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Fighting Heat and Rain: New York City's Climatic Problems and The Effect on The City's Urbanism

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Abstract

Severe weather events have come about as a result of the changing global climate, which have drastically changed local and global environments. These events have destroyed many homes, land areas, and, unfortunately, lives. Therefore, it is important for cities that are highly populated to be aware of the great damage a severe weather event can bring. New York City (NYC) has been hit with many severe weather conditions, and with over 8 million habitants, it is important that this city should be prepared for any future weather events that may occur. This paper analyzes the effects of heat waves and rainfall in NYC and the effect on its urban environment. All this followed by an analysis of how the city has been coping with these effects, those who are affected the most, and the policies that can better prepare NYC for future severe weather events. Chapter 1 provides data from the IPCC, NOAA, EPA, and NYC local government agencies regarding climate change, rainfall and heat waves, and the case study of Hurricane Sandy in order to better understand the effects of severe weather events on urban environments. Chapter 2 describes the different ways that NYC has coped with previous floods and heat waves and whether or not it has worked. Chapter 3 draws the attention of environmental injustices and those who are affected the most whenever heat waves and mass floods occur, in terms of power outages, transportation, etc. Chapter 4 looks at the policies from the local government the way they have tried to fight climate change and improve the City's urban designs through the different policies that are currently in place, or will be put into place. The final chapter concludes this paper by putting together the important information from each chapter and creates recommendations and potential solutions to the issues presented from each chapter and overall case study.

Keywords: climate change, New York City, urban planning, environmental justice, water management, NYC heat waves, sewage system, climate policy, NYC floods

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Introduction: What's Going On?: A Take on A Personal Experience

Earlier this year, July to be specific, I had relatives from Chicago come over to visit New York City. I hadn't seen them in a while, and my cousins grew up so quickly that they are now taller than me. One day when we went out to eat near Upper Manhattan, we became aware of the dark clouds approaching the otherwise clear blue sky. I didn't think much of it since it usually rains during the summer. We went inside the restaurant, sat down, and not even 5 minutes inside, it started pouring heavy rain. The days before this heavy rainfall were very hot, with people finding different ways to cool off, so I thought this was a perfectly timed rainfall. I would say it kept pouring for about 20 to 30 minutes, but when it eventually stopped, and we finished eating, we decided to head down to Hudson Yards to see the attractions that were around. We headed uptown to enter the Henry Hudson Parkway, but when we got there, the entrance was closed because it was flooded. We were stuck, not knowing how to head downtown; a few surrounding streets were also flooded making it harder to figure a safe way out. After about 2 hours, we made it to Hudson Yards, having to take the local way- regular streets with traffic lights, no highways. This made me think about the impact climate change and certain weather conditions have on cities and its ability to function properly. I would also like to mention that during the summer time, people have to resort to illegally opening fire hydrants in order to cool off because either they don’t have a functional air conditioning system, or they don’t have enough money to pay for the electricity bill for using an air conditioning unit. And is, frankly, another issue the city faces, that shouldn’t exist.

As a result, this paper analyzes the changing weather conditions, specifically heat waves and rainfall, and the effects these climatic events have on New York City, especially its

urbanism. I have been living in New York City my entire life, and this issue is very important to me, and therefore, I feel like I should address this problem and expose these issues to other New Yorkers. The first chapter will be analyzing data from the IPCC, Millennium Assessment, NOAA, and EPA, to expose the issues of climate change and further analyze data from the DEP in order to understand the environmental issues New York City faces due to the effects of climate change. The second chapter will focus on how New York City is dealing with the effects of climate change, especially the urban aspect of the city. The third chapter will be focusing on those who have to deal with the effects of climate change, especially those who have to take public transportation, and those facing environmental injustices. Chapter four will be discussing those people that have power: local and state governments, the wealthy, and the environmental and urban policies that have been discussed or passed by said governments to deal with the effects of climate change. The final chapter will wrap up this paper by connecting the dots of all the previous chapters in order to create potential policies and solutions that would benefit the environment and protect the urban features of New York City.

Chapter 1. Heat and Rain: The Effects of These on NYC

New York City is the most populated city in the United States making it one of the busiest cities in the world, and with a population of almost 9 million people, as of 2020, it is no wonder why it is called the "City That Never Sleeps" (Ballotpedia 2022). With this in mind, climate change will have a big impact on New York City and the way this urban city functions, disrupting the famous "City That Never Sleeps." Some of the big effects of climate change on New York City have been temperature rises, precipitation, sea level rise, and extreme storms. Of

these, temperature rise and precipitation/extreme storms, are the main focus of this paper. Data from the IPCC, EPA, and NOAA will be used to reflect the damage climate change has had on the world, North America, and eventually New York City, and by analyzing it, it can show us the way to fight against these weather events and when we are more likely to receive said events. In addition, data from the Millennium Ecosystem Assessment will provide understanding of the ecosystem services in New York City and how they are affected by climate change.

The Global Climate Emergency: A Brief History on Climate Change

The Intergovernmental Panel on Climate Change (IPCC) reported, in their Sixth Assessment Report that "multiple concurrent changes in the physical climate system have grown more salient, including increasing global temperatures, loss of ice volume, rising sea levels and changes in global precipitation patterns" (IPCC 2022, 126). They go on to say that "The changes in the physical climate system, most notably more intensive extreme events, have adversely affected natural and human systems around the world" (126). This is a very harsh awakening, one that just proves that climate change is in fact a real problem that humanity is facing, and we are in the front row at experiencing the consequences of our actions that led to drastic changes in global climate. It is undoubtedly true that climate change is, in big part, a result of human actions, and as the IPCC observed, "Human-induced climate change, including more frequent and intense extreme events, has caused widespread adverse impacts and related losses and damages to nature and people, beyond natural climate variability" (9). This isn't something that has been happening recently, since the mid-1700s, which is when the Industrial Revolution began, the burning of fossil fuels, deforestations, and agriculture have "led to significant

increases in the concentrations of several greenhouse gases, especially CO2, in the lower atmosphere" (Miller and Spoolman 2018, 474). However CO2 isn't the only greenhouse gas that has a large role in global warming. Methane (CH4) emissions are also a root cause of global warming, with levels of this gas greatly increasing since the 1970s. It has been revealed, through ice core analysis, that "about 70% of methane (CH4) emissions during the last 275 years are the result of human activities including livestock production, rice production, natural gas production, landfills, and the flooding of land behind large dams" (474). The National Oceanic and Atmospheric Administration (NOAA) has recorded that "Earth's temperature has risen by an average of 0.14° Fahrenheit (0.08° Celsius) per decade since 1880, or about 2° F in total" (Climate.gov 2023). This increase in temperature is a problem as 2022 was recorded to be the sixth warmest year. This global climate change has amplified the intensity of extreme weather events, events that were once mild, and affected the people, ecosystems, cities and their infrastructure. Since the atmosphere is getting hotter, climate scientists can see and project the severity of future weather events, for example storms and heat waves getting stronger and hotter, respectively (486). We are reminded of events like in California, where a wildfire, that resulted from a human-based activity, caused the skies in parts of California to have an orangey-like color (BBC News 2020). The effects of similar wildfires have been felt all the way on the east side of the country, where NOAA's RAP-Smoke model showed "significant concentrations of smoke over the tri-state region" (NBC New York 2022). Furthermore, no matter where human-based climate change starts, it is felt around the world, and it is always the most vulnerable and marginalized people who have to struggle with the effects.

