

Restoration of Coral Reefs to Desist Climate Change

What is ignorance? Is it uneducated people not knowing the facts? Or educated people who decide to ignore facts? This is a question that has led me to this research. One day, in biology class we watched a documentary about corals, this documentary explored the fundamental role of corals in the environment. It is surprising how we know more about space and less than 5% about our oceans, oceans that are on the same planet as us and cover three-quarters of it. We think we know everything about our planet, but we only know superficial things, that birds fly, that humans are mammals, and that flowers give oxygen. That the Amazon rainforest is the lungs of the Earth. But is it true? I thought so, but the documentary says otherwise. The coral reefs that are found in the unknown oceans are the true lungs of the Earth. We've been making a mistaken diagnosis, as we concentrate on trees and their ability to save our planet, we've been leaving behind the oceans and underestimating its power, diagnosing defects in the heart of the earth instead of its lungs, but today, that changes. Coral and coral reefs are the solution to cease climate change. Through time, there has been a significant increase in global temperature. Greenhouse gasses and their effect on the planet have been essential to create a suitable space for humans and other living organisms. The greenhouse effect is a natural process that occurs when gasses like carbon dioxide are released into the atmosphere, some of it will reflect into Earth and generate heat... Unfortunately, humans have become an excessive producer of greenhouse gasses, like CO₂ or methane, generating more heat than needed. This is known as global warming. The continuous growth in temperature. (*Environmental Change Institute at the University of Oxford, 2020*).

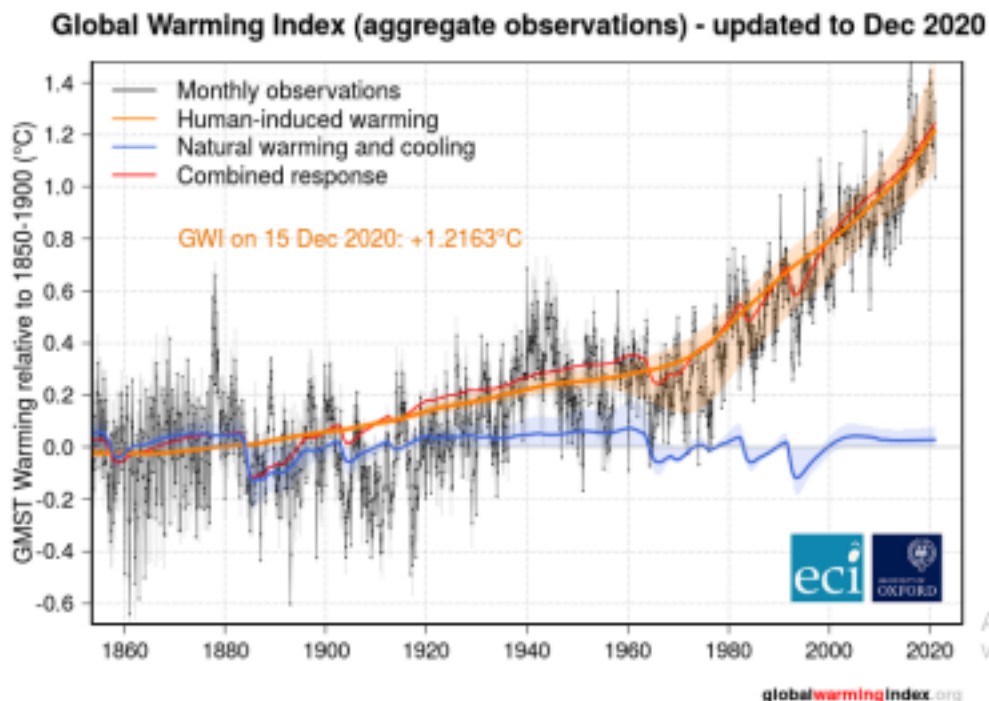


Figure 1. The increase of the temperature due to different factors through the years (*Environmental Change Institute at the University of Oxford, 2020*). Tracking progress to a safe climate, Global Warming Index, Retrieved from: <https://www.globalwarmingindex.org/>

Figure 1 shows the great increase in the Earth's temperature from 1860 until December 2020. Even if we have different factors causing this effect, the line referring to human-induced

warming follows identically the high temperatures in the graphic. An approximate 95% of escalating temperature is due to human activities. (*Environmental Protection Agency, 2022*). When the surface starts to warm up, so do the ocean floors.

