

**Introduction:**

Back in 2015, NASA released a video titled *Simple Explanation Of Sea Level Rise* that stated “a child born today can expect to see the ocean level rise one to four feet in their lifetime”. As a low-lying coastal city, Miami had a lot to lose with this prediction and government officials ranging from the local municipal level to the federal level knew that something had to be done. Around this time, officials outlined the four major problems in the Miami area that sea level rise would create. These problems were flooding in the city, loss of mangroves and wetlands, destruction of the Everglades and the economic impact on Miami. All of the solutions to this crisis would fall under three categories, prevention, mitigation and adaptation. However, while these solutions were generated by man, officials made it very clear that all three categories would be viewed with a biocentric and ecocentric mindset as it was very important to integrate nature into the ways Miami was going to fight sea level rise.

The focus on biocentric and ecocentric solutions back in the late 2010’s was generated through the lessons learned from designs that only incorporate anthropocentric thought. This can be seen in the 2013 documentary *Shored up* that showed how ocean groins and seawalls are implemented to stop erosion but in reality, cause further erosion and damage south of where they are built. As the mayor of Long Beach Island, New Jersey stated in the film, “these solutions are essentially putting a bandaid on a hemorrhage” and assume mankind’s mentality of total control over nature. With biocentric and ecocentric designs, a system featuring sustainability while helping diminish damages from sea level rise was possible.

The first step of dealing with sea level rise in the Miami area was mitigation. This can be seen in the programs that reduce pollution such as taxes on plastic and greener transportation. In addition, a sustainability course was made mandatory for all Floridian schools starting in 2020. This was done to change the culture in the area to a more sustainable one. The second step involved mitigation, which was started under Miami’s Mayor Philip Levine in 2018. Mayor Levine drew up a 50 year plan that incorporated building high power pumps throughout Miami to send flood waters out of the city. In addition to this, genetically modified mangroves and wetlands that are resistant to ocean salinity, pH and temperature increases were planted around the greater Miami area in order to protect the coast from flooding and storm surges. Lastly within mitigation, dunes with vegetation were planted in between the resorts and the ocean on Miami’s eastern edge to act as a buffer. The final area of solutions, adaptation can be seen in the 15 year project of the implementation of the Dutch Water Management System into the economically and agriculturally important Everglades region starting in the year 2030. The Dutch Water Management System was originally designed to help low lying areas avoid flooding. This implementation of an international framework was designed with a local twist, ensuring it was adapted to the local region of the Everglades.

Miami now serves as a model for biocentric and ecocentric based solutions. With the incorporation of either nature or solutions designed to help nature in the various systems created, Miami has fought back against sea level rise in a way that is both sustainable and effective.

## **Digests:**

*In 2040, we are living in a new world. We are in Miami, Florida. We have picked a few different people to explain what life is now like and how we have gotten here. First, two archivists help to develop the story by going back in history and talking about the transition from the older system we lived in to the newer system now in place.*

### **Archivist #1:**

Sea level has been rising at an increasing rate over the past century. Research has been conducted in order to understand the reasons for the increase in sea level around the world. The increase in sea level has led to more dangerous storms and more frequent flooding, especially in coastal areas. The two main causes of sea level rise are thermal expansion as a result of the warming of the ocean and increased ice melting from glaciers or ice sheets. Since water expands as it warms, the sea level continues to rise along with the changes. Increased atmospheric heat from our daily human environmental emissions force the ocean to absorb a majority of the increased atmospheric heat. As a historian, I moved to Miami when changes began to take place to help reduce emissions. I wanted to be directly involved with this project and decided to make a change. Living in Miami for the past twenty-two years has been difficult since there has not been much protection from the storms until changes began during the last few years. A large percentage of the United States lives in relatively high population density coastal areas which in turn led to the increased motivation for change in our use of certain goods that create high emissions. With continued atmospheric and ocean warming from carbon emissions, sea levels would have most likely risen at a higher rate than that of today in 2040, therefore changes have begun to take place.