Background on Floods

Floods are very dangerous weather events that cause a lot of damage, not only monetary but also physical. But in order to understand the severity of floods, it is important to first define the different types of floods. There are four kinds of floods that hit New York City: Coastal Flooding, Tidal Flooding, Inland Flooding, and Riverline Flooding. *The NYC's Risk Landscape: A Guide To Hazard Mitigation* (NYC Office of Emergency Management 2014) defines these floods as the following:

- Coastal Flooding**:** "Coastal flooding is primarily caused by storm surge – the rise in water levels caused by a storm's strong winds and low atmospheric pressure. Storm surge occurs when a strong coastal storm, such as a tropical storm, hurricane, or nor'easter, approaches land, the surge 'piles' up at the water's edge, raising water levels and flooding coastal areas" (69).
- Tidal Flooding: "Tidal flooding is caused by normal variations in the lunar cycle. Sea levels fluctuate daily due to gravitational forces and the orbital cycles of the moon and Earth. Every day brings two high tides and two low tides. Due to our city's size and geography, cycles of high and low tides vary – it could be low tide at the Battery in Lower Manhattan while it is high tide at Kings Point on the Long Island Sound. Daily high tides are at their highest twice a month, during what are known as 'spring tides,' when the Earth, sun, and moon are aligned" (69).
- Inland Flooding: "Commonly called 'flash floods' or 'urban floods,' inland floods can be caused by short-term, high-intensity rainfall (torrential downpours) often associated with sudden thunderstorms or hurricanes and other large-scale storms.

Inland floods can also be caused by moderate rainfall over several days, typically brought on by weaker storms that drift slowly or stall over an area" (70).

- Riverine Flooding: "A riverine flood occurs when a heavy rain or storm causes rivers and streams to overflow their natural or artificial channels, spilling into adjacent, low-lying areas. Erosion of riverbanks and stream banks will likely increase our risk of riverine flooding" (70).

These different floods can happen throughout the year, at any given time, but have a great impact on the city, especially those areas of the city that are man-made. The urban aspect of NewYork City, and the lack of green spaces and man-made expansion to the island, contribute to the severity of floods, making it harder to mitigate these floods, especially coastal, tidal, and inland floods, which are more common in the city (71).

Speaking of man-made expansions, many neighborhoods are built on top of landfills, that with the constant climatic change, will submerge back into the sea within the next century (Hinze and Judd 2021, 398). Not only will this affect communities and their individual function, but also have a big impact on on the city's economy, which is something that was reflected back in 2012, when Hurricane Sandy hit the tri-state, and $19 million in financial expenses due to the force destruction of the storm and the loss of economic activity throughout the city (397). The effects of these extreme weather events are expensive, and the money that is used to get back up and make the city function again comes from taxpayer money, who have to already deal with their own personal economic losses they experience as a result of these weather events, which was reflected by the 300 homes destroyed and 69,000 residentials units damaged.

Staying on the topic of Hurricane Sandy, this case study reflects the impacts heavy rainfalls, and the subsequent floods, had on the Tri-State area, keeping in mind the effects on New York City. Storm surges caused water to rise a staggering 13.88 feet, suspending all MTA services, flooding train stations, leaving debris on the streets, and disrupting the morning commute of many New Yorkers (Baruch College Weissman Center for International Business 2021). Power outages left as many as 800,000 New Yorkers without power, with downtown Manhattan becoming a deserted and obscured place after the sun went down. With electricity services down, homes flooded, and modes of transportation blocked, New York City had to set up 73 shelters throughout the five boroughs, in which 6,700 people were housed. And even though the storm left, there were many communities that years later still felt the impacts of the destruction left behind by Hurricane Sandy. For example, the Breezy Point community in the Rockaways, just out of Queens, was hit very hard, as this is a community built on sand near the coast. 100 homes were consumed by fires as a result of firefighters not being able to reach these fires as roads were flooded (Fetch 2017). And even though the rebuilding process has been positive after 5 years, there were still homes that weren't completely rebuilt and others that were left as lots, signifying that people had moved away from this community as a means to either escape the memories of the storm or live in a community that wouldn't be hit as hard by storms. However, this can't be said the same about other communities, especially ones in which residents don't have the financial means to rebuild their homes. Or as Fetch states "It's the older, flimsier structures, owned by people who are less well-off, that fall into the second category. Poorer people are also less likely to have the resources to rebuild while they spend years fighting for help from the government or an insurance company—if they even had insurance to begin with"

(2017). Therefore, understanding Hurricane Sandy as not only an environmental issue, but also a socioeconomic one allows it to become a framework to understand the outstanding effects of floods, and climate change overall.

The continuous sea level rise from melting ice caps and storm surges, from intensified hurricanes, means that there will be significant threats for cities, especially along the eastern seaboard of the U.S. (398). That being said, there is still much to do in order to mitigate the effect of climate change and sea level rise.

In New York State, the EPA reported that it has "warmed one to three degrees (F) in the last century, heavy rainstorms are more frequent, and the sea is rising about one inch every decade." (EPA 2016). This, as a result, causes beaches to erode, low lands to submerge, and coastal floodings to be worse (EPA 2016). Not only is this a problem to the overall state, but it has a more severe effect on New York City, being how this city is surrounded by a body of water, especially around the island of Manhattan, of which part of the island has been built over landfills. As a 1971 New York Times article mentions, "3,650 acres of new land have been added‑to Manhattan. More than one‑fourth of the island is now man‑made, taken from the water." (The New York Times 2022). Furthermore, downtown Manhattan is very susceptible to both flooding (due to sea level rise, heavy precipitation, and man-made land expansion) and heat waves (due to the effects of being an urban heat island), making it a very vulnerable area to the effects of climate change. Although scientists can't be fully confident that floods are increasing, or affected, by climate change, it can still be observed that climate change has intensified the number of heavy precipitation events (Shao 2022). So if the number of heavy precipitation events increases due to climate change, New York City, with a very outdated urban system, can

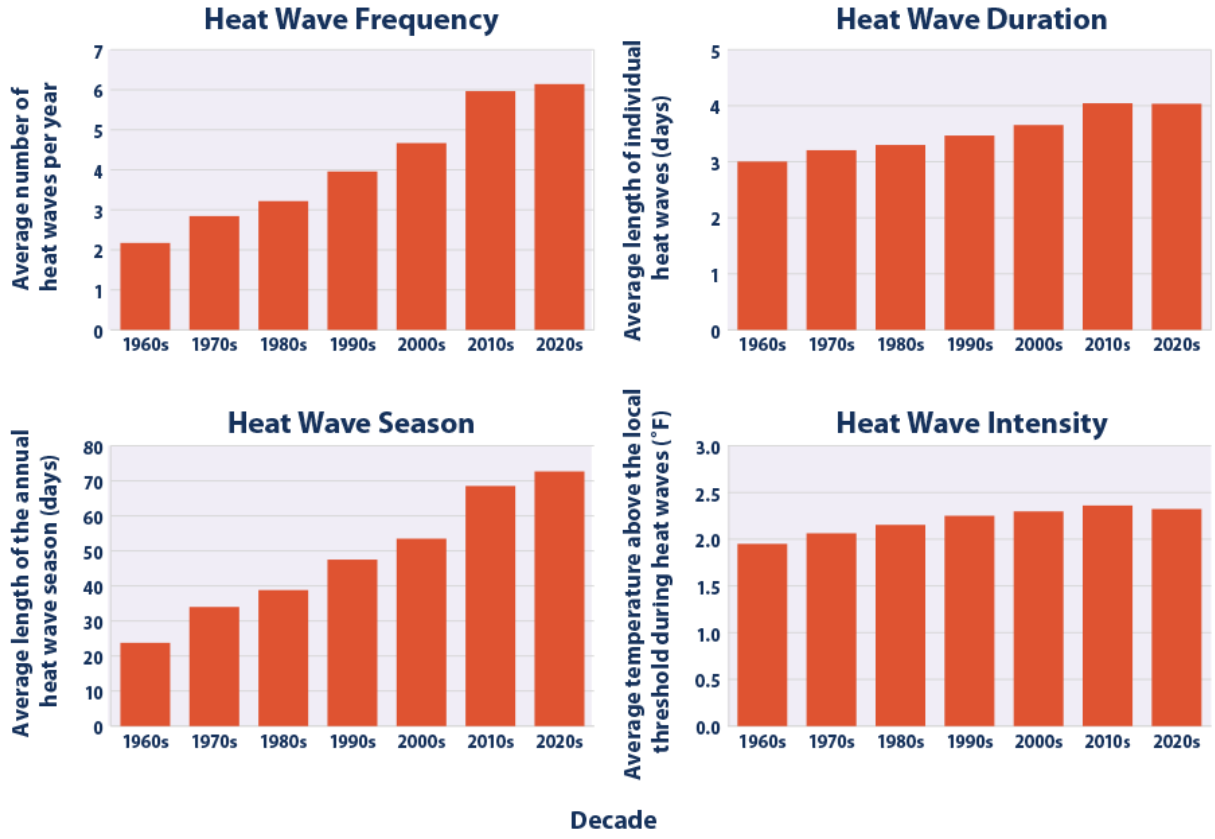
be prone to experiencing intense floods as the sewage system and other wastewater and stormwater management systems would become overwhelmed with the intensity of rainfall. As for river floods, climate change is "likely exacerbating the frequency and intensity of the extreme flood events, but decreasing the number of moderate floods…" (Shao 2021). In addition, coastal floodings will increase as the sea level keeps rising while flash floods will also increase as heavy precipitation events keep occurring.