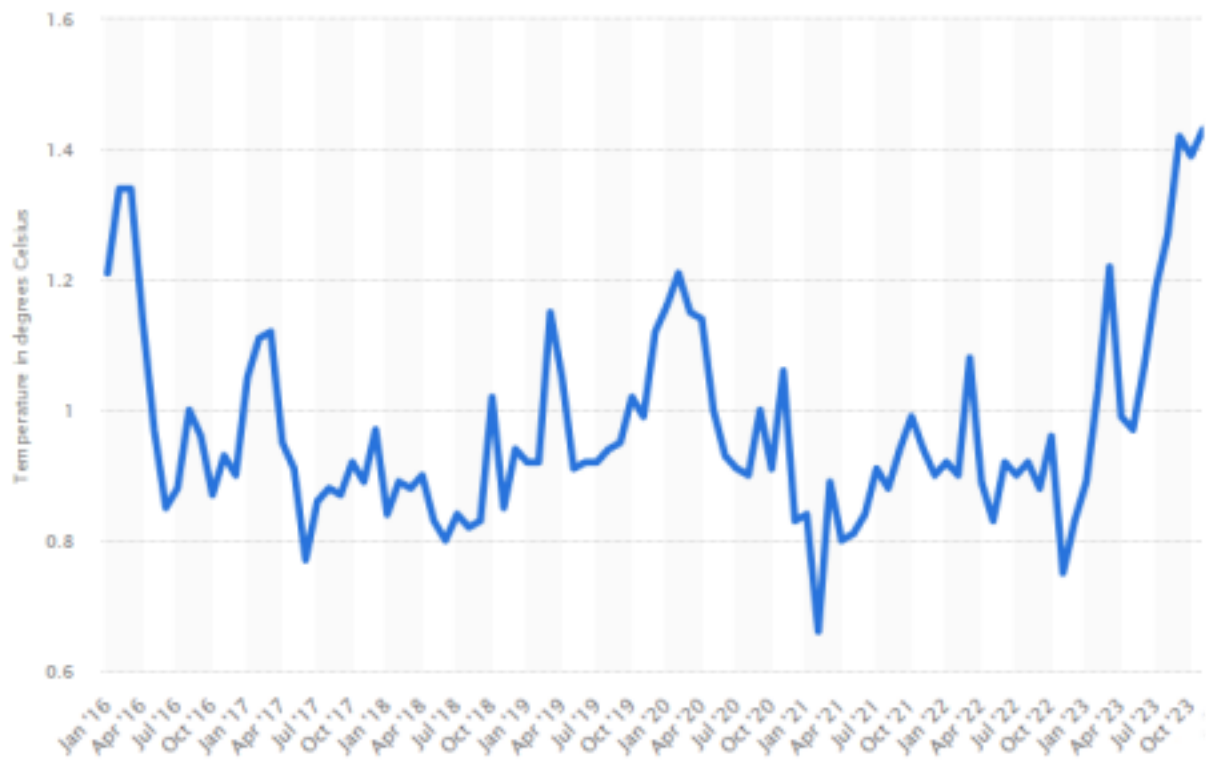


Figure 2. Temperatures on the ocean's surface from 2016 to 2023

(*Burgueño Salas, 2023*) Monthly anomalies in land and ocean surface temperature worldwide from January 2016 to October 2023, based on temperature departure. Statista, Retrieved from: <https://www.statista.com/statistics/1038544/monthly-land-and-ocean-temperature-anomalies-based-on-temperature-departure/>

