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Infiltrating Green into the Urban Machine: Creating Equity Through Zero-Acreage Farms in NYC

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Infiltrating Green into the Urban Machine: Creating Equity Through Zero-Acreage Farms
in NYC

Hania Hribal-Kornilowicz

Abstract

Urban centers have long been areas characterized by teeming activity, innovation, and idealized opportunity. However, without fail every urban center contains the paradox between abundance and injustice as evidenced by high rates of food insecurity, lack of green space, and the compounding health disparities experienced by predominantly low-income and minority residents. These injustices will only worsen as the impacts of climate change accelerate. In response, this thesis uses New York City as a case study to explore the efficacy of ZFarming, which is farming in and on buildings, for creating more equitable and sustainable cities. This is accomplished by establishing the quantitative data surrounding food insecurity, poverty, and access to green space in America, and then more specifically, in New York City. These issues are then analyzed through the history and framework of the environmental justice movement. Next, the ecosystem services provided by ZFarming and access to green space are discussed, which reveals the importance of environmental amenities for public health. This results in an exploration of current New York City's policies and local initiatives for implementing ZFarming, and improving access to green space and food security. Finally, after considering the scope of injustices that plague one of the most abundant cities in the world, a series of policies are suggested to encourage future ZFarming implementation. This is vital, because ZFarming has the potential to serve as a model for sustainable city development through the provision of ecosystem services, while simultaneously weaving together the paradox of abundance and injustice existing within New York City.

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Introduction: Can A Concrete Jungle Grow New Roots?

By 2050, the world population is expected to pass the 9 billion mark with more than half of the world's current citizens living in urban areas. By 2030, 60% of the world's population is expected to live within cities. Today's cities consume more than two thirds of the world's energy and account for more than 70% of global CO₂ emissions.¹ Furthermore, according to the UN, the amount of arable land per person decreased from about an acre in 1970 to half an acre in 2000 and is projected to decline to about a third by 2050 due to climate change.² As such, the real challenge of the future will be designing urban landscapes with a wide range of cooperating functions to create equitable and sustainable urban infrastructure that can provide environmental goods and services to increasing urban populations in the face of climate change.

ZFarming is an out of the box solution for numerous current and projected future urban ills. It is defined as innovative forms of green urban architecture that combine food production and design in order to produce food on a larger scale in and on buildings through the construction of rooftop horticulture, rooftop greenhouses, indoor farming (vertical farms), and other building related forms. The idea behind ZFarming is to link food production with buildings to create a small-scale resource recycling and savings system. The free space for urban-agriculture is limited and will be increasingly more desirable as city populations continue to grow and development increases. Access to green space is a related issue that ZFarming can solve through the creation of creatively placed green spaces throughout urban areas where ground level land is unattainable.

¹ Specht, Kathrin, Rosemarie Siebert, Ina Hartmann, Ulf B. Freisinger, Magdalena Sawicka, Armin

² Despommier, Dickson. 2009. "A Farm On Every Floor". *Nytimes.Com*.
<http://www.nytimes.com/2009/08/24/opinion/24Despommier.html>.

Throughout this thesis, the predominant focus will be on rooftop horticulture, which includes green roofs, greenhouses, and rooftop farms, instead of other forms of ZFarming. This is due to the greater potential rooftop horticulture has at benefitting and engaging citizens in underserved areas compared to other forms of ZFarming that focus more on high-end commercial food production. Although urban areas require the most effort to retrofit and redevelop into sustainable areas, they also offer the most reward due to the high density of consumers, high rates of food insecurity, and concomitant health disparities for the urban poor and minority populations.³

Chapter one will focus on the quantitative data surrounding food insecurity, poverty, and access to green space. Broader national data is discussed first, followed by an in depth look at the scope of New York City's paradox of abundance and injustice. The data reveals stark rates of poverty, food insecurity, and health disparities among low-income and minority residents. Chapter two then focuses on how built environments that facilitate racial and economic segregation occur through exclusionary zoning and city planning policies. This is intertwined within the environmental justice movement's history and framework. The chapter will then look into the evolution of the environmental justice movement and how food insecurity, green space, and public health are all distributive environmental justice issues. Chapter three will delve into the history of rooftop horticulture from the ziggurats of Mesopotamia, to the insulating green roofs in Norway, up until the theater gardens of New York City. Societies have long reaped the benefits of rooftop horticulture through the provision of ecosystem service. The ecosystem services provided by rooftop agriculture and green spaces are discussed in

³ (Specht et al. 2013)

detail, and are central to this thesis due to the provision of greater food security and improved physical and mental health. Chapter four then goes on to determine the efficacy of New York's political framework for green infrastructure, environmental justice, and food security. Finally, chapter five will conclude this thesis by providing policy suggestions that incentivize the broad range implementation of ZFarming. Future implementation of these suggested policies will create stronger communities, improve health outcomes within underserved areas, provide healthy affordable food, access to green space, and green job training. As a result, ZFarming has the potential to unify New York's existing paradox between abundance and injustice through equitable and sustainable development, which simultaneously mitigates the effects of climate change.

Chapter 1. A Tale of Two Cities

America is the richest country in the world and rests on the ethos of providing equal opportunity for all. As a capitalist consumerist society, we are known for both our abundance and excess, but looking beyond the hubris provided by affluence is the stark reality that “the richest country in the world” has a shocking number of citizens who are suffering from food insecurity. The World Food Summit of 1996 defined food security as existing “when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life”. Commonly, the concept of food security is defined as including both physical and economic access to food that meets people's dietary needs as well as their food preferences.⁴

The most accessible up to date statistics from 2014 state that 48.1 million Americans were suffering by living in food insecure households, including 32.8 million adults and 15.3 million children. About 14 percent of households (17.4 million households) were food insecure with 6 percent of households (6.9 million households) experiencing very low food security. Households that had higher rates of food insecurity than the national average included households with children (19%), especially households with children headed by single women (35%) or single men (22%), Black non-Hispanic households (26%) and Hispanic households (22%). In 2013, 5.4 million seniors (over age 60), or 9 percent of all seniors were food insecure.⁵

One factor that impacts food security is the unequal access to healthy food within the built environment of American communities. This geographic lack of access has been

⁴ The World Health Organization., 2016. *Global Health Observatory Data-Urban Population Growth*. The World Health Organization.

