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ISCI 121

Scientific Proposal

Introduction

With an increase in carbon emissions and greenhouse gases accumulating in the atmosphere, global warming has become an inevitable threat to the planet. Overtime, this issue will continue to cause harm to many areas around the world. The longer these issues are left alone, the harder it will be to come up with a viable solution, which is one reason why global warming needs to be addressed as soon as possible.

When looking at global warming and its origin, the main causes of the issue are greenhouse gases entering the atmosphere, due to the constant burning of fossil fuels on Earth (Rosen, 2009). A majority of causes linked to global warming are predicted or confirmed to be caused by humans, which makes it so much more important to educate the public about this crucial issue. When looking at the effects of global warming, there are many, but one of the most intimidating effects that could have the biggest impact on Earth’s population is sea level rise.

Sea level rise is predicted to be increasing by .32 meters every decade, and if this rate continues, areas all around the word will be extremely negatively affected (Strauss, 2013).  While this is an issue around the world, one place in particular where sea level rise is a serious issue is the Chesapeake Bay. The Chesapeake Bay is the largest estuary in the United States. The Bay is home to thousands of species and is vital to surrounding ecosystems. This Bay is extremely beneficial and important to humans, as it provides food, employment, and many other positive factors for human life (Costanza et al, 1992). Sea level rise has affected many aspects of the Bay, including its natural geography, habitats, and economy that now needs to weave through the maze to restoration.

Natural geography is changing around the world every single day due to sea level rise. Sea level rise-induced erosion is predicted to be one of the main factors destroying shorelines and the natural geography around the world (Jimenez et al, 2016). Natural geography deterioration in the Bay as well as around the world causes many conflicts within itself, as it directly affects humans who live in these areas who are now losing their land and even their housing in some cases. When dealing with sea level rise, shorelines play a big role in the effects it has on natural geography. Around the Bay specifically, most of the shoreline types, other than natural, consist of living shorelines and hardened shorelines in order to attempt to combat erosion and its destruction of shorelines and natural geography due to sea level rise from global warming (Chesapeake Bay Program, 2018). Unfortunately, while these shorelines have been helping the issue of deterioration of natural geography due to sea level rise in the past, this is by no means a final solution.

An example of sea level rise’s destruction of natural geography is the devastating current situation of the Chesapeake Bay’s Tangier Island. Sea levels are rising at such an uncontrollable rate that it is predicted that a majority of Tangier Island’s natural geography will be underwater in just 50 short years (Schulte et al, 2015).  Even with the possible “solutions” put in place, such as various shoreline protection and a large jetty, the devastating fate of Tangier Island is inevitable (Demirbilek, 2015). This scary reality stands behind this proposal and underscores the importance of the issue at hand and allows people to get a look at all the harm that has already been done to natural geography, specifically within the Bay.

Along with the destruction of the Bay’s natural geography, sea level rise due to global warming is also threatening habitats of wildlife within and around the Bay. It is predicted that wetland habitats of the Chesapeake Bay will be one of the worst affected by sea level rise (Rosencranz et al, 2018). As sea levels rise, these wetlands and marshes will be ingulfed in water and species such as the American black duck will have no habitat in the Bay and will be forced to migrate somewhere else (Chesapeake Bay Program, 2013). In addition to wetlands in the Bay, areas directly surrounding the Bay are in danger of being flooded, therefore destroying the habitats. If these habitats are destroyed, the wildlife inhabited in these areas will diminish, disorganizing the entire food chain and flow of the ecosystem in the Chesapeake Bay (Rosencranz et al, 2018).

Another major effect of global warming on the Chesapeake Bay is the economy. Many industries near and far from the Bay rely on it for business. This is once again clear when looking at Tangier Island. If sea level continues to rise at the rate it currently is, residents of Tangier Island will have to evacuate sooner than expected, strictly for economic reasons. A majority of the jobs in Tangier Island revolve around the seafood industry, involving fishing and oyster farming (Schulte et al 2015). As this takes place along the shore, the availability of these occupations will diminish before the island itself does.