The evidence of Figure 2 and a NASA research study has demonstrated that ninety percent of global warming is happening in the oceans. One of the main consequences of this phenomenon is hurricanes. When the temperature of the ocean's surface is above 26 degrees Celsius, the humid warm air moves up to the atmosphere, creating a storm that can flood cities and islands. Then, , if the wind is strong enough, it starts to create a circular movement, if the wind exceeds 119 km/h (kilometers per hour) it is considered a hurricane. They are generally formed in tropical waters like the Gulf of Mexico and, if they occur on the shore, they can devastate cities and the living communities close to it. This is just an example of a change in climate that the planet uses to defend itself and reduce the great temperatures. As temperature continues to rise, not only hurricanes but other natural phenomena become more common and strong; even these powerful and big climate patterns can be less devastating with my proposal, coral restoration. (*NASA, 2024*).

The community of Gardi Sugdub is a subtribe of the Gunas which are all the people who live in Guna Yala, an indigenous region in Panama. Its territory is made up of 3200 km² in the continental part and with 350 islands of coral formation. Communities in Guna Yala have been fighting to keep their indigenous culture since 1492. Even if all live in different islands and areas through this region they all share the same religion and education system, separated from

Panamanian cultural practices. In 1925 this community started to construct their autonomy and declared their independence from the Panamanian Republic. In this same year, the education was guided by the Christian church invading their cultural and educational practices, intervening in their religion, their spirituality, and everything else that formed part of their indigenous identity. Nowadays they have a new educational project called Intercultural Bilingual Education (IBE) created by the Guna General Congress (GGC). Regarding their religion and culture, tourists have formed part of it for decades, and they have been very welcome to all these islands. This is beneficial to the Gunas due to the fact of how they are familiar with mercantilism and international trade. Their economy is based on activities like fishing, agriculture, and clothing. Economic success and self-determination are values that have allowed the Gunas to function and work independently. One of the best-known aspects of the Guna culture is a decoration piece of clothing called “mola”. Which is used to adorn the front and the back of traditional dresses worn by women of the community. “The colorful designs of the molas typically represent sacred animals or cosmogonic origin stories, based on their belief system of three principles: God, Nature, and the Cosmos. For the Guna people, humans and nature are part of the same entity and therefore the rules of nature apply equally to human life from birth to death.” Gardi Sugdub has been a victim of climate change and its side effects like the rise of sea levels. This island of 4 hectares equivalent to 4 football fields is the home of 4 to 5 member families, with a population of 1300 people. Due to the number of people living on the island, the housing is dense and made with basic materials like wood, zinc sheets or cane, and dirt floors. Information on specific schools and hospitals is limited, but there are small local schools and healthcare facilities with basic resources, yet there is a lack of public services. There is no drinking water. The indigenous people must go out by boat to look for it in the rivers or buy it in stores on the continent. Reports suggest a new school is being built on the mainland for the relocated community (*Calvo, 2018*).

Corals are sessile animals (animals that don't move). They are formed by millions of animals called polyps. Polyps are an extension of the coral with a little circular mouth surrounded by tentacles that help it to feed. They are the skin that covers the coral. Corals are classified into hard corals and soft corals. Hard coral is also known as the reef-building coral. Is formed by extracting calcium from the surrounding seawater which gives them a hardened structure that provides the coral with protection and growth. Coral reefs are home for thousands if not millions of other species. Coral reefs form through an organism called coral larvae that attach to submerged rocks or other hard surfaces along the island or the continent. Coral reefs are truly remarkable ecosystems that play a vital role in sustaining marine life and supporting coastal communities. These vibrant