⁵ "Hunger And Poverty Facts And Statistics". 2016. *Feeding America*.
<http://www.feedingamerica.org/hunger-in-america/impact-of-hunger/hunger-and-poverty/hunger-and-poverty-fact-sheet.html?referrer=https://www.google.com/>.

coined a “food desert,” and although food deserts do not have a strict definition, they have come to embody the structural constraints that limit food access based upon the proximity of supermarkets.⁶ The USDA defines food deserts for the Let’s Move Initiative as having at least 500 people and/or at least 33 percent of the census tract’s population residing more than one mile from a supermarket or large grocery store (for rural census tracts, the distance is more than 10 miles).⁷ There are approximately 2.35 million U.S households, including 6.5 million children, living in a food desert more than a mile from a supermarket and do not have access to a vehicle. An additional 3.4 million households, or 3.2 percent of all households, live between one-half to 1 mile and do not have access to a vehicle.⁸ Food insecurity and the geographic prevalence of food deserts are inextricably linked to poverty in the United States.

The United States determines the percentage of residents living in poverty through a measure called the federal poverty line. The U.S. Census Bureau determines this by comparing pre-tax cash income against a threshold that is updated annually for inflation and set at three times the cost of a minimum food diet in 1963. The thresholds are adjusted for family size, composition, and age of householder. The federal poverty line is used to compare poverty over time, by demographics, and as a base level determinant for eligibility in federal aid programs.⁹ In 2014 the federal poverty line was

⁶ Kato, Yuki and Laura McKinney. 2014. "Bringing Food Desert Residents To An Alternative Food Market: A Semi-Experimental Study Of Impediments To Food Access". *Agric Hum Values* 32 (2): 215-227. doi:10.1007/s10460-014-9541-3.

⁷ United States Department of Agriculture., 2009. *Access To Affordable And Nutritious Food: Measuring And Understanding Food Deserts And Their Consequences*. Economic Research Service.

⁸ (United States Department of Agriculture 2009)

⁹ "How Is Poverty Measured In The United States?". 2014. *Nstitute For Research On Poverty At The University Of Wisconsin–Madison*. <http://www.irp.wisc.edu/faqs/faq2.htm#supplemental>.

14.8%, which means 46.7 million Americans were living in poverty.¹⁰ To put that into concrete numerical context, the Federal Poverty Level for 2014 states that an individual citizen is below the poverty line if they make \$11,670 per year, a two person household is \$15,730, three person \$19,790, and four person household \$23,850. For each additional person after an eight-person household the federal poverty level increases by \$4,060.¹¹ Interestingly, the total number of Americans suffering from food insecurity is similar to the number of those in poverty, 48.1 and 46.7 million respectively.

Broad national statistics, with an arguably outdated methodology, only paint a fraction of the mural of injustices and compounding negative health outcomes from those who suffer from both food insecurity and poverty. The lack of access to affordable and nutritious food is linked to obesity, especially among low-income and minority residents. For example, a study done by the University of Minnesota found that the highest levels of obesity, between 32-40%, were observed in census tracts with no supermarkets.¹² Policymakers have begun to examine the built environment, specifically access to healthy and unhealthy foods, to understand how neighborhood food availability may be contributing to racial/ethnic and economic disparities in weight, obesity and diabetes.¹³

So how do these disparities actually play out on a smaller and less generalized scale? Using New York City as a case study to examine the linkages between poverty, food access, and access to environmental amenities through an additional lack of green

¹⁰ "Income, Poverty And Health Insurance Coverage In The U.S.: 2014". 2015. *Census.Gov*. <https://www.census.gov/newsroom/press-releases/2015/cb15-157.html>.

¹¹ "Federal Poverty Level Guidelines". 2016. *Obamacare Facts*. <http://obamacarefacts.com/federal-poverty-level/>.

¹² Segal, Adi. 2010. "Food Deserts: A Global Crisis In New York City". *Consilience: The Journal Of Sustainable Development*, no. 3: 197-214. <http://dx.doi.org/10.7916/D8PG1RCG>.

¹³ Gordon, Cynthia, Marnie Purciel-Hill, Nirupa R. Ghai, Leslie Kaufman, Regina Graham, and Gretchen Van Wye. 2011. "Measuring Food Deserts In New York City's Low-Income Neighborhoods". *Health & Place* 17 (2): 696-700. doi:10.1016/j.healthplace.2010.12.012.

space in predominantly minority and low-income neighborhoods, an image of urban contrast emerges. As a result, one of the most glorified cities in the world has become a concentrated example of disparate health impacts due to unequal distribution of numerous amenities and ills within the built environment. New York has come to epitomize a tale of two cities; one of abundance and one of injustice, which is perhaps most starkly seen through segregation across all five boroughs by socioeconomic status and race/ethnicity.

According to data released by the Census Bureau's American Community Survey, which looks at demographics, housing statistics, and the economic and social statuses of Americans, New York City's poverty level from 2014 has remained high with 20.7% of the city's population, or nearly 1.8 million New Yorkers, living below the poverty line. Additionally, New York City's Coalition Against Hunger found that one out of every five NYC residents earns 19,790 a year or less to support a family of three. One of the highest poverty rates is with single moms at 41.1%, which is twice the rate of poverty for the overall NYC population.¹⁴ The Center for Economic Opportunity released a new report that found that nearly half of New Yorkers (45.6%) are barely making ends meet. Meanwhile, the median NYC rent has risen by 75% between 2000 and 2012, showing the stark levels of income inequality in NYC.¹⁵

New York City's Center for Economic Opportunity (CEO) created a tool that allows users to select certain demographic features by both poverty and population type in order to provide numerous options for the statistical analysis of poverty within the

¹⁴ O'Neill, Maggie. 2015. "Grim Data Reveals City's Poverty Rate Isn't Getting Any Better". *Observer*. <http://observer.com/2015/09/grim-data-reveals-citys-poverty-rate-isnt-getting-any-better/>.