The other major factor affecting the economy regarding sea level rise in the Chesapeake Bay is tourism and its inevitable decrease as the rise in sea level continues. The abrupt stop this will make in the tourism industry’s income will detrimentally harm the overall global economy by throwing off the current equilibrium (Bigano et al, 2008). The United States is bound to go into even more debt if the sea level continues rising because it will have to pay for the damage and will not be receiving the money necessary for these payments due to the lack of tourism (Bigano et al, 2008).

When it comes to global warming, it’s been a struggle for the world as a whole to find a realistic solution for global warming. Although this has been an issue, there have been small efforts put in place to attempt to delay the effects of global warming and more specifically, sea level rise. One of these efforts include, as mentioned before, building up shoreline protection to minimize erosion (Chesapeake Bay Program, 2018). This has been the major combat against sea level rise, especially surrounding the Bay. In addition, some efforts being made include raising roads and buildings, building stormwater pumps, and upgrading sewage systems (Sea Level Rise, 2019).

Global warming is putting an obvious hinder on the health of our natural world as we speak. The effects of sea level rise on various areas around the Chesapeake Bay specifically are detrimental. It is important for us to examine this in order to see how some causes of global warming lead to these dangerous effects. While much is known about these effects and how they are caused, there are many holes regarding global warming and how some aspects of sea level rise effect the Chesapeake Bay. This proposal strives to fill in these holes and gain understanding on how certain aspects of sea level rise interact with many different ecosystems within the Chesapeake Bay. Learning about these effects will help us evolve as humans to fight back against global warming and learn to live with its unforgiving effects. Building upon preexisting data and research will allow us to see sea level rise’s negative effect on specifically natural geography, habitats, and the economy in the Bay.

Specific Aims

Global warming is quickly taking a toll on the Chesapeake Bay as a whole, as it negatively impacts many areas within and around this natural landmark. It is well known that sea level rise is one of the main effects of global warming and that it is destroying land around the world. On the other hand, not as much is known about how sea level rise is affecting many aspects of the Chesapeake Bay specifically. Without this knowledge, there is little that can be done to help the Bay or help diminish the astonishing effects sea level rise is having on the Chesapeake Bay.

This proposal strives to fill in the various holes regarding these effects and gain understanding on how certain aspects of sea level rise interact with many different ecosystems within the Chesapeake Bay. Building upon preexisting data and research will allow us to see sea level rise’s negative effect on specifically natural geography, habitats, and the economy in the Bay. We predict that if sea level rises due to global warming, then natural geography, habitats, and the economy in the Bay will be negatively impacted. These three factors have been seen to be the most affected elements in the Chesapeake Bay, so it only makes sense to focus on these three elements and examine the effects they exhibit due to sea level rise.

**Aim 1​**. To address is to determine how the natural geography of the Chesapeake Bay will deteriorate due to sea level rise from global warming. We hypothesize that if sea level rise in the Chesapeake Bay continues, it will cause more detrimental harm to the Bay’s geography and have irreversible effects. The goal of this aim is to determine what role sea level rise plays in the degrading of natural geography along the Bay’s shoreline. In order to assess this question, measurements can be done on the land area surrounding the Bay, then checked in on in intervals to see how much of that natural geography is now submerged and how that is affecting the Bay’s health.

**Aim 2.​** To investigate the role of sea level rise in the various habitats around and within the Bay. This is very important because the habitats and wildlife that inhabit them keep the Bay’s biodiversity rich. The goal of this aim is to investigate how sea level rise is negatively impacting these habitats and what effect that has on the Bay itself. This can be investigated through tracking businesses over a period of time and see if the overall status of the industries increase or decrease. We can see how much these industries rely on the Bay and how they decline due to the Bay’s deteriorating health.

**Aim 3.​** To investigate the economy and the various industries that rely on the bay from an economical standpoint. The goal of this aim is to investigate the negative impact sea level rise has on the economy of the Bay. A deteriorating economy can then lead to bigger issues within the Bay and need to be addressed. We can test this by tracking a certain species of wildlife over a period of time and see how the population changes.