As humans living in the United States in the twenty-first century, we consume an excessive amount of goods, whether it is through transportation, food consumption, or the purchasing of many plastic toys. Something that we, as a country, have worked on during the past twenty years is reducing our consumption habits. We realized that a change in our consumption of certain goods would help reduce emissions and put less of an impact on the earth's atmospheric temperature, which in turn would help with the increasing sea level. Specifically, we have significantly reduced the use of plastics and also have been recycling many goods that were not often recycled about twenty years ago; in order to reduce our overall consumption. Now in 2040, we are proud to say that we have slightly decreased the rate at which the sea level is rising but this does not necessarily mean people are able to live the life they were accustomed to on the coast back in 2018. Most people have been moved from their homes temporarily due to safety reasons. There are high risks of flooding and people have been working on solutions to prevent this. Even though as a country we are happy with the slight change that has been made to the rate of sea level rise, we realized that more needs to be done. We hope to continue to make changes to our daily lives that will in turn help the environment.

Over the past few decades, engineers have taken significant steps in order to help bring all parts of the coastal cities back to safe habitable places again. One significant change to our coastal cities has been the increased use of elevated homes and infrastructure. Back in 2012, when Super Storm Sandy hit the coast of New Jersey, many homes were completely destroyed and swept away. When the homes were rebuilt many chose to elevate them with the use of pilings so that when flooding occurs it does not reach their homes. Elevated homes are primarily designed for homes located in flood zones. Since Miami Beach is in a flood zone, many of the same actions have been implemented here in the past ten years. Depending on the location of your home, flood elevation certificates performed by surveyors determine how high off the ground ones first floor must be built. Government programs like Federal Emergency Management Agency (FEMA) create the flood maps that determine the height of ones home to prevent flooding. These actions are now enforced by local governments. Back in 2018 it was an option for one to raise their house to protect from flooding. If one chose not to then they would pay extremely high insurance and fees. Now in 2040, it is mandatory through a government program that a house is elevated to prevent complications and help with emergencies when flooding or storms take place. One positive result of the elevated homes other than the flooding protection, is that the house plan offers space for parking and storage. People have been taking advantage of this and seem to be excited for what this option has to offer. Hopefully, in the next few years most people will be back living in their homes on the coast as a result of these new laws.

Over the past 20 years, many people have lost their homes in the coastal areas due to the rising sea level. In the United States, the areas around the coast are the more highly populated locations which leads to difficulty when looking to relocated families. Now that changes have been made and continue to be made, people are currently moving back to their homes and/or living with other family members nearby while they wait. Increased sea level in certain parts of the city made transportation very difficult since one would need both a vehicle that works on land and in water in order to get around the entire city so roads and all forms of infrastructure have also been raised. Over the past twenty years, engineers have brainstormed and tested a few new ideas in order to help bring these cities back to a functioning state. The increase in sea level has not only threatened homes but also all forms of infrastructure such as bridges, subways, and roads. Changes are currently taking place to help create a better, safer habitable environment on the coast.

Rather than giving up and losing land to the increased sea level, we as a country have made many changes and are looking forward to a brighter future. Many have lost their jobs in the coastal cities but have found new ones that are involved with making these cities habitable again through finance based positions or construction based work. Some scientists have even created natural solutions such as the implementation of more mangroves near the coast lines. Mangroves play an enormously large role in the reduction of flooding so this change has also helped with getting a step closer to a better living situation. If we continue to make these positive changes as a community, everyone will be back living in their homes in no time.

## Archivist #2:

It is the year 2040 and the main, “frontline” method to mitigate sea level rise in Miami, seawalls, is starting to become less effective. With the coast now touching the walls, a minor storm results in some sort of flooding somewhere in the city. In fact, with climate change and the rise in world temperatures, “the climate can change in unexpected ways” (What Is Global Warming?) and with this, weather patterns have become increasingly unpredictable. Storm surge and wave heights during hurricanes have dramatically increased in the wake of sea level rise, magnifying the damage done by hurricanes that hit Miami (Letson, 2016). This is why the seawalls effectiveness have decreased as time progressed, leaving the city more exposed.