Background on Heat Waves

Just like floods, heat waves are very dangerous to both the environment and the ecosystems that make up these environments, and the public health of New Yorkers. The New York City Panel on Climate Change (NPCC) observed that between 1900-2013 the mean annual temperature increased at a rate of 0.3 degrees Fahrenheit per decade, this in Central Park (DEP 2019, 23). The constant use of fossil fuels to power different aspects of the world, especially in populated cities, like New York City, are big factors to the rise in global temperature, resulting in increased climate change. The cost of climate change has an impact on basic services, infrastructure, housing, human livelihoods and health on cities (UN Environment Programme 2022). This has an impact on New York City as rising temperatures can melt the snow at an earlier time: early spring, increasing the evaporation making the soil dry during summer and fall times (EPA 2016, 1). This detail becomes more evident when we see that cities are responsible for about 70% of global CO2 emissions (UN Environment Programme 2022). The DEP provides a map in which it depicts the neighborhoods that are most vulnerable to high temperatures, and shows that the most vulnerable neighborhoods are the ones made up

predominantly of low-income and people of color (24). This comes to show that 1) New York City isn't completely ready to mitigate climate change and its outcomes, and 2) it will be those most vulnerable that will be the most affected by these events.

Figure 1. Heat Wave Characteristics in the United States by Decade, 1961–2021 (EPA 2022)



As represented by Figure 1, climate change has affected the effects of heat waves throughout the United States. The EPA mentions that it is urban cities that are affected the most, but also the ones that contribute to these effects as cities remove green spaces and lands that once had vast amounts of vegetation to make room for buildings and concrete streets. The urbanization of cities has contributed to an effect called the urban heat island (2021).

Urban Heat Island Effect in NYC

New York City is classified as an urban heat island, which, according to the United States Environmental Protection Agency (EPA), is an urban area where structures, such as buildings, roads, and other infrastructure "absorb and re-emit the sun's heat more than natural landscapes such as forests and water bodies." (EPA 2022). So in other words, the urban components of New York City, specifically the skyscrapers that are usually built from steel, and the lack of green spaces, trap and reflect the heat that comes from the sun, causing different changes to climate. There are different causes of heat islands, which according to the EPA are:

- Reduced Natural Landscapes in Urban Areas: the lack of natural green spaces or bodies of water in place for buildings, streets, and roads provide less shade and moisture which contribute to higher temperatures in cities (EPA 2022).
- Urban Material Properties: the way man-made materials are used in urban environments allow for higher temperatures due to the way it absorbs the sun's heat, in contrast with the low heat absorption natural surfaces have (EPA 2022).
- Urban Geometry: buildings within the city have a certain dimension and spacing that influences wind flow and urban materials' ability to absorb and release solar energy (EPA 2022).
- Heat Generated from Human Activities: cars, AC units, buildings, and other grand structures emit heat into the urban environment (EPA 2022).
- Weather and Geography: the clearness and calmness of certain weather conditions facilitate the severity of a heat island by maximizing the amount of solar energy

> reaching the concrete, buildings, and other urban surfaces and minimizing the amount of heat that's carried away. (EPA 2022)

The severity of the impact heat islands have is also based on the location, size of the urban area, and time of day. The high temperatures are usually seen during the day, when the sun is still out, and in the downtown area of the city, as the buildings tend to be taller, with less green spaces around

Ecosystem Services Affected

In terms of ecosystem services, there are a few that are not only crucial to New York City, but also to the entire planet that depends on one or more of the same services NYC receives. These ecosystem services are freshwater service, climate and air quality regulation, and wastewater treatment. According to the Millennium Ecosystem Assessment we, humans, are "fully dependent on Earth's ecosystems and the services that they provide, such as food, clean water, disease regulation, climate regulation, spiritual fulfillment, and aesthetic enjoyment" (2005, 49). Therefore, it is very important for humans to be aware of these ecosystem services, how New Yorkers specifically use these services, or at times misuse these services, and the way to preserve these services in an urban environment like New York City. Ecosystem services are equally important and affected by climate change as humans, and therefore require a vast amount of protection in order to prevent these services from disappearing, that would otherwise cause greater impacts not only on the environment, but also human society.

In terms of freshwater services, the exponential population growth has caused water to be consumed in larger amounts, and even though freshwater supplies are “renewed through a more or less stable global water cycle,” it is human consumption of this resource that is causing it to deplete (Millennium Ecosystem Assessment 2005, 181). With New York City having a population of over 8 million people, it makes sense that water consumption will be large and therefore making the local government look for more sources of freshwater to bring into the city. Water resources will eventually be diverted into different methods that will allow for efficient use of water supplies, allowing for less water to be misused and over consumed for unnecessary activities (182). For example, opening fire hydrants on hot summer days instead of finding a local library or cooling centers, that are opened and funded by the local government, creates a water misuse problem. This usually happens in low-income communities that either don’t have an AC unit or can’t afford to pay the electricity bill if they do use their AC units, causing this issue to also become an environmental justice issue. Not only is water misused, but there is also the probability of water becoming contaminated. For example, findings from the Millennium Ecosystem Assessment (2005) show that the “major pollution problem is eutrophication from agricultural runoff and acidification from atmospheric deposition. Major problems also include persistent toxic water pollution from point and non-point sources" (183). The use of some of these chemicals in agriculture reflect the impact small actions can have on a larger scale, in addition, of course, of the agricultural methods that consume a lot of water and the great impact this has on the environment due to the transformation of natural green spaces into farms and fields. Water pollution becomes a big issue in New York City when it rains, this due to the outdated sewage system that, when it reaches full capacity, causes combined sewage overflow

(CSO) to release untreated wastewater into the city streets, making its way onto the Hudson River and posing a public health risk.

When it comes to climate and air quality regulation, we all have the right to clean air, as stated by the EPA through the Clean Air Act in order to protect the environment and the healthcare of the population (EPA 2022). Therefore, it is very important that air quality is protected for the sake of human health, especially those in very vulnerable parts of an urban city. The Millennium Ecosystem Assessment (2005) points out that smoke pollution "generated by vegetation fires occasionally reaches levels with major public health and economic impacts—usually when wildfires or land management fires get out of hand under extreme weather conditions. Vegetation fires particularly enhance the risk of acute respiratory infections in childhood, a major killer of young children in developing countries, and affect the health of women already exposed to high levels of indoor air pollution" (380). This comes to show that many people that live in countries that can't regulate or create a legislature that protects air quality, will eventually suffer the most from climate change and fires that start in other parts of the world disproportionately affecting them. The World Health Organization (WHO) describes wildfires, and the effect this has on human health. They explain that wildfires "lead to a deterioration of the air quality, and loss of property, crops, resources, animals and people" (World Health Organization 2022). Not only that, but in urban cities car traffic also creates air pollution that affects the communities that surround highways, parkways, or other frequently used roads.