From this study, we expect to find that the Bay is being negatively affected by global warming in more ways than we expect. Gaining intel about these effects will help us humans realize this issue’s importance and fight back against global warming so we are not forced to learn to live with its unforgiving effects. People should care about this issue to make sure that this natural Bay that provides plenty of life is not destroyed. Every effect sea level rise has on the Bay creates a chain reaction that in turn affects more than just the Bay and more than those people living along the Bay.

Experimental Design

**Aim 1. To determine how the natural geography of the Chesapeake Bay will deteriorate due to sea level rise from global warming.** The goal of this aim is to test the hypothesis that sea level rise due to global warming will have a negative impact on the natural geography of the Chesapeake Bay, specifically the shorelines. This will allow us to determine whether or not shorelines along the Bay are at risk and what steps need to be taken to resolve or reduce the issue to ensure that humans and wildlife aren't losing precious land. In order to address this hypothesis, it will need to be determined if global warming is playing a role in the deterioration of sea level rise, and if so, how much it is affecting the bay.

**Aim 1.2. To determine how quickly natural geography is being submerged in the Chesapeake Bay due to sea level rise.** Experimentation will be used in order to determine how quickly sea level rise is taking over natural geography in the Bay. As many studies have indicated, different elevations of land are at different risk when it comes to sea level rise (Shulte et al, 2015). Due to this, we will be measuring various locations around the Bay with different angles of elevation to see how each is affected. There will be 40 sampling sites surrounding the Bay. Sampling locations will only be in areas where the water is still to ensure accuracy. Once the 40 sampling sites have been determined, the research team will visit each. The time that each location is visited is very important, due to the tide changes within the Chesapeake Bay. For this research, locations will be visited and examined during high tide. High tide timing needs to be closely watched, as it will change over the course of this research. This will force the group to split up and examine each site at similar times. At each location, a long stake will be placed in the land where the sea level currently sits. The stake will be deep and sturdy enough to where little movement occurs, but a margin of error will be calculated in case. A carving will be made in each stake where the sea level currently sits. In 30 day intervals, the sampling sites will be evaluated. Rather than constantly carving the stake in a slightly different spot every month, the distance of the sea level to the initial carve in the stake will be measured during each of these visits that occur every 30 days. After one year, the experiment will conclude, and the results will then be examined to create a conclusion on how much the sea level has risen in the Chesapeake Bay during that year. Knowing this information will help us go forward and find a way to counteract the sea level rise that is occurring in the Bay and save its natural geography. This will also help us determine how the Bay will be affected in the coming years based on the rise of the sea level annually that we collected, as well as how much land the Chesapeake Bay is losing to water submergence alone.

**Aim 1.3. To investigate the loss of natural geography to erosion due to sea level rise caused by global warming.** Another factor leading the Bay to a loss of natural geography is erosion from sea level rise due to global warming. In order to determine these rates of erosion, we will conduct a thorough experiment. We will be using the extraction of multiple soil cores to determine the health of many areas of shorelines along the Bay (Steinmuller et al, 2020). 10 sampling sites will be selected surrounding the Bay. The first day of sampling will act as the control. At each location, sample soil cores will be extracted from various distances from the current sea level. It is important to conduct these sampling extractions at the same time to ensure data isn’t inaccurate due to tide changes. The soil samples will be safely kept in a lab. This process will be repeated every 2 weeks for 12 months. The soil we collect will be analyzed using physiochemistry in order to determine the erosion rates of different areas of the Bay. Aspects will be taken into consideration such as bulk density, moisture, etc. (Steinmuller et al, 2020).

An interesting question to ask is how we will differentiate between sea level rise due to global warming and sea level rise due to various confounding variables. We can see that sea level rise due to global warming has been heightened over the past few decades. Ever since global warming began to increase and an exponential rate, sea levels have been rising faster (NASA, 2020). This allows us to generalize that a majority of the sea level rise occurring in the Bay is in fact due to global warming.

**Aim 2.** **To investigate the role of sea level rise in the various habitats and wildlife around and within the Bay.** The goal of this aim is to test the hypothesis that wildlife and habitats surrounding and within the Chesapeake Bay will be negatively impacted by sea level rise due to global warming. Determining the extent to which habitats in the Bay are being impacted by this effect of global warming will emphasize the importance of finding a solution to protect the Bay and its wildlife. In order to determine how habitats are being impacted, we will formulate an experiment to examine the condition of some of the Bay’s habitats.