¹⁵ Oh, Inae. 2014. "Half Of New York City Is Living In Near Poverty". *The Huffington Post*. http://www.huffingtonpost.com/2014/04/30/nyc-poverty_n_5240355.html.

city.¹⁶ This tool and the Center for Economic Opportunities' individualized poverty report use a different methodology, because the federal poverty line is outdated and much too narrow in scope. For example, the federal poverty line does not take into account geographical context concerning the cost of living, which is vastly different across the country. Furthermore, it has not been adjusted for changes in the standard of living over time, nor does it reflect modern expenses and resources like taxes, work expenses, food assistance, etc.¹⁷

The CEO bases their New York City specific poverty threshold on what families spend on basic necessities like food, clothing, shelter, and utilities, and is additionally adjusted to reflect the variation in housing costs across the US. As a result, their 2014 poverty line came in at \$31,581 for a four-person household compared to the federal poverty line of \$23,850 for the same size household. The CEO's demographic tool shows a data range between 2010 and 2014 that more accurately represents the poverty experienced by New Yorkers. In 2014, the total NYC population poverty rate was 20.7% with each borough breaking down as such: the Bronx at 26.5%; Brooklyn 21.9%; Queens 20.4%; Staten Island 18.3%; and Manhattan with the lowest rate at 14.6%.

Unsurprisingly, the rates of poverty within community districts of Manhattan correlate closely to racial/ethnic breakdowns as evidence by the New York Times "Mapping Segregation" interactive map. The Upper East (7.2%) and West Side (9.4%) and Greenwich Village (9.2%), all of which are predominantly white, are all well below the city average while poverty rates in predominantly minority areas like Central (23.4%)

¹⁶ "CEO - Poverty Data & Research - Poverty Data Tool". 2015. *Nyc.Gov*.
<http://www.nyc.gov/html/ceo/html/poverty/lookup.shtml>.

¹⁷ ("How Is Poverty Measured In The United States?" 2014)

and East (22.4%) Harlem, Chinatown (19.7%), and Morningside/Hamilton Heights (24.8%). Although none of these are disparagingly above the five-year NYC poverty line, they are still extraordinarily telling of the stark racial and economic split that exists.¹⁸

This is even more apparent when comparing Manhattan's statistics to other boroughs. For example, The Bronx, which is known for being minority majority, is broken into twelve community districts, of which only two are below the 20.7% NYC average poverty line. Three of the twelve districts have more than 30% of their population living below the poverty line including; Highbridge/South Concourse (31.9%), Morrisania/East Tremont (32.4%), and University Heights/Fordham (35.6%). The majority of Brooklyn neighborhoods fall in the mid twenties for poverty percentile. However, neighborhoods that are known for being very white, wealthy, and gentrified like Park Slope (9.5%) and Brooklyn Heights/Fort Greene (12.3%) have noticeably lower rates of poverty compared to East New York/Starrett City (33.0%), Brownsville/Ocean Hill (30.6%), Borough Park (31.1%), Sunset Park (28.2%), and Bushwick (27%). Queens had fewer stark contrasts, but the neighborhoods with the lowest poverty rates include Forest Hills/Rego Park (14.4%), Bayside/Little Neck (15.3%), and Bellrose/Rosedale (12.7%). The neighborhoods with the highest poverty rates were Elmhurst/Corona (27.2%), Jackson Heights (25.2%), and Flushing/Whitestone (24.5%). Staten Island is not particularly remarkable, but the predominantly white Staten Island South Shore boasts only an 11.6% poverty rate compared to the North Shore, which has a greater number of minorities at 21.1%.¹⁹

¹⁸ ("CEO - Poverty Data & Research - Poverty Data Tool" 2015)

¹⁹ ("CEO - Poverty Data & Research - Poverty Data Tool" 2015)

It is not particularly surprising that the community districts with higher rates of poverty and minority majority populations also suffer from higher rates of food insecurity in New York City. Unfortunately, an all-encompassing list of food insecurity percentages across community districts does not currently exist. However, The New York City Coalition Against Hunger did a comprehensive report on food insecurity based on average statistics from 2012 to 2014, which were collected from the US Consensus Bureau on behalf of the US Department of Agriculture. The report found that more than 1.4 million (16.8%) of New York City residents were food insecure and were unable to consistently afford an adequate supply of food throughout the year. The Bronx, which also happens to be the urban county with the highest poverty level in the country, has the highest percentage of food insecure residents at 29.07%. Brooklyn comes in second at 19.25%, then Manhattan at 13.24%, and finally Queens at 8.62% (Staten Island did not have enough federal food insecurity data to accurately calculate percentages).²⁰ New York City has adopted its own official method for measuring food insecurity to better digest raw statistics and provide a more relatable reference point of what food insecurity actually looks like for households. This measure is called the Meal Gap and represents the number of meals missing from the homes of food insecure households over a year. New York City's overall "Meal Gap" in 2014 was 250,236,400 and by borough: Bronx (53,022,500), Brooklyn (88,494,600), Manhattan (45,355,000) Queens (54,787,900), and Staten Island (8,567,400).²¹

²⁰ Allen, Magen, Joel Berg, and Rasna Sethi. 2015. *New York City Hunger Report*. New York: The New York City Coalition Against Hunger. <https://nyccah.org/files/Final%20NYCCA%20Report%202015%20small.pdf>.

²¹ (Segal 2010)

A quick glance at the above maps makes it abhorrently apparent that racial and economic segregation in New York City occur within the same community districts that also suffer from higher rates of food insecurity. The South Bronx (16th congressional district), where 37% of residents are food insecure, is perhaps the perfect case study for how these factors play out in terms of negative health outcomes for residents. A recent survey found that the South Bronx boasts the most severe hunger related problems in the nation, and is also one of the country's capitals for obesity. This is due to the hunger-obesity paradox, which shows that statistically speaking, the hungriest people in America are excessively fat. Hunger and obesity are flip sides of the same malnutrition coin that is endemic of poverty. In fact, the Bronx has New York City's highest prevalence of poverty, with residents facing an 85% risk of obesity compared to residents in Manhattan.²² As a result, policymakers have finally begun to examine the built environment, specifically access to healthy and unhealthy foods, to understand how neighborhood food availability may be contributing to race/ethnic and economic disparities in overweight, obesity, and diabetes²³.