On the city’s western edge, the edge closest to mainland Florida, the coastal Mangrove forests and wetlands have shrunk. This has left the city more vulnerable to flooding as the “salt marshes, reefs, mangrove forests and barrier islands defend coastal ecosystems & infrastructure, such as roads & buildings, against storm surges” (Letson, 2016). Throughout the course of human history, humans have seen how natural barriers are vital to maintaining a coastline. The Atchafalaya River in Louisiana is a great example of this, as the silt is carried downstream helped build up the Louisiana coastline and delta (McPhee, 1987). This built up coastline serves as a natural shock absorber in times of turbulent weather conditions. In an effort to keep with the important idea of natural barriers, the city of Miami, the USDA and Monsanto have partnered up to create genetically modified mangrove trees and wetland species, all native to Miami, that are better resistant to various changes as seen within the sea level, ocean pH and temperature. With this, Miami will be able to grow these species on the Western edge and around the region to better protect the coast.

The Everglades Agricultural Area, an area that was designated by the Central and Southern Florida Project in 1948 incorporates over 1,158 square miles of highly productive agricultural land. With over twenty-thousand people working in this area (The Interested Parties), it is both an important employer for the region and also an important producer, as many of Southern Florida’s crops are grown here. However, with the rise in sea level, the Everglades have become threatened as the region is low lying, serving as nature’s flood plain (Treuer, 2017). Due to the important economic and agricultural contribution the Everglades have on Miami and Florida, it is extremely important to protect this land. This is why the region began to use Dutch water management systems featuring fjords, dykes and canals in addition to other natural barriers such as mangrove forests and wetlands.

*Now that we understand how we got to the point we are at currently in 2040, two engineers will explain to us how these changes were made and anything we will see change in the near future in order to help make positive progress.*

## Engineer #1:

Several advances have been made in the last 30 years. Miami is now a place focused less on tourist attractions like late night party scenes and warm sun and beaches; rather it is a spot with the mangroves, canals and raised beds as well as its reefs that people can explore. The path to innovation was arduous as rising sea levels threatened Miami (as it did many coastal cities). About 30 years ago, the flooding occurring due to this rising sea levels had made several damages to infrastructure and private property. The South Beach was at a massive disadvantage being completely surrounded by water and only connected to the greater part of Miami through bridges. These bridges also were not most prepared to face the issue at hand. The Netherlands' approach to flooding were a source of inspiration for early solutions to the problem. The Netherlands' Eastern Scheldt barrier which protects the country's coast against storm damage by strategically opening and closing gates was used as an early blueprint for the Miami Barrier. The Miami Barrier implemented had major issues withstanding the amount of water coming into the coast as well as complaints from the local public of its appearance and effectiveness. The effectiveness of the barrier made it difficult to support more projects similar to it. All the while more implementations of emissions control were put into place in the US as a whole to limit the exacerbation of climate change. This meant that certain technologies at the time were limited and newer more Eco-friendly technologies arose. With an emphasis on efficiency and clean energy, more "green" infrastructures were used. For example, a project to create a wall (similar to the New Orleans' levy) was put forth. Yet due to concerns of structural integrity and fear of strong flooding, a different technology was put in place.

This technology was a buildup, otherwise known as dunes. Where the ground was elevated and injected (with sand) along with highways built atop of it. The elevated highways atop the dunes gave an extra purpose to them. The dunes have been quite effective but also have support from other technologies (Figure 1). There was a movement for the integration of natural and man-made barriers. The natural barriers being the mangroves and wetlands build up. The mangroves were a time-consuming project which only now (2040) the benefits can be seen with its effect on flood management and attraction for Eco-tourists. The mangroves create more protection from oncoming waves and storm damage to Miami.

Through the last 15 years the infrastructure has been built with the idea of increasing sea levels, which has led to more high rises, and build ups of all forms of infrastructure. Houses closer to the coast now have to be above sea level by a few feet and have flooding proof basements. Highways have also been built higher along with all bridges. New project ideas for the future include implementation of more technologies such as underwater (at least water resistant) transportation with tunnels. There has even been planning on the front of building an



Figure 1. Coastal Miami Beach and Dunes (Shutterstock)

underwater hotel or possibly an underwater observatory/city center as an attraction for tourists in the next 50 years. Miami has really embraced its identity as an outdoors location and has used the forming technologies in sea level rise protection to create a real niche.