**Aim 2.1. To determine how habitats are being affected by sea level rise due to global warming.** In order to test this aim, habitats on the Bay will be examined, as they are the habitats most affected by sea level rise. In recent years, there has been a tool developed known as a PCF that is used as an assessment tool to see if a stream within a habitat has decent stability (Environmental Protection Agency, 2020). This ensures that habitats will be protected if high flow events occur in a body of water. We will use this tool to see if habitats in the Chesapeake Bay are being negatively affected by sea level rise due to global warming. This study will take place at the same time as we measure sea level rise and erosion rates in order to compare the relationship. PCF will be used at 15 different habitats all around the Chesapeake Bay watershed. These will be a variety of habitat types to ensure the best results. Every month, the stability of the habitats will be measured for one year. After all the results have been gathered, we will be able to see if sea level rise and erosion have a negative overall effect on the habitats in the Bay.

**Aim 2.2. To determine how land animals are affected by sea level rise due to global warming.** Experimentation will be used to determine the ongoing health and wellbeing of Chesapeake Bay habitats using the populations of specific wildlife to make generalizations. In order to do this, we will observe a species present in the Bay over a period of time and see how the population changes. A common method to monitor populations utilizes a technique called spotlighting. Here, a large light is taken out in the night and shined around the area in question, and the eyes of certain nocturnal animals will glow (Mitchell et al, 2007). Researchers then determine if that animal is the animal in question and begin to count. This is often a long process and it is noted that some animals will be counted twice, while others will not be counted at all, so a margin of error is present. In our research, we will be spotlighting the number of barred owls surrounding the Chesapeake Bay. The barred owl is a nocturnal owl that lives in areas surrounding the Bay (National Parks Service, 2020). Our researchers will begin research on a given night at 12am. Starting then, the team will spotlight the perimeter of the Machodoc River for barred owls and keep count. This will be repeated every month for 2 years to determine how the population is changing with consideration for the margin of error. The barred owl population is being measured here to determine the wellbeing of the Bay’s habitats for various reasons. First, a barred owl is one of the main nocturnal species living within the Bay, which allows them to be a subject of our spotlighting process. In addition, while barred owls don’t live in an area directly impacted by sea level rise, this allows us to see how the actual habitats in the Bay are affected due to the fact the barred owl’s diet consists of reptiles and amphibians that live in the Bay itself (National Parks Service, 2020). If the habitats of these reptiles and amphibians in the Bay are diminishing, those populations will slowly decline, which will leave barred owls with a limited food supply, which in short will also show a decline in their population.

**Aim 2.3. To determine how aquatic animals are affected by sea level rise due to global warming.** In this experiment, the same method will be used, except we will be studying the population of an aquatic animal. As we are using spotlighting, a species that is active in the night will be chosen for the study. This species will be the bull redfish.Scientists have concluded that due to global warming, drier areas will become drier and wetter areas will get wetter, with regards to rainfall (Hausfather, 2018). Whether the Chesapeake Bay is considered a wet or dry area, the lack of or increase in rainfall can cause detrimental harm to plants in the Chesapeake Bay, more specifically, underwater grasses. Having too much rainfall can cause an excess of runoff and strip the Bay of its nutrients, while not enough rainfall can cause an increase in salinity in the water, which kills most underwater grasses (Chesapeake Bay Program, 2020). In this experiment, we will be studying the health of widgeon grass, a species of underwater grass in the Bay. Since sea level rise in the Bay represents global warming, we will compare our results of sea level rise increase to the health of this sea grass on the same timeline to see if there is a correlation. To determine the health of the grass, we will dive underwater to find 8 locations around the Bay that contain widgeon grass. Every week, we will return to those locations and use an underwater camera to take a picture of each widgeon grass location. At the end of one year, we will analyze the pictures. Brown grass will indicate unhealthy grass. We can create an overall percent of unhealthy grass for each week and see if it has a correlation to the increasing sea level rise.