A 2008 study done by the New York City Department of Planning estimates that 3 million New Yorkers live in neighborhoods spread throughout Harlem, the South Bronx, and Brooklyn without access to supermarkets.²⁴ The locations of these food deserts correspond to areas with the highest proportions of Black residents and the lowest

²² Dolnick, Sam. 2010. "The Obesity Hunger Paradox". *The New York Times*. http://www.nytimes.com/2010/03/14/nyregion/14hunger.html?_r=0.

²³ LeClair, Mark S. and Anna-Maria Aksan. 2014. "Redefining The Food Desert: Combining GIS With Direct Observation To Measure Food Access". *Agric Hum Values* 31 (4): 537-547. doi:10.1007/s10460-014-9501-y.

²⁴ "America's Worst 9 Urban Food Deserts". 2011. *News One*. <http://newsone.com/1540235/americas-worst-9-urban-food-deserts/>.

median household income. Small convenience stores, also known as bodegas, and fast food restaurants, are the primary sources of affordable food within East and Central Harlem and North and Central Brooklyn.²⁵ These stores primarily consist of packaged snacks that are high-energy dense (high in calories, saturated fat, and sugar), which are heavily processed and extremely cheap compared to low-energy dense foods like fruits and vegetables. This is largely due to federal subsidies that are skewed to encourage the environmentally unsustainable industrial agricultural production of inexpensive crops, like corn and soy, which are present in nearly every high-energy dense, cheap, processed, and unhealthy food. It is easier to overeat unhealthy energy-dense food because it often tastes better and is more satiating in volume per cost. For example, a 2,000-calorie diet would cost only \$3.52 a day if it consisted of junk food, compared to \$36.32 a day for a diet of low-energy dense foods. Americans who eat a mix of both high and low-energy dense foods spend around \$7 a day. Low-income people comparatively spend only \$4 a day indicating the prevalence for unbalanced diets. Unbalanced diets cause numerous health impacts besides obesity, including impaired cognitive development, lower resistance to disease, and increased risk during childbirth for both mothers and children, which subjects many underprivileged youth to a negative trajectory from birth.²⁶

The compounding negative outcomes of such stark inequity in New York City due to policy and the built environment are linked to a plethora of interconnected adverse health impacts that are worsened by a lack of access to green spaces within urban areas.²⁷

²⁵ (Gordon et al. 2011)

²⁶ (Segal 2010)

²⁷ Wen, Ming, Xingyou Zhang, Carmen D. Harris, James B. Holt, and Janet B. Croft. 2013. "Spatial Disparities In The Distribution Of Parks And Green Spaces In The USA". *Annals Of Behavioral Medicine* 45 (S1): 18-27. doi:10.1007/s12160-012-9426-x.

A lack of access to green space is an issue of environmental justice due to the lower health outcomes experienced among low socioeconomic and minority populations in America. For instance, studies have shown that proximity to green space, parks, and physical activity sites are linked to an increase in exercise and positive impacts on health outcomes like lower rates of cardiovascular disease, diabetes, and obesity among numerous other environmental amenities provided by nature.²⁸ As will be thoroughly discussed within the next chapter, lack of access to these amenities is an issue of environmental justice. Unfortunately, there is little national data on the spatial and demographic disparities of parks and green space access in the United States.²⁹

Data from 2014 states that New York City has over 1000 ground-based community gardens/farms with over 80% producing food, but there is little to no data on the prevalence of green roofs and rooftop farms.³⁰ The only available data concerning green roofs across all five boroughs is from the Climate and Urban Systems Partnership's GIS (geographical information systems) Map, which only shows the green roofs constructed by New York City, thus excluding all other private constructions. The CUSP Map indicates that Manhattan has 40 green roofs, the Bronx has 19, Queens has 10, Brooklyn has 15, and Staten Island has 3.³¹ No comprehensive data exists concerning the prevalence and potential of rooftop gardens, rooftop greenhouses, indoor farming, or the other building-related forms of green urban agriculture, also known as ZFarming, in New

²⁸ Maroko AR, et al. 2009. "The Complexities Of Measuring Access To Parks And Physical Activity Sites In New York City: A Quantitative And Qualitative Approach. - Pubmed - NCBI". *Ncbi.Nlm.Nih.Gov*. <http://www.ncbi.nlm.nih.gov/pubmed/19545430>.

²⁹ (Wen et al. 2013)

³⁰ (Specht et al. 2013)

³¹ Climate and Urban Systems Partnership., 2016. *CUSP Map NYC*. Image. <http://cuspmap.org/NYC/#>.

York City.³² This significant information gap concerning the spatial distribution of green space by demographics both nationally and for New York City can be attributed to GIS's primary use for spatial environmental justice issues concerning pollution, the characteristics of potentially affected populations, and the associated negative health outcomes. GIS has been used much less frequently to determine the relationship between health promoting land uses and environmental goods and positive health impacts.³³

Although the body of research concerning the impacts of green space in urban areas is growing, there is no consensus among scholars on methods for measuring access to green space. Most studies rely on GIS and use the following metrics: presence versus absence of access to a park or recreation facility near the home; density of facilities; and total park acreage within a given radius from a home. However, physical characteristics alone may not capture actual park usage, which also relies upon the safety, walkability, built environment, facilities, and programs offered. One of the further challenges is that green space is consistently heterogeneous concerning aspects like size, range of facilities, availability of organized recreation, perceptions of safety, design quality, etc. A variety of studies show that racial/ethnic minorities and lower-income people have less access to green space, parks, or recreational facilities than their wealthier and whiter counterparts. Additionally, studies of public and non-profit funding of parks has found a similar socio-racial trend with low-income individuals and minorities having far less to spend on parks and recreation and having fewer non-profit resources as well.³⁴

³² (Specht et al. 2013)

³³ (Maroko AR 2009)

³⁴ Wolch, Jennifer R., Jason Byrne, and Joshua P. Newell. 2014. "Urban Green Space, Public Health, And Environmental Justice: The Challenge Of Making Cities 'Just Green Enough'". *Landscape And Urban Planning* 125: 234-244. doi:10.1016/j.landurbplan.2014.01.017.

