Climate Change and the Hudson River Marshlands

By Isabella J. Thayer

AUTHOR BIO

Isabella Thayer is a Junior at Millennium Brooklyn High School, in Brooklyn, New York. She is a National Honors Society student and loves biology. She is very passionate about the impact climate change has on the world and the environment, especially her home, and is an avid activist. She also has a side passion for genetics and evolution. She loves the theory of natural selection and the role it plays in life and is disappointed that it is sped up because of the effects of climate change.

ABSTRACT

Climate change effects on the Hudson River are becoming an ever-looming threat. There are several ways climate change is affecting the Hudson River including the inevitable rising sea levels that contribute to erosion of beaches, inundation of deltas as well as flooding of homes, schools, and stores. This research examines the following research question: how does climate change affect the Hudson River marshland? An often overlooked impact of climate change on the Hudson River is the expansion of wetlands into riverside marshes. This paper explores how the increasing amount of seawater from global climate change, can affect the Hudson River marshes. To answer this question a literature review and analysis using Google Scholar was implemented. The findings suggest that based on the increase in global temperatures, the amount of marshlands that have become wetland areas has increased in volume. Marshlands are critical to protecting cities from flooding. The implications of this research could prove valuable for other coastal cities, in the United States and globally, that seek to protect themselves from the increasingly unpredictable and catastrophic impacts of climate change.

Keywords: climate (change), Hudson (river), NYC marshlands, Hudson marshlands, brackish tidal flats, wet wastelands, effects of climate change, catastrophic, problematic, and riverside marshes.

INTRODUCTION

The effects of climate change are becoming an ever-looming threat to the Hudson River. To understand the nature of the beast the Hudson River can be considered an extension of the Atlantic Ocean. It is about one hundred and fifty miles long and stretches from the Narrows in New York Harbor to the Federal Dam at Troy, running on the eastern side of New York State. Sea levels along the entire estuary are linked to changes in water levels in the Atlantic Ocean. The major difference between the Hudson River and other river systems is that the Hudson is a unique case since it is a river system that affects a coastal city due to New York City's placement in New York. The city lies on the Lower New York Bay estuary of the East and Hudson Rivers, creating brackish waters.

More specifically, the rising sea level is forcing the Hudson River to pour gallons of salt water into riverside marshes, (Tabak et al., 2016). Marshlands are defined as "wetlands frequently or continually inundated with water, characterized by emergent soft-stemmed vegetation adapted to saturated soil conditions" by the Environmental Protection Agency (Classification and Types of Wetlands, 2024). They can be considered useful, because they are natural buffers from large amounts of flood water, specifically salt water, however, wetlands which are the result of flooding of marshes are considered bad for ecosystems and people who live by these marshes. These marshlands are gradually disappearing, replaced by tidal flats that offer minimal protection against flooding, thereby posing a threat to the communities and businesses situated along the riverbanks.

Marshes' ecosystem functions are to help buffer environments, typically dry forest land or large fields from heavy flooding. Today they can be used as a buffer for homes and cities along the shores that don't have other natural buffers like beaches. Through an examination of the research question this study aims to elucidate the consequences of rising sea levels on the marshes along the Hudson River.

WHAT IS CLIMATE CHANGE?

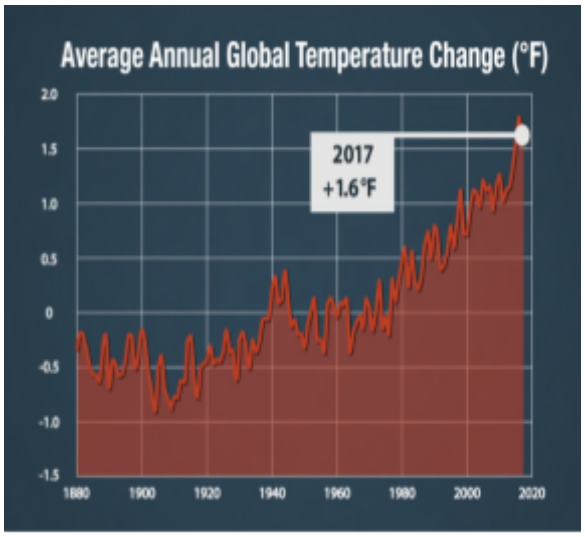
Climate Change is caused by greenhouse gasses like Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), and Ozone (O_3). These gasses come from the combustion of coal, oil, and natural gas all found in the earth. These gasses are not only poisonous, but they are also anthropically trapped in the ozone layer due to excessive mining and fracking carried out by humans. Additionally, because these gasses are prone to bond together, they trap heat in the ozone layer slowly raising the temperature. Eventually, as the ozone layer heats, it slowly heats the earth, raising global temperatures to frightening levels, (NASA, 2023). Table One illustrates how much the world temperature has increased since the nineteenth century due to anthropic activities.