**Aim 3. To investigate the economy and the various industries that rely on the Bay from an economic standpoint.** The goal of this aim is to test the hypothesis that if sea level rises due to global warming, the economy surrounding the Chesapeake Bay will be negatively impacted. This is a very important factor to address regarding the Bay, because if the economy deteriorates more, there will be less and less resources available to help the aspects of the Bay that are in great danger due to sea level rise, such as the natural geography, the wildlife, and various habitats.

**Aim 3.1. To investigate how badly affected industries relying on the Bay by sea level rise due to global warming are.** In order to test these effects, experimentation will have to be used, although with this specific aim, field work is not necessary. Instead, this will be a strictly observational study. We will choose a total of ten businesses/industries located directly on the Bay, as well as ten businesses/industries in the surrounding area that rely on the Bay. Examples of industries we will choose from include the tourism industry, fishing industry, and real estate industry. One industry in our sample will act as a control. This will be an industry or business that is located more inland and will most likely have little affects from sea level rise in the Chesapeake Bay. First, the industries will be contacted to determine if they would like to take part in this research. If agreeable, we will get the number of the approximate profit of that industry for the past month. This will occur in monthly intervals for one year with every business/industry in our sample. Other questions will be asked to these businesses during each month that will help the researchers determine if there are any confounding variables that could have also caused this deterioration or spike in the business’s profit level. After gathering all these numbers from each different business, they will be put into a spreadsheet and appropriate charts will be created to get an idea of how each business did over the past year, and an average conclusion will be drawn to see how most businesses related to the Chesapeake Bay are doing during a time of increased global warming. Making sure the Bay has a stable economy is important to ensure that it still has enough attention and having people rely on it will keep this attention. If people stop relying on the bay from an economic standpoint, there's a good chance they will no longer care at all, which will lead to the Bay’s health completely falling apart.

Expected Outcomes

**Aim 1.1. To determine how quickly natural geography is being submerged in the Chesapeake Bay due to sea level rise.**

Expected Outcomes: If our hypothesis is correct, we predict that over the course of one year, the amount of natural geography in the Bay submerged by water will increase. Global warming has been shown to have an exponential increase over the past years and has directly correlated with rising sea levels (Lindsey, 2019). From that data, it would be expected that after our year of experimentation is complete, that increase in sea level rise and the submersion of natural geography will be shown.

Possible Problems and Alternatives: A problem we might face during this experiment regards the tide changes in the Bay. While we will be tracking the tide changes and attempt to test each location when the tide is highest, it will be very hard to get it exact. Having a surplus of sampling sites and the amount of replication done will lead to a smaller margin of error in our results.

**Aim 1.2. To investigate the loss of natural geography to erosion due to sea level rise caused by global warming.**

Expected Outcomes: If our hypothesis is correct, we predict that erosion rates will increase with relation to sea level rise due to global warming, which will lead to the loss of natural geography along the Chesapeake Bay. More land being submerged in water due to sea level rise caused by global warming generally leads to greater amounts of sediment washing into the Bay, leading to higher rates of erosion (Environmental Protection Agency, 2020).

Possible Problems and Alternatives: A question to ask regarding our results of this experiment is how we will differentiate between sea level rise due to global warming and sea level rise due to various confounding variables, such as land subsidence in the Chesapeake Bay (Sea Level Rise, 2020). We can see that sea level rise due to global warming has been heightened over the past few decades. Ever since global warming began to increase and an exponential rate, sea levels have been rising faster (NASA, 2020). This allows us to generalize that a majority of the sea level rise occurring in the Bay is in fact due to global warming, which is then leading to this increased rate of erosion.

**Aim 2.1. To determine how habitats are being affected by sea level rise due to global warming.**

Expected Outcomes: If our hypothesis is correct, we predict that an increase in sea level rise due to global warming will show a decreased overall stability of habitats within the Chesapeake Bay. We predict that similar to any type of infrastructure, if an animal’s habitat becomes submerged in water, it will no longer be able to support itself and inevitably fall apart. When the sea level rises in the Bay, the waves and the overall rate at which the stream moves becomes faster, causing the destruction of Chesapeake Bay habitats (Environmental Protection Agency, 2020).