Reports consistently show that areas with a higher socioeconomic standing have much greater access to green space, and that adversely neighborhoods with higher percentages of Black and Hispanic residents have much less access to green space. When minorities and lower socioeconomic individuals do live close to parks and green spaces, they often lack the social access to these spaces due to issues with safety, traffic, and walkability. A recent study examined both the spatial and social access of parks in New York City and found that the advantage low-income individuals have of living near a park quickly disappeared once neighborhood qualities like crime, pedestrian safety, and toxic industrial land uses were accounted. The benefits of built environments in non-white neighborhoods are often offset by social characteristics.³⁵ The reason for these racial, economic, and negative health trends are numerous, complex, and will be explored in later chapters more thoroughly, but can most certainly be attributed to policies that have created vast injustice and discrimination as evidence through the built environment.

Chapter 2: The Built Environment and Environmental Justice

The previous chapter outlined the quantitative reality of built environments that create vast injustices through the concentration of poverty, food insecurity, and a lack of environmental amenities and green space access specifically for highly segregated low-income minority groups in NYC. These communities have long faced the disparate health outcomes of inequity through the caprice of social, economic, and political power structures that created the unequal distribution of environmental goods and ills, among other inequities, also known as environmental injustice.³⁶ However, before going into a

³⁵ (Wen et al. 2013)

³⁶ The US Commission on Civil Rights., *What Is Environmental Justice*. The US Commission on Civil Rights.

further discussion of the environmental justice movement in America and how it has evolved to include issues like food security and green space, it is necessary to understand the predominant historical method of creating such stark racial and economic segregation: restrictive and exclusionary zoning. Examining these issues through the lens of racial residential segregation offers insights into the junctures of the political economy of social inequality with discrimination, environmental degradation, and health.³⁷

Zoning and planning have important implications for the design of advantaged and disadvantaged neighborhoods and the concomitant health disparities due to inequitable development and urban fragmentation. New York City pioneered the first comprehensive zoning ordinance to separate land uses in 1916, which was justified by the efforts to decrease the spread of infectious diseases due to population concentration and the proximity between businesses and homes. The zoning approach established by NYC was then implemented nationally through the Standard Zoning and Enabling Act (SZA), which is still utilized for contemporary zoning practices. In 1926, the landmark United States Supreme Court case of *Ambler Realty Co v. Village of Euclid* provided legal support for the segregation of land, usages, and people in neighborhoods and cities as an exercise of the state's police power because these ordinances claimed to protect the health and safety of the community. This case foreshadowed the utilization of

³⁷ Morello-Frosch, Rachel and Russ Lopez. 2006. "The Riskscape And The Color Line: Examining The Role Of Segregation In Environmental Health Disparities". *Environmental Research* 102 (2): 181-196. doi:10.1016/j.envres.2006.05.007.

exclusionary zoning classifications that allow for discriminatory practices against low-income and minority residents.³⁸

These discriminatory planning practices created urban environments of unequal development by limiting access to affordable housing, public transportation, good school systems and the kind of economic infrastructure that enables high paying jobs in the technology, health, and service sectors.³⁹ This was accomplished by creating exclusionary zoning laws that segregated the population according to income and race by setting aside different parts of cities for different kinds of housing. For example, the construction of low-cost housing was prevented in certain areas through zoning laws that only allowed the construction of single-family homes instead of apartments. In addition, many neighborhoods restrict the total amount of housing that can exist in any given area, which essentially means that wherever higher-income populations decide to move, they will bid up the price of housing until it is out of reach of everyone else. This was especially obvious after *Brown v Board of Education* and the prospect of school integration induced white flight to affluent suburbs and suburban school districts.⁴⁰ Increased housing segregation was supported and fostered by Federal agencies like the Federal Housing Authority and the Veteran's Administration through subsidized suburban growth at the expense of urban areas, supporting racial covenants by denying African Americans

³⁸ Wilson, Sacoby, Malo Hutson, and Mahasin Mujahid. 2008. "How Planning And Zoning Contribute To Inequitable Development, Neighborhood Health, And Environmental Injustice". *Environmental Justice* 1 (4): 211-216. doi:10.1089/env.2008.0506.

³⁹ (Wilson, Hutson and Mujahid 2008)

⁴⁰ Hertz, Daniel. 2014. "One Of The Best Ways To Fight Inequality In Cities: Zoning". *Washington Post*. <https://www.washingtonpost.com/posteverything/wp/2014/08/13/the-best-way-to-fight-inequality-in-cities-is-through-zoning/>.

mortgage insurance in integrated communities, providing mortgage insurance in segregated residential communities, and redlining.⁴¹

The result of such segregated housing practices created a built environment where poor and minority neighborhoods are often under-resourced with health promoting facilities like supermarkets and recreational facilities that promote healthy diets and physical activity. Conversely, the same segregated areas are over-resourced with health-restricting facilities like liquor stores and fast food restaurants, as well as chronic stressors and excessive advertisement for risky behaviors like alcohol and tobacco billboards, all of which encourage unhealthy behaviors and limit the ability of local residents to have healthy lifestyles. Unsurprisingly, studies have shown that living in these disadvantaged neighborhoods is positively associated with increased disease morbidity, mortality, and mental illness. These high-risk geographical settings created by inequitable planning and zoning are termed “riskscapes.” Several researchers have discussed how riskscapes burden poor communities of color in New York City and other metropolitan areas, creating an urban underclass that is denied access to mainstream opportunities.⁴²

Living in or exposure to these riskscapes leads to poor populations of color being the most vulnerable to the effects of environmental hazards, air pollution, urban decay, man-made and natural disasters, and climate change.⁴³ This is evident in zoning laws that are race-neutral on their face, but routinely allow low-income communities of color to be zoned “industrial.” As the presence of industry increases, property values decrease,

⁴¹ (The US Commission on Civil Rights)

⁴² (Wilson, Hutson and Mujahid 2008)

⁴³ (Wilson, Hutson and Mujahid 2008)

community members are slowly displaced, and these areas become increasingly undesirable. The remaining residents, who are primarily poor people of color, have few housing alternatives and little political clout. The lack of political influence and connections to decision makers on zoning boards or city councils prevents communities from mounting “NIMBY”, or “not in my back yard”, defenses against siting and permitting decisions that have adverse health and environmental consequences.⁴⁴

As a result, low-income and minority populations were denied the three fundamental dimensions of justice: distributive (allocation); participatory (decision making power); and recognition (exclusionary history).⁴⁵ These same exclusions from justice reverberate in a lack of food security and green space access and the resulting negative impacts on physical and psychological health, which are specifically a manifestation of environmental injustice through denied environmental amenities. Environmental justice is defined by the US Commission for Civil Rights as “fair treatment of people of all races, incomes, and cultures with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies, and their meaningful involvement in the decision making processes of the government.”⁴⁶ As such, environmental justice encompasses a wide range of issues that combine concerns of social justice and environmentalism.