THE IMPORTANCE OF CLIMATE CHANGE

As the sun's heat hits the Earth, it is regulated by the ozone layer protecting people, animals, and the environment. When there is too much heat in the atmosphere, there can be strange, unusual, and atypical weather patterns, including droughts and forest fires due to high temperatures in already warm places like California, Arizona, and Nevada. Outside of the U.S., places like Chad, Nigeria, Yemen, and South Sudan also experience droughts, famine, and severe dehydration due to climate change (10 countries at risk of climate disaster, 2023). In fact, according to the Council Of Foreign Affairs, these same countries produce the smallest amounts of greenhouse gasses (2023).

In addition, large glaciers melt due to the heat from climate change, which creates extra water in the ocean, forcing slow but steady flooding of coastal cities like New Orleans, Louisiana, Miami, Florida, and even New York City. Dozens of coastal cities globally are also affected similarly (US EPA, 2022. Warmer temperatures are changing weather patterns and disrupting the usual balance of nature. Although these shifts may be natural, human activities like the burning of fossil fuels, (coal, oil, and gas) which produce heat-trapping gasses, have been

causing climate change to speed up at an unnatural and terrifying rate from the 1880s to the present day, usage of fossil fuels has had an astronomical impact on the Earth's atmosphere (Table 1). The overall outcome is that the global temperature is rising even though the global temperature rises and falls every few years (Table 1). More specifically there *is* an overall heat shift in the Earth's atmosphere, gradually getting warmer hence the term "global warming." However, the term global warming is incorrect because it signifies that the earth is only getting warmer all the time rather than the earth's climate going back and forth (NASA, 2023). Instead, the term Climate Change is more accurate because it signifies exactly what is happening- the Earth's climate is changing - and not for the better.



(NASA Scientific Visualization studio, 2023)

Table 1: Average Annual Global Temperature

METHODS

To understand how the increase of seawater, due to climate change, is affecting Hudson River marshes, this project conducted a literature review and analysis, using search engines: Google Scholar, PubMed, and the National Library of Medicine. Twenty articles were identified, however, only two studies specifically addressed how seawater, due to climate change, is affecting the Hudson River marshes. The two studies used for the analysis are: *Simulating the effects of sea level rise on the resilience and migration of tidal wetlands along the Hudson River*, (Tabak et al. 2016) and *Sea level rise will drive salt front up the Hudson, prompting water quality concerns* (Shapley, 2022). These two studies are significant because they show how marshes are not only important, but are also being destroyed by salt water, and becoming tidal flats.

More specifically, Tabak et. al. (2016) study the rise of the sea level in the Hudson River, and the migration of tidal wetlands along the river. They find that climate change directly contributes to the creation of tidal flats. Whereas, Shapley (2022) examines how large amounts of salt and fresh water mixing can influence the fast creation and spread of tidal flats, and finds that the brackish water is the cause of destroyed marshes. However, both studies provide insight into how climate change and the melting of glaciers are the main causes of the expansion of tidal flats.

FINDINGS AND ANALYSIS

The purpose of this research is to understand how the increasing amount of seawater from global climate change, can affect the Hudson River marshes. The findings reveal that the increasing rise of seawater, due to climate change, is affecting Hudson River marshes. Mainly, the land is becoming uninhabitable, and marshlands are suffering, decaying, and becoming wetlands, due to a rise in seawater. These wetlands are encroaching upon previously habitable lands.

When analyzing the increase in seawater, in the Hudson River it is clear that it is due to how climate change is creating rising sea levels. When comparing the elevation to the rising water levels, the land around the Hudson is becoming wet tidal flats and uninhabitable. In the past ten to fifteen years, tidal flats have increased by five hundred hectares (See Table 2). This occurs because ocean water is mixing with freshwater due to climate change (Shapley, 2022). The resulting volume of water is just too much for marshes, rendering them wastelands or tidal flats of eroded soil and brackish water

(Tabak et al. 2016). The amount of water directly correlates with the amount of melting water from glaciers. With additional water in the ocean, it floods marshes, destroying them, and creating tidal flats (Tabak et al. 2016).