Possible Problems and Alternatives: This experimental design involves only those habitats located directly on the Chesapeake Bay that will be the most impacted by sea level rise due to global warming. We will not be assessing habitats located in trees, grass far from the water, etc. In order to avoid confusion, it will be specified in the experimental design that we are only assessing this population. We chose to only look into these habitats because they are most affected by sea level rise due to global warming. Another hole in this experiment is that different species create habitats with various levels of strength and stability, which will lead to more variation in the affect sea level rise has on these habitats. For each habitat and species, research will be conducted to learn more about their habitats, and it will be accounted for when examining the stability of each habitat. A margin of error for this hole will be considered. Another problem would be that only the habitats of macroscopic organisms are being screened in this study. This study does not take those microscopic organisms and their habitat into account since we have not found a sufficient way to measure the effects of those species’ habitats due to sea level rise specifically.

**Aim 2.2. To determine how land animals are affected by sea level rise due to global warming.**

Expected Outcomes: If our hypothesis is correct, we predict that the population of land animals will decrease due to sea level rise from global warming. Land animals, especially the one tested in this experiment, rely on the species present directly in the Bay as a food source, and they are often negatively affected by sea level rise. This leads to this disruption of a food chain and the inevitable loss of even land species (National Parks Service, 2020).

Possible Problems and Alternatives: A major issue many may have with this experiment is that it doesn’t confirm that the populations are decreasing due to sea level rise specifically. There could be confounding variables that are causing wildlife to diminish. We have taken this into consideration and have made a generalization that the decrease in the populations due to sea level rise from global warming because the National Wildlife Federation believes that global warming is the top reason for wildlife diminish in the Chesapeake Bay (2020).

**Aim 2.3. To determine how aquatic animals are affected by sea level rise due to global warming.**

Expected Outcomes: If our hypothesis is supported, we predict that the population of aquatic animals will decline with the increase of sea level rise due to global warming. Unlike land animals, aquatic animals live in the water of the Chesapeake Bay and their wellbeing is more directly impacted by sea level rise die to global warming (National Academy of Sciences, 2020). With this issue getting worse, we believe it will take a negative toll on the aquatic animal population.

Possible Problems and Alternatives: As this experiment as the same as that stated in Aim 2.2, similar holes arise, like the fact that there could be confounding variables also causing the diminish of these species. Similarly, sea level rise is seen to have the biggest impact on these populations and research will be done to ensure that there aren’t any other major life-threatening variables in the Bay that could affect the aquatic life population.

**Aim 2.4. To determine how plant life is affected by sea level rise due to global warming.**

Expected Outcomes: If our hypothesis is correct, we predict that the sea grass population will see a decrease due to sea level rise due to global warming. Sea level rise and an increase in rainfall due to global warming in the Chesapeake Bay lead to more runoff and pollutants entering the Bay, which kills sea grass such as the widgeon grass we are assessing (Hausfather, 2018). Nutrient pollution specifically is deadly to underwater grasses and is present due to sea level rise due to global warming.

Possible Problems and Alternatives: Few problems arise from this experimentation. A problem some might question about this methodology is that it is quite difficult to measure the entire population of widgeon grass. To counteract this, we will be using a sample of a few patches of widgeon grass to create a generalization of the entire population, and continuously using those same patches to measure the growth or diminish of the grass. Another hole, same as above, is that there could be other confounding variables killing the sea grass that we are not accounting for. We will research the Bay’s health in general to make sure there aren’t any other major variables killing the grass.

**Aim 3.1. To investigate how industries relying on the Bay are affected by sea level rise due to global warming are.**

Expected Outcomes: We expect that business owners will see a decline in the overall wellbeing of their business over the course of our experimentation. Many industries rely on the Chesapeake Bay and everything it supplies greatly. If these factors within the Bay diminish, it will show in the stability of these various businesses.