When it comes to wastewater management, it is a very important feature of an urban environment because humans, especially in very populated areas, like urban cities, create large amounts of waste. This waste, especially during heavy rainfalls, can be dragged out of the sewer,

blocking it, creating large urban ponds that are contaminated with waste, becoming a health hazard. This surplus of wastewater can also fall into surrounding bodies of water, like the Hudson River and Harlem River in New York City. The Millennium Ecosystem Assessment (2005) points out the damages caused by wastes, that is generally divided into three types of harm (420):

- Direct impairment of human health
- Damage to ecosystems or organisms that creates economic losses
- Damage to organisms in an ecosystem, with loss of biodiversity

They also explain that waste, and the amounts of it that's released into the environment, can, in many ways, depend on the choices made by local, state, and federal governments, as well as organizations and individuals (422). This shows that we have to change our consumption habits in order to reduce the amount of waste we produce. There's images of aquatic animals around the world that are killed or hurt due to, mostly plastic, waste that ends up in the ocean because of landfills, lack of an efficient waste management system, and even natural factors that lead to trash ending up in oceans.

Chapter 2. How Is the City Coping?

The terms and initial background have been analyzed, and we see how New York City is greatly affected by climate change through heat waves and rainfall, so how is the city dealing with this issue? Well, the truth to the matter is that it is a very complicated issue that New York City seems to not be prepared for and can not handle. The New York City's Department of Environmental Protection (DEP) is meant to "enrich the environment and protect public health

for all New Yorkers by providing high quality drinking water, managing wastewater and stormwater, and reducing air, noise, and hazardous materials pollution" (NYC Department of Environmental Protection 2022). So it makes sense that this department, along with the Department of Urban Planning, the Office of Emergency Management, and the Mayor's Office of Resiliency have to take the lead to provide contingency plans for extreme weather events that result from climate change. The DEP has been studying how climate change and an interaction with population growth can affect wastewater collection and treatment. They reported that "Rising sea level, higher flows due to increasing population, more intense storms, and elevated surface temperatures are all factors that DEP has considered which could potentially affect the city's drainage infrastructure, wastewater collection system, and treatment operations" (NYC Department of Environmental Protection 2013). This is something that has a big impact on New Yorkers, especially those who have to rely on public transportation and as I will discuss in Chapter 3, highways, streets, and underground subways are heavily impacted by the effects of heavy precipitation, which slows down, and sometimes stops the movement of people throughout the city. However, water isn't the only factor that impacts the city, there is also heat. Therefore, local city departments also implement solutions to try and mitigate the effects of extreme heat.

Government Measures Regarding Flooding and Water Quality

The city's drinking water comes from watersheds that extend 125 miles from the city, made of 19 reservoirs and 3 controlled lakes (EPA 2011, 21). That being said, the EPA has to make sure that the water supply system isn't affected by the constant urban runoffs from storm rainfall that end up flooding urban areas instead of watershed runoffs that can be used as

drinking water. This excess water that returns to watersheds as runoff is known as reliable surface runoff, which is regarded as a stable source of freshwater (Miller and Spoolman 2018, 303). As a result, the DEP had created a plan between 2011-2014 to protect the watersheds surrounding freshwater resources. The purchase of additional land is a very important component of protecting the water sources, because without it, the city would be required to filter all the drinking water that runs into the city (EPA 2011, 21). The DEP mentions that they have "already purchased more than 115,000 acres of land in the watershed and will continue this successful program by contacting the owners of at least 50,000 acres of land every year in order to meet the requirements of our current filtration avoidance determination." (22).

When it comes to rainfall in New York City, the local government has been creating different contingency plans to mitigate the effects of heavy rainfall, sea level rise, and other water related events. The DEP along with the Mayor Eric Adams, recently announced the expansion of the Cloudburst Program, which is a program that deals with the effects of cloudburst, which according to the DEP are "sudden, heavy downpour where a lot of rain falls in a short amount of time" (DEP 2023). This program implements a combination of different methods that would absorb, store and transfer stormwater to minimize floodings from cloudbursts. One of the pilot programs in regards with cloudburst management includes the implementation of this program at the South Jamaica Houses, part of the NYC Housing Authority, which is meant to "control neighborhood flooding for rain events ranging from a 10-year storm to everyday rain events through the use of well-designed outdoor spaces and infrastructure" (New York City Housing Authority & NYC Environmental Protection 2018). This project has a large importance as it will use outdoor public spaces as means to contain

rainfall, which is beneficial to the environment and local communities. Another project, which will also be dealt deeper in Chapter 4 is the Big U, which is a project that would stretch 10 miles around the coast of Lower Manhattan in order to protect this area from future storm surges and sea level rise.

New York City's storm runoff and sewage runs through the same network of pipes, a network system that is 150 years old, to make its way to the 14 wastewater treatment plants in the city (Chaisson 2017). This paper has been mentioning wastewater a lot, so it is proper to define it as it has a large connection to the sewage system. Wastewater is the mix of used water and waste that "flows down the drain or toilet from our homes and businesses. This wastewater is then carried by a series of sewer pipes to the local wastewater treatment plant for further processing" (DEP 2023). There is another kind of water that goes through the sewage system, that being stormwater which is rain and melted snow that falls on either rooftops, streets, or sidewalks that make its way into the storm drains or catch basins located outside homes and businesses (DEP 2023). These two types of waters travel through either a combined sewer system or separate storm sewer system. The combined sewer system uses a single pipe to transfer stormwater and wastewater to the local wastewater treatment plant. On the other hand, the separate storm sewer system uses separate pipes that directly connect wastewater and stormwater directly to the wastewater treatment plant without risking overflows unlike with combined sewers. Combined sewer overflows, or CSO, happens during heavy rainfall, causing the system to exceed the design capacity and release a mixture of wastewater and stormwater onto streets and local waterways (DEP 2023). The DEP states that "approximately 60% of New York City has a combined sewer system," while "approximately 40% of New York City uses a separate

sewer system" (DEP 2023). This means that when it rains, especially during severe storms that bring heavy precipitation, the city experiences "a gruesome mixture of polluted urban runoff and raw sewage to bypass the water treatment plants and discharge directly into local waterways…" (Chaisson). This has an immediate impact on people, not only because the city is flooded and they can't go about their daily routines, but also because it has an impact on public health, as it is water that hasn't been treated and disposed of bacteria and other chemicals that may end up in wastewaters. The city understands the problem of overflow and therefore, has been thinking about how to improve the sewage system, where the rainfall sometimes goes. A solution that the city has in mind, that is not underground-related, is rain gardens. These gardens are meant to do 2 things, increase greenery throughout the city and deal with the urban ponds that are created when it rains and sewers are at max capacity (DEP 2022). A key factor is that these gardens have no effect on pedestrians or cars that park next to these gardens. This is essential as projects like these should have little to no impact on the routine of cars and pedestrians in order to keep the city flowing as it has been. It is important to address this matter first since small projects like rain gardens can only do so much to absorb rainfall, and with climate change intensifying rainfall, small projects will have little to no effect on CSOs. In addition, the state of the pipes also has to be acknowledged. With a sewage system as outdated as New York City's, pipes are bound to burst or get damaged by the surrounding environment such as tree roots causing a release of untreated sewage. As the DEP (2019) mentions, In the event a problem occurs in New York City sewers, it is usually the result of a defect in the pipes like cracks, holes or fractures. In these instances, DEP will remove the roots using a rodder truck and repair the defect."

Measures Regarding The Heat Island Effect and Heat Waves

New York City has been experiencing very severe heat waves in the past few decades, in which there were a reported 2,039 deaths related to heat in the U.S. (Leighton 2019). Since there are many deaths related to heat, New York City understands the severity of this extreme weather event, and has provided resources for New Yorkers to cool off by opening cooling centers around the city and has also provided additional resources for those who need it (Office of Emergency Managements 2022). Even though this plan seems to be a band-aid to the bigger problem that climate change brings, it has flaws. During hot days, especially during extreme heat, more people are trying to cool off, causing them to use more power than usual, which is about 20-25% more power for days when temperatures are 90 degrees, compared to when it is 80 degrees (Leighton 2019). This increased use of power can lead to power outages in New York City. In July of 2019, more than 50,000 Con Edison customers experienced a power outage, this due to the high usage of electricity during a heat wave that had been hitting the city (Scutti 2019). Having power during hot days is very crucial in urban cities, as the city tends to get hotter due to its features: high steel buildings, concrete streets, lack of greenery, etc. As a result, the city, along with Con Edison and PSEG, the companies that provide energy services to the city, work on making sure that their residents have power, especially in the summer. To reduce the strain on the power system during heat waves, certain strategies have been implemented (NYC Office of Emergency Management 2014):

- System reinforcements which would “provide alternate or additional supplies of power to minimize the risk of disruption due to heat – for example, by increasing the number of

power supply feeders, installing additional distribution transformers, building new substations, and redistributing electric loads among substations" (106).