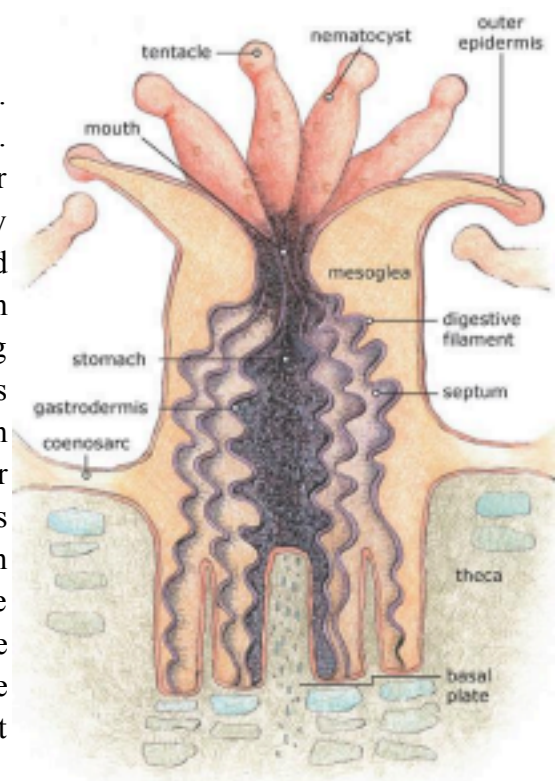


Figure 3. Structure of a polyp National Science Teaching Association (2024) What are Corals? National Ocean Service, Retrieved from: https://oceanservice.noaa.gov/education/tutorial_corals/coral01_intro.html

underwater cities are not only the largest living structures on Earth, visible even from space, but they are also part of a delicate and interconnected system that includes mangroves and seagrass beds. Mangroves, with their unique salt-tolerant trees and submerged roots, serve as nurseries and breeding grounds for countless marine species. These species eventually migrate to the nearby coral reefs, creating a continuous cycle of life. Mangroves also play a crucial role in trapping and producing nutrients that fuel the food web, stabilizing shorelines, and protecting coastal areas from the destructive forces of storms. Additionally, they act as natural filters, helping to remove land-based pollutants from

runoff before they reach the sensitive coral reef ecosystems. Seagrasses, on the other hand, are flowering marine plants that are essential primary producers in the food web. They provide food and shelter for a wide variety of marine organisms, from small invertebrates to larger animals like sea turtles and dugongs. Seagrass beds also help to stabilize sediments, reducing erosion and improving water clarity, which is crucial for the health of coral reefs. Together, coral reefs, mangroves, and seagrass beds form a complex and interconnected ecosystem that supports a vast array of marine life and provides numerous benefits to human communities. However, these ecosystems are under threat from various human activities, such as coastal development, pollution, and climate change. We must take action to protect and conserve these vital habitats to ensure their survival for future generations. Coral reefs and this entire ecosystem are threatened by the heat generated in the oceans causing coral bleaching. They don't know much about the reason for this phenomenon but they know that it is caused due to an increase in the temperature, just by two degrees Celsius. When the temperature rises, the digestive structure inside the coral and its photosynthesis process cells start to fail. The coral has a stress response like our body with fever and to protect itself starts to eliminate and get rid of these supposedly dangerous cells without knowing that this will lead to deathly starvation. This phenomenon has taken away over 50% of all the world's corals. These meager animals are for some more fundamental than others. Reefs are a source of food and income for over 500 million people, home to all kinds of fish and hard corals, and now coral reef animals and plants are being used to develop drugs as a possible cure for diseases like cancer, arthritis, human infectious diseases, etc. Besides that, they have been a crucial ally in protecting the shore from storms and maintaining the sea levels.

The Gardi Sugdub island is surrounded by a coral reef which makes it the perfect place for fish and other animals to be living close to the island. However, coral bleaching has also reached the corals that surround the island, fish and other animals have started to migrate to healthier coral reefs where they can live better, affecting the economy of Gardi Sugdub. Due to overcrowding, the in-house services such as electricity and sewage are affected by the constant floods from storms. Most of the island residents do not have a continuous supply of electricity. The inhabitants rely on a public generator that operates for a few hours at night, although some turn to solar power and private generators. Sanitary facilities are shared, with small structures on the docks consisting of wooden planks over the sea used as toilets. Additionally, they face serious problems of overcrowding. A recent report by the non-governmental organization Human Rights Watch points out that there is no available space to expand housing or for children to play (*André et al, 2023*).