Possible Problems and Alternatives: The lack of quantitative experimentation leads to some holes in this experiment; mostly that we cannot confirm 100% accuracy, as we are just asking questions to businesses. In order to make our results as accurate as possible, we will be asking a large variety of questions, including those to determine if any other variables are causing the industry’s decline. After such a long questionnaire, we should have a good grasp at the state of the industry as well as the reasoning for that state. As stated before, we believe that these businesses are seeing a decrease in overall wellbeing due to sea level rise. This study and businesses participating in this questionnaire will lead to more light being shined on these issues in the Bay and hopefully that will lead to better stability in the Chesapeake Bay, as well as these businesses. Hope for this result will be the motivation for businesses to participate in this study.

Significance

With an increase in carbon emissions and greenhouse gases accumulating in the atmosphere, global warming has become an inevitable threat to the planet. Overtime, this issue will continue to cause harm to many areas around the world. When looking at global warming and its origin, the main causes of the issue are greenhouse gases entering the atmosphere, due to the constant burning of fossil fuels on Earth (Rosen, 2009). The longer these issues are left alone, the harder it will be to come up with a viable solution, which is one reason why global warming needs to be addressed as soon as possible. The Chesapeake Bay is at great risk for being affected by sea level rise due to global warming. Sea level rise has affected many aspects of the Bay, including its natural geography, habitats, and economy that now needs to weave through the maze to restore.

There are still a lot of unknowns when it comes to global warming, and more specifically, its effects on the Chesapeake Bay and how to prevent them. It’s very important to fill in these holes and gain understanding on how certain aspects of sea level rise interact with many different ecosystems within the Chesapeake Bay. Learning about these effects will help us evolve as humans to fight back against global warming and learn to live with its unforgiving effects. Without the gain of knowledge about these effects, the Chesapeake Bay’s doom will be inevitable and precious nature and wildlife will be gone. Building upon preexisting data and research will allow us to see the negative effect of sea level rise on natural geography, habitats, and the economy in the Bay and determine how we can put a stop to it. While some efforts have been made to combat sea level rise, nothing has helped to the extent the Bay needs. For example, some efforts being made include raising roads and buildings, building stormwater pumps, and upgrading sewage systems, but this clearly has not put a stop to the ongoing rise of sea levels in the Bay, and doesn’t change the fact that little information is known about sea level rise’s negative effects on the Bay (Sea Level Rise, 2019).

We know that certain aspects of the Bay will be affected much more than others, so in this proposal we have decided to focus on three of these specific factors that are in great danger from sea level rise due to global warming.

**Aim 1:** To determine how the natural geography of the Chesapeake Bay will deteriorate due to sea level rise from global warming. We hypothesize that if sea level rise in the Chesapeake Bay continues, it will cause more detrimental harm to the Bay’s geography and have irreversible effects. This is important to acknowledge because as natural geography deteriorates, human and wildlife wellbeing is deteriorating. We have seen this in action with the state of Tangier Island. Sea levels are rising at such an uncontrollable rate that it is predicted that a majority of Tangier Island’s natural geography will be underwater in just 50 short years (Schulte et al, 2015). This will be similar for many other communities if the effects sea level rise has on natural geography is not examined and stopped.

**Aim 2:** To investigate the role of sea level rise on the various habitats around and within the Bay. This is very important because the habitats and wildlife that inhabit them keep the Bay’s biodiversity rich. Without certain organisms that will diminish due to sea level rise, the entire wellbeing of the ecosystem in the Bay will decline because the food webs and balance will be significantly thrown off. As sea levels rise, these wetlands and marshes will be ingulfed in water and species such as the American black duck will have no habitat in the Bay and will be forced to migrate somewhere else (Chesapeake Bay Program, 2013). In addition to wetlands in the Bay, areas directly surrounding the Bay are in danger of being flooded, therefore destroying the habitats. If these habitats are destroyed, the wildlife inhabited in these areas will diminish, disorganizing the entire food chain and flow of the ecosystem in the Chesapeake Bay.

**Aim 3:** To investigate the negative impact sea level rise has on the economy of the Bay. A deteriorating economy can then lead to bigger issues within the Bay and need to be addressed. If the economy is not doing well, it will negatively affect a lot of people who rely on these industries around the Bay and throw off the flow of the entire community and even the country on a larger scale, as the Chesapeake Bay is the biggest estuary in the country that we rely on a lot to bring in income for various efforts such as tourism.

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