- Improving system reliability which "safeguards system components so that they are operational and available for service. This includes inspecting and maintaining equipment, upgrading components, and implementing improvements such as redesigning circuits to minimize the number of customers affected, and installing automated switches" (106).
- Operational readiness "involves measures to prepare system operations for summer conditions by conducting engineering analyses and studies to assess system conditions, implementing protective steps such as voltage reduction, conducting staff training and exercises on how to handle extreme heat scenarios, and confirming that power generators have adequate capacity" (106).
- Increased system redundancy which "provides alternate power supplies if the main supply is disrupted due to heat" (106).
- Utility demand response programs are "short-term strategies that offer financial incentives to customers to avoid blackouts when demand for electricity soars. Con Edison runs aggressive demand-response programs in which commercial, industrial, and residential customers can enroll voluntarily. When demand for electricity soars, Con Edison pays those customers who temporarily reduce their consumption of electricity upon request" (106).

Although these strategies are helpful in the urban aspect of mitigating extreme heat, there is still more to be done regarding public health, the environment overall, and the rapidness these issues

are faced with, by creating more long-term solutions rather than short-term solutions. As previously mentioned, New York City is an urban heat island, and a way to reduce the effects of the heat produced by the absorption and intensified release of solar radiation is by regulating buildings to consume less energy and reduce emissions. As I will further explain in Chapter 4, a solution to this problem comes in the form of Local Law 97, which is a law meant to regulate buildings over 25,000 square feet to require them to "meet new energy efficiency and greenhouse gas emissions limits by 2024, with stricter limits coming into effect in 2030. The goal is to reduce the emissions produced by the city's largest buildings 40 percent by 2030 and 80 percent by 2050" (DOB 2023).

Chapter 3. Who's Paying the Price?

New York City is one of those cities that is very crowded, with people living very close to one another, and being how climate is changing drastically, or violently, it makes this urban area vulnerable to devastating disasters (Hinze and Judd 2021, 397). And as previously mentioned, New York City is the largest city in the United States, but this also happens to be the case with its transportation. New York City has the largest transportation system in North America, run by the Metropolitan Transit Authority (MTA), with about 11 million daily riders (UNC School of Government 2014). This means that whenever severe rainfall and heat waves hit New York City, the MTA and its riders are affected the most, not only underground, but also above the ground. And speaking of above ground, public transportation isn't the only thing affected but also mass transit, commercial businesses, and systems around the city that are crucial to its functioning. Many homes are affected by floods, destroying many and making them

uninhabitable. When Hurricane Sandy hit New York City back in 2012, wind, rain, and water destroyed about 300 homes and left many without power (Office of Community Development Block Grant Disaster Recovery 2022). But not only were these people affected in these specific areas, healthcare, transportation, and other essential services to survive were impacted. This affects mainly low income families, immigrants, and people of color.

Environmental Justice

According to Julie Sze (2006) environmental justice is a term that emerged as part of the movement that addressed environmental racism: the unequal distribution of environmental benefits and pollution burdens based on race (13). This term is important to further understand the disproportionate effects of heat waves and floods towards low-income and minority communities. Zong and Popovich (2022) discuss the effects redlining still has on communities that were affected by these racist practices. They mention that "to this day, historically redlined neighborhoods are more likely to have high populations of Black, Latino and Asian residents than areas that were favorably assessed at the time." They provide the examples of Berkely and Oakland, California to reflect that in these previously redlined neighborhoods, nitrogen dioxide pollution was higher than those neighborhoods that were labeled as "best" in the 1930s (2022). This isn't only seen in California, but in New York City, urban planner Robert Moses was in charge of building the many highways and parkways that make the city flow the way it does today. However, he managed to build these highways through the middle of minority neighborhoods and "even made sure bridges on the parkways connecting New York City to

beaches in Long Island were low enough to keep city buses — which would likely be carrying poor minorities — from passing underneath" (Valentine 2020).

Flooding Injustice

When it comes to floods, Manhattan is almost always the first borough to receive help, at least from a personal experience. The Mayor's Office of Climate & Environmental Justice (2022) mentions that for coastal surge flooding "populations most at risk to current and future coastal storm surge flooding are those who live in the floodplain. Southern Brooklyn and Queens are expected to experience the greatest increases in future flood risk. In addition, those who have been excluded or marginalized based on their race, income or ability are more vulnerable to the impacts of climate impacts including coastal flooding." While they also mention that for extreme rainfall "many factors make some areas vulnerable: local topography, historic stormwater flow paths, subsurface conditions, land use, and impervious surfaces such as asphalt. These areas are typically inland and low-lying. They include Southeast and Central Queens, North Staten Island, and Southeast Bronx." It is also mentioned that besides homes, schools, libraries, spaces for youth and senior services, and cultural sites are all equally impacted by coastal surge flooding. When it comes to transportation, commuters have to deal the most with the effects of climate change on the city. When heavy rain falls on the city, the MTA is largely affected, especially underground subway stations. Or as Petrana Radulovic mentions "It's not just the stations that are flooding, but the entrances and stairs as well, leaving commuters soaked both from the bottom and the top." (2018). And this is water coming from above the street, and that water is not clean, since it is a mixture of stormwater and wastewater. So, being how this transit system is very old,

it is not properly equipped to handle large amounts of rain, making the morning and afternoon commute difficult for the working class who have no other means to commute to work. Heavy rains can cause flooding and mudslides across inland regions, creating effects on highways, railways and bridges, while in coastal regions, "rising sea levels and more extreme storms can lead to more storm surge and flooding, which can damage roads, bridges, railways, ports, and coastal airports. Increased local flooding can affect roadways and tunnels, weaken roadway materials, and cause traffic congestion" (EPA 2022). This affects the commute of many people, especially in New York City, which is constantly populated with cars coming in and out of the city.

Heat Injustice

Exposure to long periods of heat can be fatal, and as the Mayor's Office of Climate & Environmental Justice (2022) mentions, "heat vulnerability across neighborhoods are rooted in social and economic disparities. These disparities stem from structural racism, which includes neighborhood disinvestment, and historical policies such as redlining." The neighborhoods that are affected the most are Central Brooklyn, Upper Manhattan, and the South Bronx, this because of the systematic racism that affects these neighborhoods, the lack of green spaces, limited access to AC and poor housing quality (2022). In addition to these disparities, rain isn't the only negative impact on the MTA, extreme heat is, in my opinion, the most harmful weather factor on this transit system. Prolonged exposure to heat impacts transportation infrastructure, especially those on the ground, like Amtrak, Long Island Rail Road, or Metro North, and those above ground, again like Metro North, but usually overhead subway stations. This exposure can "cause

railroad tracks and wires, and pavement and joints on roads and bridges to crack, buckle, or sag, resulting in service disruptions, potentially hazardous travel conditions, and the need for costly repairs." (NYC Office of Emergency Management 2014). Also the EPA (2022) mentioned that vehicles exposed to heat may overheat and roadway joints can buckle, leading to accidents.

Rebuilding Injustice

The costs of making the city more sustainable and effective towards heavy rainfall and extreme heat is very high. However, the costs of constantly reconstructing and repairing the city after these events hit, makes one prefer the high cost of improving the city but as Hinze and Judd (2021) mention, "too many cities and municipalities remain hesitant to make high-impact changes to prevent climate change from becoming even more threatening due to financial consideration: Sustainability initiatives, especially at their outset, are expensive" (404). When Hurricane Sandy hit, the cost of damages was about $19 billion, but through the Disaster Relief Appropriations Act of 2013, the city only received 4.2 billion in aid (Office of Community Development Block Grant Disaster Recovery 2022). This makes it very difficult and longer to recover, since many of those people affected are part of the working class that make just enough, and can't afford the high costs of rebuilding their homes.