Figure 4. Satellite image of Gardi Sugdub Island

(Salido, 2024) Gardi Sugdub, the Americas' Disappearing Island BBC <https://www.bbc.com/travel/article/20240105-gardi-sugdub-the-americas-disappearing-island>

As a result of coral bleaching, the island of Gardi Sugdub has suffered from an increase in sea levels and strange climate patterns like constant storms that flood houses and destroy them. Besides this, the most important part of their diet and most fundamental economic income is fish, which is scarce because of the previously listed conditions. Therefore, as a result of these living conditions, the government of Panama started to relocate people from Gardi Sugdub to a safer place where they can live, forced to flee their homes. (Salido, A. 2024).

The island is surrounded by a coral reef, but it is dying, which is why it needs to be restored. Several teams and professionals started to implement certain techniques around the Caribbean to save the corals and the planet. To do so, they are constructing fiberglass reinforced plastic to protect big, healthy coral fragments from anything that could harm them and nurseries for smaller fragments. This fiberglass-reinforced plastic is a small structure used to hang healthy coral pieces, and then they start growing around the structure forming a new coral reef (Sánchez, 2024).

Fiberglass-reinforced plastic (FRP) emerges as a promising option for creating artificial coral reefs, primarily because of its exceptional resistance to corrosion and rigidity. This lightweight and robust material is well-suited for environments exposed to saltwater or moisture over extended periods, given its ability to endure challenging conditions. Moreover, the flexibility of FRP enables effortless customization and adjustment of artificial reef structures to meet specific requirements. Its malleability and ease of fabrication empower users to craft intricate reef designs with remarkable ease and precision. (Authors of Tencom Limited, 2023).

Multiple standards ought to be met with the aid of using the terrain decided on for synthetic reef construction. Initially, it provides various topography with numerous shapes and depths to provide refuge for fish and different marine organisms. Secondly, the shape must facilitate green water move to make sure good enough oxygenation for the corals. Lastly, meticulous attention ought to take delivery of to pore length layout to align with the common dimensions of larvae (the constructing blocks of coral reefs), thereby fostering the advent of recent habitats conducive to their boom and development.



Figure 5. Fiberglass Reinforced-Plastic tree farm (Sánchez, 2024) Planting Coral Reefs to Save Them From Extinction ABC

https://www.abc.es/xlsemanal/naturaleza/arrecifes-del-caribe-peligro-extincion-especies-mari_nas-soluciones.html

This practice is called an artificial reef, creating structures of fiberglass-reinforced plastic to create a safe place for corals to grow and for animals like fish to live. The common corals around that area are species like *Pocillopora* and *Agaricia*, the cost of these corals is 14.99 USD, in each of these coral farms there are approximately 15 to 20 corals and it would be a maximum total cost of 225 USD. There are several foundations such as “Coral Reef Care” that educate small communities that depend on coral reefs. They will educate the Gardi Sugdub community on how to maintain and take care of the coral farms so that they can be put in the reef by these professionals (Coral Reef Care, 2018). And Coral Reef Alliance with their sponsors like Paul G. Allen (co-founder of Microsoft), Lida Hill Philanthropies, Paul M. Allen Family Foundation and National Geographic Society and the Wildlife Conservation Society. The budget of “Coral Reef Alliance” has reached \$4,148,102. The government and foundations grant \$2,530,325, individual

and corporate contributions grant \$1,610,848 and other revenues grant \$6,929. The idea would be to start restoring an hectare (10,000 meters) of the coral reef in the island that actually covers the previously mentioned conditions. The cost for coral reef restoration would be of 400,000 US dollars per hectare, fluctuating from 6,000 US dollars per hectare for the nursery of coral gardening to 400,000 US dollars per hectare to build an artificial reef (*Spurgeon, et al, 2023*).