In the United States, the primary focus of the environmental justice movement has been on distributive justice as minorities and lower income individuals are disproportionately burdened by environmental harm, which can have cross-generational

⁴⁴ (The US Commission on Civil Rights)

⁴⁵ Elliot, Michael. 2005. "Environmental Justice". *Encyclopedia Of Environmental Ethics And Philosophy*.

⁴⁶ (The US Commission on Civil Rights)

effects.⁴⁷ Concepts of distributive justice encompass all aspects of a social order by establishing fair and equitable distribution of goods, services, and rights to society as a whole and to understand what duties and obligations members of society can reasonably expect from one another. Society broke its obligations to low-income populations and minorities in particular through the hidden processes of political influence and decision making that has underlain the inequitable distribution of environmental goods and ills, and enough was enough.⁴⁸

Communities of color began organizing to oppose unequal environmental threats in the early 1960s, when Latino farm workers organized by Cesar Chavez fought for workplace rights, which included protection from harmful pesticides, in California's San Joaquin Valley. In 1968, residents of West Harlem in NYC unsuccessfully fought against the siting of a sewage treatment plant.⁴⁹ However, it was not until 1979 that the first environmental justice case was brought to court, when residents of Northwood Manor in East Houston claimed that the decision to put a garbage dump in their neighborhood was racially motivated and in violation of their civil rights. The neighborhood lost the case due to a lack of demographic statistical evidence that could establish intentional discrimination, but the case did highlight the need for data collection and launched the ability to use courts as a tool to address discriminatory distribution of pollution.⁵⁰

The environmental justice movement first captured national attention in 1982, when the people of Afton (84% African American), North Carolina protested the state

⁴⁷ (Elliot 2005)

⁴⁸ Wolf, Clark. "Intergenerational Justice". *Encyclopedia Of Environmental Ethics And Philosophy*.

⁴⁹ Skelton, Renee and Vernice Miller. 2016. "The Environmental Justice Movement". *National Resource Defense Council*. <https://www.nrdc.org/stories/environmental-justice-movement>.

⁵⁰ (Skelton and Miller 2016)

government's decision to place a highly toxic polychlorinated biphenyls (PCBs) landfill with a high risk of groundwater contamination in their community.⁵¹ Residents of Afton followed cues from the civil rights movement and held nonviolent marches and protests for six weeks, where more than 500 people were arrested—the first arrests in US history over the placement of a landfill. The protests in Afton failed, and the landfill was placed there regardless by the state government creating an undeniable parallel between the placement of environmental ills in low-income minority neighborhoods and the racism civil rights activists encountered for decades in terms of housing, education, and employment.⁵² Environmental justice activists took notice of this early on and often portrayed themselves in opposition to the conventional, or “mainstream” environmental movement, because it was predominantly white, middle class, and focused on protecting wilderness, endangered species, and clean air and water while undermining the importance of people outside of its socioeconomic and cultural framework.⁵³

Racial disparities became scientifically undeniable, as the EPA has pointed out; there are at least 80 studies that have consistently stated that minorities and low-income communities are disproportionately exposed to environmental harms and risks.⁵⁴ As a result, the predominance of research concerning environmental justice has to do with the distribution of environmental harms and risks from Locally Unwanted Land Uses (LULUs) like hazardous waste facilities, incinerators, landfills, and refineries, which are

⁵¹ (The US Commission on Civil Rights)

⁵² (Skelton and Miller 2016)

⁵³ Anguelovski, Isabelle. 2013. "New Directions In Urban Environmental Justice: Rebuilding Community, Addressing Trauma, And Remaking Place". *Journal Of Planning Education And Research* 33 (2): 160-175. doi:10.1177/0739456x13478019.

⁵⁴ (The US Commission on Civil Rights)

traditionally sited in poor black or Latino neighborhoods rather than in affluent suburbs.⁵⁵ This has given rise to the concept of environmental racism. For example, a report in 1994 found that people of color were 47% more likely than whites to live near a commercial hazardous waste facility.⁵⁶ Racial imbalances often occur regardless of the socioeconomic standing of the community.

The growth and scope of the environmental justice movement was particularly evident in 1991, when the First National People of Color Environmental Leadership Summit brought together environmental justice leaders, including the heads of the previously criticized and predominantly white NRDC and Sierra Club, to network and strategize. The summit produced “Principles to Environmental Justice” and “The Call to Action,” two foundational documents of the environmental justice movement.⁵⁷ The document, Principles to Environmental Justice, outlines 17 core environmental justice principles that essentially demands that public policy be free of discrimination, the right to ethical and balanced land use, universal protection from environmental ills, the right to self-determination for all peoples, industrial accountability, participation at every level of legal decision making, a safe working environment, full compensation and reparation for past environmental damages as well as quality health care, the education for present and future generations, and the ability to ensure the health of the natural world for present and future generations.⁵⁸

The seventeenth, and final, principle of justice outlines a focus on intergenerational justice, which attempts to determine if the same concepts of duty and

⁵⁵ (Anguelovski 2013)

⁵⁶ (The US Commission on Civil Rights)

⁵⁷ (Skelton and Miller 2016)

⁵⁸ "Principles Of Environmental Justice". 1991. *Ejnet.Org*. <http://www.ejnet.org/ej/principles.html>.