So, who do we seem to prioritize when it comes to emergency preparedness and infrastructure improvements? Well, that answer seems to be easy to respond to. After the effects that came from Hurricane Sandy, rebuilding began, but most of the federal aid went to projects to rebuild the shores, which are projects that are not still finished (Maldonado 2021). This money could have been used elsewhere, for example throughout the city's infrastructure, in order to

prevent massive floods in the city due to the lack of improvement in the sewage system. Not only that, but there is currently a project that is meant to protect areas of Lower Manhattan from floods, since many parts of that area were built over landfills. Not only is this project costly, but it also leaves out other neighborhoods in Upper Manhattan and the other 4 boroughs. Since Wall Street is located in Lower Manhattan, it seems like the city is prioritizing their economy over the safety of their residents. Federal government-funded laws can provide a temporary economic income to New York City, which should allow the city to focus on protecting all 5 boroughs, not just Manhattan.

Chapter 4. NYC's Climate Change Policies

When it comes to New York City, it seems that local and state government leaders have interests of their own when dealing with problems resulting from climate change. At first it may seem that it isn't meant to prioritize a certain area, but in the long run, one can see that there are more solutions and plans being made that are meant to protect and improve the parts of Lower Manhattan over, say the Bronx or Brooklyn. The Office of the Mayor had a strategy plan in which its purpose was to approach urban water management, and one of the examples was coastal resiliency. This example described an investment as part of a $20 billion climate resiliency program across the 5 boroughs in order to make neighborhoods more prepared to mitigate the effects of climate change (Office of The Mayor, 2). Although this solutions sounds that it will be inclusive, it immediately goes on to say that "This includes major new coastal resiliency investments that protect the most vulnerable coastal communities in New York City, including large-scale flood protection systems like the East Side Coastal Resiliency project, as

well as the Raised Shorelines initiative, which will mitigate the impacts of sea level rise and erosion in low-lying neighborhoods." (2). This shows that one of the priorities is East Side coastal development, which does make sense when we remember how parts of Manhattan are built on landfills, but it doesn't mean that it should be your main priority. There are more vulnerable areas in Central Brooklyn, Upper Manhattan, the South Bronx, Southeast and Central Queens, and North Staten Island that would very much benefit from this program. These neighborhoods are vulnerable because they disproportionately experience the effects of heat waves, coastal surge floods and rainfall, as previously mentioned in Chapter 3. As Hinze and Judd (2021) mention, these forms of resiliency planning in the city have "focused mainly on Lower Manhattan, which, admittedly, is extremely vulnerable to storm surges and flooding but also contains an agglomeration of concentrated wealth. Other, less wealthy areas, which may be similarly threatened, have seen little to no initiative for planning ahead." (398). What this shows New Yorkers is that the city cares more about protecting the neighborhoods that attract more tourists, where the financial district is at, where City Hall is, over affordable housing buildings, small homes, and lower income neighborhoods that are equally or more affected by the effects of climate change.

Rainfall and Flood Plans

In terms of rainfall, some projects or legislation that have been passed are meant to deal with the effects of heavy rainfall on the city. For example, the Sewer System Management Plan is meant to analyze sewer backup complaints and focus on how to fix the problems related to these complaints in order to allow for water to flow freely into the sewer system. It makes sense

that these sewers are fixed because as previously stated, wastewater and stormwater usually run through the same pipe and therefore if stormwater overflows and blocks sewage drains, it can cause a mixture of stormwater and wastewater to flow onto the city streets and into the environment. Another idea the city has implemented is rain gardens. These gardens are located at the edge of sidewalks with openings that connect the road to the garden on the sidewalk. The DEP explains that these gardens can "improve your street by reducing ponding, providing summer shade, and greening your community. Most importantly, rain gardens improve the environment by allowing rain to be naturally absorbed into the ground instead of flowing into the sewer system." (DEP 2022). This is a very ambitious project because it allows rain to naturally return to the soil instead of ending up in the sewer system, that is, honestly, very flawed, leading to less sewage overflow and potential blockage. Projects like these seem very beneficial, not only because they are trying to mitigate the severity of weather events, but also because they also are, slowly but surely, re-introducing green spaces into the urban environment. Mayor Eric Adams, along with the DEP, have released a plan that will prepare New York City's government and New Yorkers for increased, and more extreme, rainfall in the future called the Rainfall Ready Plan (City of New York 2022). Part of this plan includes planning for intense storms, in which the government would notify residents and owners about flood risks and providing resources to help protect their property, while at the same time completing short-term infrastructure projects to mitigate the floods (DEP 2022). I honestly don't like the strategy they would be implementing because there isn't any long-term plan. I do agree that, at this point, we have to start adapting to more severe rainfall, but not by creating short-term projects that will still allow for large floods to occur and cause parts of the city to be temporarily shut down. Another project, that has

already started its initial stages, is a project known as the Big U. according to the BIG Team, the Big U is a protective system surrounding parts of Lower and Midtown Manhattan, made by the needs and concerns of the surrounding communities (BIG Team n.d., 8). This project would stretch from West 57th Street down south to The Battery up to East 42nd Street as it "protects 10 continuous miles of low-lying geography that comprise an incredibly dense, vibrant, and vulnerable urban area. The proposed system not only shields the city against floods and stormwater; it provides social and environmental benefits to the community, an improved public realm." (8). This project builds off the SIRR Report recommendations on making New York City adapt to climate change. The short-term adaptation plans include "reducing upland flooding on the Lower East Side; creating flood protecting topography in our parks to protect the city beyond and making the parks themselves more resilient, and promoting the creation of green jobs to maintain this green infrastructure," while the long-term plans include "big moves like covering the FDR Drive with a park will have a transformative effect on the city" (25). These plans seem good for protecting the coastal area of Lower Manhattan. In addition, this project would be tailored to the needs of each community that would make part of the Big U, this includes the hybrid solutions of resiliency infrastructure with programs, resiliency infrastructure with people, and resiliency infrastructure with community, which basically means connecting an infrastructural element with the desirable social functions which would allow the project to become one with the community rather than being the center of attention (27). The project isn't meant to shadow over the local communities, but rather hide in plain sight, while still protecting these communities and other parts of Lower Manhattan. The scope of this project is divided into three customized compartments: C1, C2, and C3.

- C1: “The northern compartment protects a deep floodplain next to the FDR Drive, which separates it from East River Park. The park, now badly connected to the community, has room for a protective berm” (45).
- C2: “At Two Bridges, the relative lack of space between the residential areas and the waterfront favors a mixed-flood-protection strategy. Limited-height flood protection shields the area against most recurrent floods while allowing for views to the waterfront. This is complemented by systematic measures to raise generators, etc., in a so-called ‘wet feet’ strategy that will allow the community to deal with the much rarer, bigger flood” (45).
- C3: “The unifying theme in compartment C3 is the enhancement of the touristic infrastructure in Lower Manhattan. A sequence of attractive urban spaces on the waterfront will protect the city while serving and pleasing the millions of visitors and thousands of workers in the area” (45).

These three components are interconnected in the overall function of the Big U, but they are also their individual projects, created to fit the needs of the communities they will be protecting.

Although appealing, this project, as stated in their plan summary, focuses on protecting Lower Manhattan, leaving out the rest of Manhattan along with the other boroughs, which also face the same threats of floods that may come from severe storms and hurricanes. To think that the local government approved for this, a project that would cost a little over $1 billion to protect only a small part of New York City seems very excessive (214). There are many New Yorkers in

the rest of the city that would not have a barrier to protect themselves from floods, especially low-income communities and communities of color.