As a swimming community that Gardi Sugdub is, foundations can find an easier way to teach the population how to maintain coral, they will start by improving their swimming abilities to dive deeper and be able to take care of the coral farms themselves. This will help them recover their fish population and have not only a resource to eat but also to maintain their economy while doing what they love as a culture, being one with nature. This could also be the solution to continue living on their beloved island and not have to move to another one. Not only could the Gardi Sugdub community help restore the reef, but students of universities in Panama can be involved in this process. The University of Panama, the University of Santander, and the Latin University of Panama has several biology programs for bachelor's specializing in topics like environmental biology and environmental management. Inside this program the restoration of coral reefs could be a project for them to implement. The class of marine zoology is taught to the students of the faculty of ocean sciences at the end of the second semester, in which the topic of corals and coral reefs could be an interesting topic inside the course. The students that are in this class will have enough knowledge to take care of the corals and restore the reefs. This would ease the work for the Gunas as well as give the students an experience to help a community and learn from their culture along with their traditions, moreover empirical knowledge for further subjects during their master's degree (*Barrier Reef Foundation, 2021*). Education is key when it comes to these experiences, it not only gives a refreshing point of view but makes you wonder and notice things out of the ordinary world in which everybody lives. Even today, climate change and its effects have been questioned by society. Scientific evidence will always be questioned, not only because you are just seeing the results through the lens and investigations of someone else but because it is difficult to believe what you haven't seen and challenge that biased ideology. But when it comes to practices and being in the actual place, seeing how coral reefs are disappearing and no one is doing anything about it, knowledge and education suddenly turn into the most effective method for an actual change.

We think we know everything about our planet, but we only know the superficial things, that birds fly, that humans are mammals, and that flowers give oxygen. That the Amazon rainforest is the lungs of the Earth. And now I know I was wrong. The coral reefs that are found in the unknown oceans are the true lungs of the Earth. We've been doing a mistaken diagnosis, as we concentrate on trees and their ability to save our planet, we've been leaving behind the oceans and underestimating its power, diagnosing defects in the heart of the planet instead of its lungs, but today, that changes. Corals have been dying in vain and we don't even notice how this is affecting us, communities like Gardi Sugdub are collateral damage of all our actions. According to different sources, corals are susceptible to climate change patterns. To prove this, they used several methods, like reef ecosystem projections. In these projections they put coral reefs under all kinds of weather circumstances, including tropical cyclones, impacts from flood plumes, heat waves, and ocean acidification. All of these situations increased the mortality of coral reefs and its bleaching. (*Condie, 2022*) In another recent study, scientists conducted an experiment in Spain. They tried to find a correlation between the posts on social media (Twitter) and the change in climate. In their conclusion, they mentioned that the correlation between their variables did exist. The number of tweets made during the year was lower than the ones made when the temperature was below 5 degrees Celsius or 26 degrees Celsius, which is the average temperature in Spain. They remarked in their study that it may or may not occur at a conscious level but people had mental representations of climate change, they could notice the sudden changes in temperature and other uncommon climate patterns as well as making tweets about it. "The magnitude and rate of climate change and associated risks depend strongly on near-term mitigation and adaptation actions, and projected adverse impacts and related losses and damages escalate with every

increment of global warming.” These are the quoted words of the Intergovernmental Panel on Climate Change of Nasa. They explain that current data has superseded what scientists have predicted in the past regarding climate change. A report published in 2021 found that human emissions have warmed the climate by 2 degrees Fahrenheit (1.1 degrees Celsius) since 1850. The global average temperature is expected to increase 3 degrees Fahrenheit (1.5 C°) within the next decades. And that the actual damage made to earth will be irreversible during the next hundred of thousands of years. (*NASA, 2024*). There could be millions of explanations and evidence in this investigation, but without action the world will never change. The corals will continue dying, climate change will continue to destroy cities, villages and little islands filled with culture and history. So... Would you still blame it on ignorance?

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