obligation for the present generation are owed to future generations. This is important concerning climate change's long-term effects because future generations cannot punish or reward present generations for their actions, regardless if those actions have the potential to help or harm. Environmental justice rests upon the precedent that if there is some potential victim of society's current actions there maintains an obligation to uphold a social contract and act to mitigate harmful effects. Furthermore, a concept called communitarianism argues that obligations to future generations are inherent through the sense of human connectedness that is fostered through participation in a social and political community.⁵⁹

This extension of justice began to become apparent as the environmental justice movement expanded its scope to represent the intersections between environmental justice, poverty, food security, and the resulting health disparities. For example, the summit produced the first notion of extending environmental justice past issues concerning contamination and uneven distribution of environmental ills to other public health concerns, which are impacted by transportation, land use planning, housing issues, and community empowerment. By the 2000s, the focus of the environmental justice movement more holistically expanded to ensure that every person regardless of race, income, culture, or gender has the right to a decent and safe quality of life.⁶⁰

Scholars began to take this new perspective into account by documenting how urban inequalities exist in the territorial allocation of environmental goods and

⁵⁹ (Wolf) Intergenerational Justice

⁶⁰ Anguelovski, Isabelle. 2015. "From Toxic Sites To Parks As (Green) Lulus? New Challenges Of Inequity, Privilege, Gentrification, And Exclusion For Urban Environmental Justice". *Journal Of Planning Literature*. doi:10.1177/0885412215610491.

amenities.⁶¹ For instance, research has found that when parks and green spaces are present in lower income and minority neighborhoods they can be underutilized due to a lack of “social access.” Social access is a term used to describe socio-demographic features like walkability, safety, and traffic, all of which can be impediments to park usage.⁶² Furthermore, urban neighborhoods tend to get the poorest environmental services, such as street cleaning, park management, and waste collection, while wealthier and white communities disproportionately enjoy environmental privileges.⁶³ Environmental privilege is defined as having disproportionate access to green space, fresh food, healthy housing, playgrounds, and waste management systems.⁶⁴

Equitable access to green space is a key step in promoting environmental justice because a number of empirical studies have established significant correlations between disproportionate exposure to noxious land uses, pathogenic infrastructure, and lack of green spaces to human health. Disparities in diseases like such as asthma, cancer, obesity, diabetes, and cardiovascular disease in urban environments.⁶⁵

Minorities are on average exposed to 38% more nitrogen dioxide, linked to higher risks of asthma and heart attacks, than whites in communities where they live. The gap is wider in larger cities and accounts for an additional 7,000 deaths a year from heart attacks. The New York/Newark metropolitan area ranks as having the widest disparity in average exposure between low-income minorities census block groups and upper income whites. Nitrogen dioxide tends to be high around highways and busy central business

⁶¹ (Anguelovski 2015)

⁶² (Wen et al. 2013)

⁶³ (Anguelovski 2013)

⁶⁴ (Wolch, Byrne and Newell 2014)

⁶⁵ (Wilson, Hutson and Mujahid 2008)

sections. It is politically easier to uproot low-income and minority neighborhoods, which is why many LULU's and highways are routed through them. The disparities in exposure by race, after controlling for income, were more than two times larger than whites.⁶⁶

South Bronx (community district 1) is over 96% black and Hispanic, and is expected to be the home of FreshDirect, which would bring an additional 1000 trucks to an area already heavy with traffic. The Bronx is additionally home to Fedex, a printing and distribution center, and four waste transfers center. The community district is also the center of highest public housing concentration in New York and has some of the highest asthma rates. In fact, the asthma rate is 21 times higher than richer sections of the city and one in five children have asthma.⁶⁷ In addition, 37% of residents in the South Bronx's 16th Congressional District are food insecure, it borough boasts the most severe hunger related problems in the nation, and it has some of the highest rates of obesity. Residents face an 85% risk of obesity compared to residents in Manhattan.⁶⁸

The Centers for Disease Control and Prevention considers park proximity within a half mile of a residence an important community design feature for promoting physical activity. For instance, research shows that low-income areas, in coordination with irregular physical activity, are 3.7 times more likely to be obese compared to wealthier areas. Obesity is associated with numerous comorbidities like cardiovascular disease, which is the leading cause of death in the United States. A report from the American Heart Association estimates that nearly 44% of the US population will have some type of

⁶⁶ Clark, Lara P., Dylan B. Millet, and Julian D. Marshall. 2014. "National Patterns In Environmental Injustice And Inequality: Outdoor NO2 Air Pollution In The United States". *Plos ONE* 9 (4): e94431. doi:10.1371/journal.pone.0094431.

⁶⁷ "South Bronx Environmental Health And Policy Study". 2002. *Icisyu.Org*. http://www.icisnyu.org/south_bronx/AsthmaandAirPollution.html.

⁶⁸ (Dolnick 2010)

cardiovascular disease by 2030. Racial and health disparities in cardiovascular disease is a major public health challenge as the premature mortality rate is higher for blacks compared to whites (65.5% vs. 43.2%).⁶⁹ The difference in life expectancy in New York City between high poverty neighborhoods compared to low poverty neighborhoods was 7.4 years in 2013.⁷⁰ Minorities and low-income communities lack access to the aesthetics and green access that support cardiovascular health and well-being. An increase in cardiovascular and respiratory illness was linked to tree loss. Other studies observed an inverse correlation between amount of green space, stroke incidence, and other cardiovascular health, respectively. Green space is a cultural service.⁷¹

Climate change is expected to exacerbate the urban heat island effect (UHI), which is the release and absorption of solar energy by impervious buildings, resulting in increased temperature in cities. This causes numerous preventable deaths, and between 2000 and 2009, the United States an estimated \$5 billion in health costs. Neighborhoods with higher density rates, less access to trees, higher poverty rates, more minorities, and lower educational attainment had significantly higher scores on a human thermal comfort index, which is an indicator for heat vulnerability. A national-level study found that African Americans, Asians, and Hispanics were at least 21% more likely than non-Hispanic whites to live in areas with less tree canopy cover, which reduces heat risk and

⁶⁹ Jennings, Viniece and Cassandra Gaither. 2015. "Approaching Environmental Health Disparities And Green Spaces: An Ecosystem Services Perspective". *International Journal Of Environmental Research And Public Health* 12 (2): 1952-1968. doi:10.3390/ijerph120201952.