As previously mentioned in Chapter 2, cloudburst management has become a potential solution to deal with the sudden heavy rainfalls, or cloudburst, that hit the city. This project would implement a mixture of grey and green infrastructures in order to minimize the damage to property and infrastructure by reducing the strain on the sewer system (DEP 2023). When the city looks at cloudburst infrastructure, they pay attention to factors such as (2003):

- the array of physical features, both natural and constructed,
- the number and size of area storm drain and sewer pipes,
- available space for new projects,
- below ground conditions, such as soil quality and existing utility infrastructure,
- the possibility of connecting green and gray infrastructure, and
- the social and economic conditions of the people and businesses in a community.

New York City has also worked on the Stormwater Resiliency Plan, which was created to be consistent with Local Law 172, passed n 2018, which "required the City to produce maps showing areas of the city most vulnerable to increased flooding due to the anticipated effects of climate change and publish a long-term plan to prevent or mitigate such increased flooding" (Mayor's Office of Resiliency 2021, 4). Therefore, this plan outlines the city's approach to manage extreme rainfall and their risks and commits to four goals that would optimize emergency response to extreme rainfall (4):

1. Inform the public about flood vulnerability from extreme rain.

2. Update NYC's flash flood response procedures to prioritize response in vulnerable areas.
3. Advance policies that reduce urban flooding and research that informs future risk
4. Leverage stormwater investments to help manage future flood risk from extreme rain and sea level rise. Future investments can alleviate flooding throughout the city.

One of the major portions of this plan is stormwater investment, which is important because it deals with the sewer system, and as previously stated, it is an outdated system with flaws that result in CSO. The sewage system depends on gravity to move the water through the pipes, but with high tides, it temporarily disrupts the ability of stormwater infrastructure to drain streets as they were designed to (7). Therefore, improving the sewer system is crucial to dealing with rainfall and floods. It is not enough to implement these resiliency plans, if they require to function with an updated urban environment, which does include the sewer system and can also include the MTA, as these are both outdated systems that lose their functionality when heavy rainfall events occur.

Heat Waves

A program implemented by the city called NYC Cool Roofs Program is meant to coat building rooftops with a white reflective coating that would help alleviate the effects of heat waves (United States EPA 2022). This seems like a smart idea since for the most part buildings rooftops have been coated black, allowing for heat to be absorbed and trapped in the city for a longer period of time. Another project New York City adopted was the Million Trees initiative to

plant a million trees by 2017. This is also a beneficial initiative as it allows for more green spaces to be made for trees which can then mitigate the excess of greenhouse gases by creating shade and reducing the effects of the urban heat island (United States EPA 2022). A citywide plan that helps alleviate the effects of heat waves for people is the Cool It! NYC, which plans to increase the amount of cooling features throughout the city that are made available to the public (NYC Parks n.d.,). This plan seems ideal, especially for low-income New Yorkers that can't pay for or don't have an AC unit, and for the city to avoid the effects of power outages due to the amount of people consuming energy to keep themselves cool. However, it seems that this plan involves a lot of water usage, when it can focus more on more natural shading in order to avoid overconsumption and misuse of water sources.

Hinze and Judd (2021) discuss New York State's plan called The Climate Leadership and Community Protection Act, which would require the state to get to 100% carbon-free electricity by 2040 and to 0% carbon emissions by 2050, while investing 35% of clean energy created into marginalized communities that experience high levels of pollution (406). This would work well with the plans behind Local Law 97, which would require most buildings over 25,000 square feet to meet new energy efficiency and greenhouse gas emissions limits by 2024, with stricter limits coming into effect in 2030 (NYC Sustainable Buildings). This law is important as "buildings account for approximately two-thirds of greenhouse gas emissions in New York City,"which would eventually help reduce the effects of the urban heat island and reduce the severity of heat waves.

Fundings

Some of these projects have very well-thought-of plans that would definitely work if properly implemented, and with the proper funding to actually see these projects through. However, with so many plans, some focusing on the same overall issue, and others on specific issues, the cost to see these plans go through is very high. As previously stated, many cities become hesitant on making high-impact climate change solutions, as these projects are expensive, and therefore seems almost impossible to create long-term solutions (Hinze and Judd 2021, 404). Yet, state and federal fundings for environmental projects has opened the door to fully fund many of the projects the city has planned out.

The Clean Water, Clean Air and Green Jobs Environmental Bond Act, or Bond Act for short, was voted for approval by New Yorker as part of the November 2022 elections. This act would invest $4.2 Billion in New York's Environment and Communities (NYS 2023). The act's main priorities include mitigation of climate change and job creations. It's mentioned by New York State that investments will "help municipalities reimagine, redesign and rebuild to withstand future high-water and storm events," while also promoting job creations "by establishing an estimated 84,000 green jobs" (2023). This is a great step into partially or fully funding projects like the NYC Stormwater Resiliency Plan, Cloudburst Management, Wastewater Resiliency Plan, and Big U. It's hard to understand the massive work that it would take to go through with these plans, but also the cost, which is why maybe not that many projects have been approved of, either because it was too expensive or not a strong long-term solution, which another thing; resiliency plans should aim for long-term solutions rather than short-term ones.

As for the federal government, the Biden administration was able to have Congress pass the Infrastructure Investment and Jobs Act, a bill that provides new funding for infrastructure projects, which include (Congress.gov 2022):

- roads, bridges, and major projects;
- passenger and freight rail;
- highway and pedestrian safety;
- public transit;
- broadband;
- ports and waterways;
- airports;
- water infrastructure;
- power and grid reliability and resiliency;
- resiliency, including funding for coastal resiliency, ecosystem restoration, and weatherization;
- clean school buses and ferries;
- electric vehicle charging;
- addressing legacy pollution by cleaning up Brownfield and Superfund sites and reclaiming abandoned mines; and
- Western Water Infrastructure.

Although the fundings for this bill could be used for New York City's many resiliency plans, it should be used to improve the public transportation system. Many New Yorkers rely on this system, so when stations flood and lack the proper infrastructure to mitigate them, it disrupts

the everyday lives and routines of New Yorkers, which can also have economic problems as many of them work in Manhattan, the center of tourism and economy.

In addition to these bills, there is another one that can benefit people in a more immediate manner. This being the Inflation Reduction Act of 2022, which in part would grant income tax credits for those who purchase qualifying plug-in electric vehicles (EV) (Congress.gov 2022). This is groundbreaking, especially in New York City because of the large amounts of car traffic that the city has to deal with. If people take advantage of this opportunity, more EVs can hit the roads, reducing air pollution from car exhaust, which would also target reduction in the intensities of the urban heat island effect.

So, the plans are made, the funding is there, and people are becoming more environmentally aware, but will these plans work? That is a question that would involve deeply analyzing what is good for the environment and New York City in terms of social and economic issues that arise from climate change and the effects they have on heat waves and floods.

Chapter 5. Improving the City

We have seen what climate change has done to New York City, but we also saw how the city has been dealing and will continue to deal with the effects of climate change. Whether it's rainy days or hot sunny days, the city has to be prepared for anything that may disrupt the "City that Never Sleeps." If we look back at how the different services are distributed, we can think about creating a plan that protects these services.

Personal Power Grids

Power outages not only affect households, it also affects hospitals, fire stations, police precincts, supermarkets, etc. Therefore, creating long-term plans that benefit these services should be implemented. An idea I had in mind was placing these services on a “personal” power grid, based on communities they serve. For example, if we look at the Fordham neighborhood in the Bronx, there is the 52nd Precinct, 2 fire stations (Engine 48/Ladder 56/Div. 7 and Engine 88/Ladder 38) and St. Barnabas Hospital. These are crucial services that benefit the public and urban environment, and without them, it would be harder for the Fordham community to live effectively during environmental disasters. As I previously stated, power outages that affected New York City came after or during an extreme weather event. That being said, these new personal power grids should have the ability to withstand the effects of floods, but also the possible overconsumption of energy during heat waves. These grids should also be sustainable, meaning that it should rely on solar or wind power, as these are environmentally-friendly rather than using natural gas. I could see some variation of Local Law 97 applying here because these grids should also help reduce the unnecessary energy consumption and emissions of hospitals, fire stations, police stations, and supermarkets. Therefore, these services won’t be disrupted in the event of an extreme weather event. The implementation of such grids would be very expensive, which is why requesting funds from state and federal governments through the Bond Act and Infrastructure Investment and Jobs Act, respectively, would allow for these grids to become a reality. Implementing an initial pilot program in a community that has a large number of public services, such as Fordham, would allow city agencies to measure data to see whether or not this project would be cost effective and beneficial.