## Engineer #2:

After about twenty years have passed, Miami has introduced many forms of new technology and new innovative ideas that have allowed people to live in areas with high rates of flooding due to the increased sea level. The use of mangroves, dunes, artificial reefs, a new bullet train system, and elevated homes and infrastructure have all allowed Miami to once again be a habitable area. As a city, Miami has worked to embrace its identity of being a place where one can explore outdoors. Their goal as a city is to make helpful changes to help improve the living conditions with increased sea level but also to maintain a visual look close to what it was in the past.

One of the ways scientists worked to reduce impact of the rising sea level is through the use of mangroves. The implementation of mangroves allows for the reduction in the height and energy of wind and waves passing through them. This in fact reduces the waves or winds ability to erode sediments and to cause damage. Other cities have attempted to build up walls but have found that this was not necessarily a successful approach to prevent flooding. Mangroves help to preserve structures such as dunes and sea walls since it reduces the power of the waves and wind. Mangroves have tightly packed roots and low branches which present a great obstacle to waves passing through, compared to trees with areas with few or no roots above the ground (Figure 2). Another important part that mangroves play are tied to the ability to hold carbon. Large

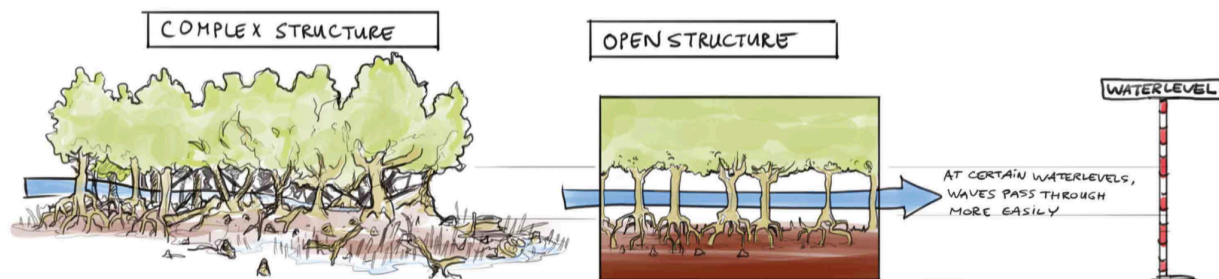


Figure 2. Mangroves Reduce Wave Damage (Spalding, 2014, p. 16)

quantities of carbon are held in both the roots of the tree above the ground and in their soils. This is unlike what typical tropical forests do with carbon emissions, the mangroves retain carbon and store carbon emissions in their soils where it remains for many years. This is possible because the conditions of the plant allow for the preservation of organic material by preventing breakdown by bacteria.

Another change to the environment has been seen through the introduction of more dunes on the beach. Dunes play a similar role as do mangroves since they can slow down the buildup of waves which in turn will reduce the impact the land receives from storms. The mangroves are close to land, whereas dunes are on the beach which is a place where mangroves cant survive.

Both the implementation of dunes and mangroves tie to Miami's goal of continuing to be location based off of outdoor activities. Visitors can take trips to Miami and spend time kayaking through mangroves or snorkeling through reefs.

Additionally, the increased use of elevated home and infrastructure have become widely used in the Miami area. In order to assist with the travel to Miami for their eco-tourism attractions, an elevated bullet train has been built that travels from Boston to Miami (Figure 3). This train is elevated so that its travel along the coast can avoid flooded streets. The use of the bullet train also helps the environment and reduces emissions compared to the use of an airplane or driving in a car.



Figure 3. Elevated Bullet Train (PTI, 2016)

More specifically in Miami, the government has now forced all homeowners to raise their homes using an engineering technique involving pilings that are placed deep into the ground (Figure 4). Raising homes allows for the prevention of possible flooding and evacuations for homeowners in this area during storms with flooding. Overall, these improvements have helped during times of flooding and dangerous storms but they have also helped with the reduction of emissions released into our environment which has slowed down the increase in sea level for the first time in many years. Miami hopes to continue to make improvements as time goes on



Figure 4. Elevated Home (House Plans)

*Finally, now that we see in more detail the new ideas being implemented in Miami to help combat the increasing sea level. We will speak to two citizens who will explain what life is like in 2040 in the new Miami area. With the increase in sea level, it brings some noticeable changes to the way of life but as you can see some people of Miami have learned to embrace every part of it while others are still struggling to adapt.*

**Citizen #1:**

Miami, a place once filled with palm trees, white sandy beaches, ritzy resorts and the aura of a tropical oasis. It was a place of extreme multiculturalism, fueled by its geographic location and the tourism industry that pumped billions into the local economy. As a kid, I remember to this day driving down South Beach, a place where you looked to the right and saw a football field worth of white sandy beach separating the street from the Atlantic Ocean. This view was classic Miami, a view that branded the city and made it such a distinguishable location. It was next to these beaches that high rise resorts were built, seemingly right on the beach. I will never forget these days, the days when Miami was the Miami portrayed on old television shows such as Miami Vice.