Table two compares the greenhouse gas emissions versus the amount of marshland turned into tidal flats. The Mean Highwater Mark, or the MHM is the definition point between bodies of water and land (for example, marshes versus oceans). If it's a low marsh it typically erodes the marshland, but if a marsh is considered high it means that it is still functioning and acting as a buffer to the marsh inhabitants. What is depicted on the graph is the amount of marshes that are being overlapped by higher levels of seawater. As time goes on, the amount of high marshes should grow, which is beneficial. However, the area of low marshes is increasing, parallel to the number of tidal flats being made. The creation of tidal flats can allow flooding - since marshes act as a buffer, the large problems that come with flooding like; homelessness, intense property damage, water damage, and in some cases, death.

These findings illustrate that the rising global temperature which is currently at 13.9°C or 57.0°F according to the (National Centers For Environmental Information, 2022) creates a decrease in Marshlands around the Hudson river and an increase in tidal flats. In the past ten to fifteen years tidal flats around the Hudson Marshlands have increased by five hundred hectares. That is, as the temperature increases, so does the level of the water in the Hudson River. This increase in water level contributes to increased marshlands. In addition, the implications of this, especially on the lowermost part of the Hudson River Basin could be catastrophic. The lowermost part of the Hudson River Basin is in a very residential area, New York City, meaning if it were to overflow or flood from rising sea levels, gallons of water would flood the people who live there.

Legend:
Tidal Flat: areas where sediments from river runoff, or inflow from tides, deposit mud or sand.
Low Marsh: a tidal marsh zone located below the Mean High Water Mark (MHM).
High Marsh: a tidal marsh zone located above the Mean High Water Mark (MHM).
New Open Water: An expanse of an ocean, sea, or large lake which is distant from shore and devoid of nearby islands or other obstructions.
Best Case Emissions: The best amount of Greenhouse Gas Emissions (GGE) that will limit the amount that Climate Change effects waterways.
Likely Emissions: The likely amount of Greenhouse Gas Emissions (GGE) that will limit the amount that Climate Change effects waterways.
Worst Case Emissions: The worst amount of Greenhouse Gas Emissions (GGE) that will limit the amount that Climate Change effects waterways.
(Colors on graph correlate with the colors on the legend)

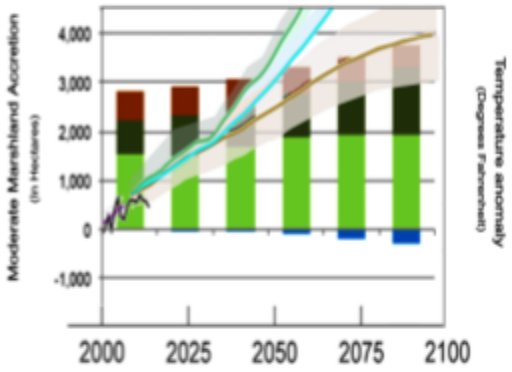


Table Two: Marshland Acceleration Over Time Versus Temperature Rising

CONCLUSION

In analyzing how climate change affects the Hudson River marshland, the data illustrate an increase in marshlands around the Hudson due to the increase of water in the river. This is significant because if the Hudson River continues to overflow, it will create additional marshland. These marshes take land away from schools, homes, stores, railroads, and highways which are fundamental to the sustainability of cities. Although it might not appear to be a big ordeal, if these places flood, it will cause catastrophe for those inhabitants. This is only the immediate effect. For example, there could also be an impact on wildlife. Since these lands were dry, only mammals and land animals lived there. Flooding pushes fish and other aquatic

animals into these areas creating a swampy tidal flat killing the protective marshlands, and pushing the original animals out. Therefore, due to the overflowing water, once habitable places are becoming a wet wasteland. Other coastal cities can learn from the example of the Hudson River by making efforts to protect their marshlands, such as decreasing their carbon emissions. By protecting our marshlands we can protect not only cities and wildlife but also the broader ecosystem supporting a call to action to stop climate change.

ACKNOWLEDGEMENTS

Thank you to K.L. Marriott who helped me create and find graphs. I would like to thank M.J. D'Agostino for helping me curate and strengthen this very paper.

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