by the low pH of oceans and corals would have a higher chance of natural regeneration, strengthening their probability of survival and growth.

The UAE would then benefit from these solutions by eliminating the risk of job loss of fishermen and hence preserving the traditionally valuable fishing industry in the country. Furthermore, these industries would be able to meet people's rising demands of seafood, since 25% of marine species living in coral reefs, many of which humans eat, would not be exposed to the possibility of extinction. In addition to that, as a result of the protection of coral reefs, the tourism economies in the country would not face threats of decline. Finally, coastal areas, many of which are popular attractions of the country, would remain safeguarded by coral reefs from numerous natural disasters, such as storms and floods.

Since the Climate Action Tracker (2021) rated the UAE's current strategies as inadequate, the previously mentioned solutions should be considered. If sustainable long-term solutions are not implemented to counter the negative effects of climate change on oceans, then both marine ecosystems and human life would be further impacted in an adverse manner. Fossil fuels would continue to be burned in order to generate enough electricity to power inefficient cooling systems, and the transportation sector would continue to increase emissions at the hand of petrol road vehicles. As a result of that, more carbon dioxide and other greenhouse gasses such as methane, nitrous oxide, and hydrocarbons would be emitted into the atmosphere, and then absorbed by oceans. Consequently, coral bleaching would continue to occur, leading to loss of coral habitats (Hoegh-Guldberg et al., 2017). Furthermore, the absorption of carbon dioxide by oceans would lead to lower ocean pH, which would put fish at risk of sensory and brain malfunctions as well as possible extinction when matters get worse. This would then disrupt the marine ecosystem by causing a dent in the food-chain; as smaller reef species die due to habitat loss, bigger species that depend on those reef fish as their source of food would also suffer and eventually die of starvation. In addition to that, several industries in the UAE would also bear the consequences, such as fishing and tourism, both of which, as mentioned earlier, are economically and traditionally important to the local culture. Overall, the negative effects of climate change on oceans would harm both marine and human life if not acted upon.

Suggestions to Improve Current Strategies in the UAE

More sustainable measures must be taken within the UAE in order to effectively reduce the damage being done to oceans and to limit the amount of ocean acidification and coral bleaching occurring. Since it could be difficult to actually see changes happening when it comes to anthropogenic activities, making individuals and companies less likely to make changes of their own accounts, aggressive governmental interference is needed. It could be beneficial, for instance, if the government launched an initiative to make delivery companies in the UAE transition from emission-intensive delivery motorcycles and vehicles to more sustainable electric cars or motorcycles. Furthermore, financial incentives could be given by the government to encourage logistics chains to work towards more sustainable transportation services through the use of electric vehicles instead. As the UAE is already implementing a strategy to increase renewable energy use through the construction of a solar power plant, it could be beneficial to expand this action and build more solar power plants in multiple cities in the country. This would decrease the overall energy and electricity demanded for both air conditioning systems and electric vehicles. Ultimately, less climate change would occur by doing so, and, since it is the main factor contributing to both coral bleaching and ocean acidification, the damage currently being done to oceans around the UAE would lessen, benefiting marine life and protecting the local UAE culture.

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