However, this was the old Miami. It is now 2040 and Miami has evolved. This evolution has been forced in light of global sea level rise, an epidemic that is destroying many coastal cities. In particular, Florida has been hit the hard. Floridian cities that dot the coast, such as Tampa and Jupiter are all facing catastrophic situations but the most noticeable is the “The Gateway to the Americas”, also known as Miami. Now surrounded by high sea walls, the classic Miami image is no more. I drive down South Beach to work now, and look to my right, only to see tall houses covering the views of the beach. Instead of hearing the laughter of children playing on the beach, seagulls squawking and vendors picking coconuts out of the trees, I smell and feel the ocean mist and hear the constant, ominous roar of the waves. This loss of pristine beach is directly correlated with the unprecedented financial hit our tourism industry has felt. These losses can be physically seen, as most of the “mom and pop” hotels Miami was oh so famous for are long gone. Many of the bars along South Beach, all of which were fueled by tourism are now either derelict or converted into some other type of business. Miami is not the same as it feels rather empty without a massive tourism industry. Many of my friends were tied to this sector and while a few are still employed within it, most were laid off with some finding new work and others leaving the area to start a new chapter in life. This is not the Miami I used to know.

As Miami evolved, so have its citizens. With the city surrounded by sea walls, we are protected from flooding in times of calm weather. However, with climate change, the weather has become rather unpredictable and the storms are of greater scale. The city is flooded all the time, even in the smallest of storms, preventing citizens from getting to work, essentially putting the city at a standstill. To make matters worse, the western part of the city, the side closest to mainland Florida, needs to be completely avoided in times of rough weather as the loss of natural buffers such as mangrove forests and marshes due to coastal development, erosion, and sea level



rise have left it extremely vulnerable. This is why whenever it rains, I must carefully select my route.

The impact isn't just seen on a financial or city scale, it was also seen in the way us Miami citizens eat. With the rise in sea levels, the low lying Everglades and the surrounding areas have become almost completely swamped, decimating the local agriculture industry. About a century and a half ago, the people who settled this area built a massive network of farms on this land and now, it seems as if nature is reclaiming it. Many of the crops grown in the Everglades helped feed not only Miami, but also the regions bordering it. These crops, such as oranges, tomatoes and corn were a staple, and kept local farmers markets and food stores stocked. Luckily, changes have been made using the dutch water management system and goods are being farmed again. I remember as a kid going to the local farmers market dotted with hundreds of stands with my parents, a place that displayed the agricultural might of the region, I missed it for a few years, but now it is mostly back.

While it may seem like the city has not been bracing for sea level rise, it has and some of its strategies have impacted the cleanliness of the city itself. In the 2010's, Miami's mayor introduced a bold program to mitigate the damage of sea level rise within the city (Letson, 2016). The plan was a three step solution, the first step consisting of building one-way flex valves for all the city's outfall pipes, allowing floodwater out but not back in. The second step consisted of the construction of pumps throughout the city, which would discharge all floodwaters into the surrounding bodies of water.

My Miami is in crisis. While I want it to revert back to the old days, I am afraid the city simply can't as the dials on Mother Nature's clock only move forward. Just like the city needs to learn to adapt, so must I as its citizen. I must learn to adapt to the flooding, as it is a common occurrence now. I must deal with the financial impact my city has been dealt, which means helping my friends and family who are struggling because of it. I must learn to cope with a new diet, a diet that is not as fresh or as Floridian as I might like. I must turn a blind eye to the remaining polluted beaches and the stench of the stormwater that is, what I like to say, 20% human junk. Sea level rise is real and even though man has created many new ways to help, it still has not completely stopped the wrath of mother nature.