Larger Rain Gardens

Another thing the city has recently implemented that can be created on a bigger scale are the rain gardens. The rain gardens that the local government has implemented are meant to deal with the large puddles that result from rainfall. This water would be absorbed by the garden allowing the street corners, sidewalks, and roads to be free of floods. The bigger scale implementation is something like an entire playground/park that is permeable - meant to absorb the rainfall and make sure it doesn't leave the area that makes up the park. This park has an additional benefit: adding more greenery to the city, which can help reduce the intensity of extreme heat. The city needs to create more multi-beneficial solutions, because if they keep focusing on single-service solutions, it will take longer to address the larger impacts that climate change brings.

Improving the Sewage System

Throughout this paper, I have been talking about the flaws of the sewage system, specifically how this system is really outdated to be used to mitigate the current climatic changes in the city. CSO poses a big threat to the environment and public health, and therefore improving the city's sewage system becomes a priority in terms of infrastructures that are hit more severely due to climate change. The main improvement of this system is its pipes. Some of these pipes can burst releasing untreated sewage on local waterways. So, upgrading the pipes should be one of the main priorities. Another priority should be increasing the capacity of the system, especially in combined sewer systems because they receive stormwater and wastewater from different sources, all leading to a single pipe that ends up in the wastewater treatment plant. This

would obviously involve a high cost, but through the Infrastructure Investment and Jobs Act, money could be allocated from the federal government to fund the upgrade of these pipes. Other plans seem to not really focus on the problem with the pipes, mainly because of the expensive work it would be to upgrade these pipes. The Stormwater Resiliency Plan has a lot of its focus on public outreach and would provide information to New Yorkers about the threats of extreme rain and how to be prepared for potential flooding. But the sewage system could easily take care of stormwater runoff, but once the system reaches capacity, it will release excess water onto the streets, then causing said floods. However, if the system was up to date by analyzing the current data on floods and extreme rain, intensified by climate change of course, then the system would be able to mitigate with the intensities of rainfall. But since monetary efforts aren't being made to upgrade the system, the problem will continue to worsen.

More Electric Vehicles

Personally I am a big advocate for EVs because they help reduce greenhouse gas emissions from car exhaust that contributes to air pollution and climate change. Cars are essential for the movement of people throughout New York City, but they are not really sustainable since they emit large amounts of greenhouse gases. That being said, more bills like the Inflation Reduction Act should be created because it provides tax cuts for those who purchase qualifying EVs. What I had in mind was a system in which you could trade in your current gas or hybrid vehicle for a fully EV. Obviously different cars have different values, so no, no one will get a Tesla Model X for trading a Toyota Corolla, there has to be a proper system that takes the value of your car and gives you an EV that is the same price or slightly higher. And I

say slightly higher because it doesn't seem fair to devalue someone who is making the effort to change to EV and reduce their carbon footprint. The effects of changing from gas cars to electric cars would reduce air pollution, especially around neighborhoods that are surrounded by highways and parkways. This would solve a few problems:

- Air pollution
- Urban Heat Island Effect
- Improved Public Health

However, in order for this program to work, you need a car, which is something that a lot of people in lower-income neighborhoods, made up of people of color, lack. They rely so much on public transportation because at the end of the day, even though the MTA has its flaws, during rush hour times it is more time efficient to take the train than driving. You have thousands of people trying to go to work, school, home, or wherever they need to go, and therefore it causes a lot of traffic congestion, which is intensified by floods, as floods cause certain entrances to highways and parkways to be blocked off. This exacerbates the amount of traffic on local streets, bringing the air pollution of cars from highways into the inner parts of the city.

Overall the plan for EVs would just involve incentivising New Yorkers to switch towards an EV. This is a major solution to reduce the amount of emissions cars make. New York City agencies should see EVs as a newfound necessity to fight climate change, not a luxury. I am not talking about giving people Teslas, there are other companies that are also creating EVs that don't cost as much as a Tesla EV.

Coastal Protection

Protecting New York City from sea level rise is one of the top priorities throughout the city. That is why projects like the Big U have been discussed and approved to help prepare the city for rising sea levels. However, a project like the Big U wouldn't be enough since its main focus relies on Lower Manhattan. In addition portions of this project would involve completely removing spaces and playgrounds that have been part of the community for a long time, and yes change sometimes is good, but this would involve completely erasing the history of a place of which the locals have very fond memories of. My solution would involve a larger scope of what the Big U is trying to do, except implementing it as one with the community rather than reshaping it. Coastal communities along the five boroughs would be protected by a project that implements next generation sea level rise mitigation that has either been developed in other cities, or a groundbreaking new strategy. All five boroughs should be treated equitably because they all have different topographies and hence, different means to mitigate sea level rise. And just like the previous solutions mentioned above, federal and state governments should be able to fund this project. Specifically the Bond Act which is more New York centered and would also create jobs from approving this project. Completely protecting all of New York City's coastlines would require years of construction, this is because the plan should focus on protecting the city in the long run.

Urban Heat Island

Heat waves have a huge impact on cities, and New York City is no exception. Heat waves pose a threat to people's health, infrastructures, and other services. Therefore, a contingency plan has to be made to protect New Yorkers' health and the stability of tall buildings that make New

York City iconic. As mentioned in Chapter 3, heat can melt different surfaces which include metals, a material that most buildings in the city are made out of. The urban heat island effect just amplifies the heat and makes it worse, so an additional solution would be to regulate the amount of pollution and moderate the amount of heat reflected by buildings. The initiative of coating rooftops in a white reflective substance to mitigate the amount of heat reflected back into the atmosphere seems like a very effective solution. Not only that, but reducing emissions from cars can also reduce the extreme effects of heat waves, which goes in part with the solution mentioned above regarding EVs and the potential they have to reduce emissions. Dealing with heat also poses a power grid problem, as power outages may occur due to the amount of people relying on their AC units to keep themselves cool. Furthermore, financing these solutions is probably the easiest to do since it involves a lot of long-term effective solutions. Solutions to mitigate and reduce heat waves and the urban heat island effect also solve other problems such as switching to EVs, improving the overall grid system, and protecting public health.

In conclusion, New York City has a lot to work on in terms of protecting the city and its people. The city has a lot of vulnerabilities that end up affecting the economy, public health, and other important services throughout the city, mainly resulting from infrastructure, social and racial issues. So it is essential that these services be protected from extreme weather events that are intensified by the effects of climate change. Heavy rainfall causes floods throughout the city, causing monetary damage and disruptions to people's everyday lives. These heavy rainfalls have a huge impact on the city's sewage system and on coastal communities. Heat waves can cause people to experience power outages due to the high demands of power usage to stay cool. Not

only that but extreme heat waves are weather events that cause a lot of deaths, and therefore it becomes an issue of public health. Those who are affected the most are those low-income and minority groups that receive the most environmental injustices. Communities that are in coastal areas outside of Lower Manhattan, and those communities that are surrounded by highways are disproportionately affected by effects of climate change, including heat waves and floods. So what New York City needs to do is implement solutions that not only protect the environment, but also prioritize those New Yorkers that are most affected from the effects of climate change, instead of just focusing on the tourist scenery of Lower Manhattan. Even though New York City's economic center is located in Lower Manhattan, it doesn't mean that the other boroughs are less essential, on the contrary, many people who work in Lower Manhattan commute from other boroughs. Just because Lower Manhattan may be protected from sea level rise, floods, and heat waves, that doesn't mean that other boroughs are. And with transportation accessibility being crucial to the movement of people throughout the city, this economic center would be paused without its essential workers being able to commute. So to protect New York City and to keep calling it the "City That Never Sleeps," important climate resiliency plans will have to be created to allow the this city to mitigate against heat waves and heavy rainfall.

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