## **Citizen #2:**

Miami is not what is used to be for sure. No longer are there busy streets with tourists looking for a sun tan, and a bustling nightlife. Now the Miami beaches are protected by a combination of natural and man-made barriers. Long ago, sea levels continued to rise causing flooding that damaged our beaches and way of living. I remember all the tourists flocking, causing destruction in their wake, now the tourist we get are more conscientious. I guess all of us are now. We finally woke up and decided that change needed to happen, that we could not get by using destructive behavior. Nature has been trying to claim back what we have taken, seemingly hostile towards humans. Yet, we have endured Nature's rising sea levels and warming climate. Miami is not going anywhere.

There is talk about moving out of the area, and unsurprisingly there is pushback against relocation. This is our home, we argue. "Where would we even really go?" The sentiment is against such an inconvenience. We have realized that we can build up and now all the structures are built prepared for higher sea levels. The houses are on stilt like structures and the beaches have been built up. There are dunes and raised high ways. Our transportation has improved greatly in the recent years. We now have a fast train connecting us to other major East Coast cities like Boston, New York and others. It has been very convenient for everyone. Most of our tourists now are from the East Coast who take this train down. Now no longer focused on sunning and clubbing, the tourists have evolved to be eco-tourists. Their interest in our local projects such as the reefs and mangroves. There is still impact felt by the tourists, but it has significantly decreased. People argue we are no longer like we used to be, the vacation spot. Yet, I see all these eco-tourists paying for guided tours through the mangroves, snorkeling in the reefs and trips alongside of our sandy dunes/beaches.

We have stricter laws on emissions and plastic use. We are trying to treat the Earth well, so that it may be kind in return. We still make mistakes; the sea levels are still rising although at a slower rate than before. We have changed the way we view our energy use. Now there is a feeling of collective effort in saving our coastal cities. Miami is just another example of a city adapting to nature. Miami now may not what it used to be, but I think its for the better. I do not miss certain things about old Miami, while still being nostalgic for the old beaches. I never thought change would be so difficult, but it is for the best. Miami is now the outdoors spot and I do not mind that.

## **Conclusion:**

Life in Miami has changed to solve the problem of sea level rise and its effects. Adaptation, mitigation and prevention approaches were used in addressing the problem. The new technological configuration (mitigation, adaptation and prevention methods) demonstrate that nature can not be completely subjugated by humans and technology. Technology is now no longer solely used to dominate nature. It has also been revealed that nature is powerful and can be used as a technology itself. This is shown with Miami's revival of its wetlands and everglades and build of sand dunes to protect the city. The mangroves are a "natural" technology that protect the coasts from waves and storm damage. With the use of natural barriers for protection, technology has revealed a near symbiotic relationship between humans and nature. Humans have created these technologies to help prevent worsening of the problem (sea level rise) and adaptation to current living conditions as well as perceived future living conditions. Mitigation approaches to technology have created mangroves and dunes which help decrease the impact of storms.

Furthermore, such approaches enables nature to grow/propagate with the focus on these natural barriers. These natural barriers such as the mangroves and the dunes protect coastal living while not harming the environment extensively. The control of nature is maintained with more attention given to the possible negative consequences of certain technologies. These technologies which would have an adverse effect on the environment have been greatly reduced and eradicated. Technology that promotes balance and even a coexistence between humans and nature is a primary focus that the new technological configuration has.

Miami's new technological configuration is meant to promote human interactions with nature while protecting it. In fact, human interactions were widely anthropocentric before Miami adapted to the changing world. This was evident in the general understanding that Miami was a party destination, a time to rest on the pristine beaches and in the five star resorts. However, Miami's culture has changed overtime, just like the identity of South Florida's famous Pink Flamingo changed overtime (Price, 1999). Now, citizens and residents view "nature" as another attraction and a vital part to its identity, with people coming far and wide to see the Everglades and the massive mangrove forests and tropical wetlands. People also now want to preserve Miami, which means limiting sea level rise. In order to do this, humans in the area have adapted sustainability, with many of the younger generations exceeding in this thought process because of the locally adapted "sustainability" course. This sustainability can be seen with greater use of alternative, green transportation such as high speed rail in addition to new, innovate and sustainable waste management programs.

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