⁷⁰ "Health Department Releases Annual Vital Statistics Data Showing Improvements For The City Overall, But Disparities Between Neighborhoods Persist". 2016. *NYC.Gov-NYC Health*. <https://www1.nyc.gov/site/doh/about/press/pr2016/pr018-16.page>.

⁷¹ (Jennings and Gaither 2015)

stress. Heat stress can prompt physiological responses that cause the body to become more vulnerable to illness.⁷²

Managing stress is important to offset depression and other mental health challenges. Socially disadvantaged populations are at a higher risk of unique stressors related to discrimination, unemployment, and other factors. Low-income populations express low emotional well-being and low life evaluation. Stress is detrimental to psychological health and leads to depressive symptoms and higher rates of suicide. Lack of green space reduces the aesthetic qualities and social benefits that help residents cope with life and stress. Despite these findings, critical features of the natural environment are not fully integrated into the health disparities dialogue.⁷³

Remediating urban spaces to increase use within these neighborhoods comes with an additional justice paradox; greater green space and improved public health make neighborhoods more desirable and could raise prices leading to gentrification.⁷⁴ This kind of green or ecological gentrification is defined as the implementation of an environmental planning agenda related to public green spaces that leads to the displacement or exclusion of the most economically vulnerable populations while espousing an environmental ethic.⁷⁵ Perhaps one of the best examples of this is New York City's High Line, which has created a highly successful ecological corridor through the redevelopment of an old rail line. A study done by the New York City Economic Development Corporation found that between 2003 and 2011 nearby property values increased by 103% despite the

⁷² (Jennings and Gaither 2015)

⁷³ (Jennings and Gaither 2015)

⁷⁴ (Wolch, Byrne and Newell 2014)

⁷⁵ (Anguelovski 2015)

economic depression in the later half of those years.⁷⁶ In order to avoid green gentrification, stakeholders, city planners, and developers need to take the needs and concerns of the community into account.

This is challenging, as it requires stakeholders to be willing to look beyond the typical urban design formula and market-driven ecological approaches and communicate with community activism sources in order to emphasize development that encourages community gardens to address local concerns about food security, job creation, and human health. These solutions are termed “just green enough,” and require a careful balancing act, because they positively impact the community by addressing issues of environmental justice and access while simultaneously avoiding gentrification. More grand civil projects tend to geographically concentrate resources and are more likely to induce gentrification. The focus of urban greening should be on smaller underutilized sites that are spread out relatively evenly through communities in order to equally distribute green access.⁷⁷ This equally distributed green access additionally ensures the equitable distribution of a plethora of environmental services that impact human health and the sustainability of urban areas.

Chapter 3: History and Ecosystem Services of Zero-Acreage Farming

Modern civilizations are just now rediscovering the efficacy of ZFarming, or zero-acreage farming in and on buildings for their many benefits, but this technology is nothing new. Societies have been utilizing rooftop horticulture for hundreds of years for its aesthetic purposes, as responses to the climate of their region through ecosystem services like insulation and heat mitigation, to display wealth, and to provide recreation.

⁷⁶ (Wolch, Byrne and Newell 2014)

⁷⁷ (Wolch, Byrne and Newell 2014)

The first rooftop garden harkens all the way back to the ziggurats of Mesopotamia, built between 4000 A.D. and 600 B.C. Ziggurats were great stepped pyramid towers of stone that were accessible by outer spiraling staircases on their outer edges. Evidence found by the British archeologist Leonard Woolley indicates that plantings of trees and shrubs were put on the flat terraces of the steeped towers in order to provide relief from the sun. The ziggurat of Nanna in the ancient city of Ur is the best-preserved example of this ancient tower pyramid. However, the most famous rooftop gardens are the fabled Hanging Gardens of Babylon, which are one of the Seven Wonders of the World. The gardens were purportedly built by king Nebuchadnezzar II to console his wife, who missed the greenery of her homeland, however there are no contemporary accounts of their construction or existence.⁷⁸

Although little is known about individual rooftop gardens during the Roman emperors, the eruption of Mount Vesuvius in 79 A.D. perfectly preserved some buildings with terraces that fits within the parameters of a rooftop garden. One of these buildings, known as the Villa of Mysteries, boasts a large U-shaped terrace where plants were grown directly in soil. The Middle Ages and Renaissance saw the creation of numerous aesthetic rooftop gardens, some of which still exist. One of the best preserved is the rooftop garden Pope Pius II called Palazzo Piccolomini, in Pienza, Italy, which was the first example of the concept of “landscape” being controlled and manipulated by humans for urban design. Tenochtitlan, the Aztec capital of Mexico is an excellent example of superior urban designing through green roof utilization on dwellings, because the city consisted mostly of man-made islands and had limited ground-level availability for

⁷⁸ Osmundson, Theodore. 1999. *Roof Gardens*. New York: W.W. Norton.

farming/gardening. Similarly, Norwegians responded to the environmental challenges of long cold winters by utilizing sod rooftops for insulation. The roof was covered with soil and then planted with grasses to stabilize the soil. Early settlers in the United States' Great Plains region used the same method in the mid to late 1800s to great effect.⁷⁹

The first rooftop garden in New York City was built in 1882 on the Casino Theater at 39th and Broadway thanks to the conductor and musician Rudolph Aronson. Aronson was enchanted by Parisian summer theaters and wanted to bring the concept to New York, but the price of land was too expensive so the idea of a theater surrounded by plants and trees was moved to the roof. This idea became immensely popular and spurred other theaters, hotels, and restaurants to add rooftop gardens. The most well known examples were Madison Square Garden, which got its name from its roof garden, and the Waldorf Astoria. Two of the most influential architects of the 20th century, Frank Lloyd Wright and Le Corbusier, both designed buildings that incorporated rooftops as functional space. Le Corbusier's most notable work included roofs' terraces as one of his five tenets of modern architecture and considered the roof an exterior room. Neither he nor Lloyd Wright specifically recommended that their roofs be used as gardens, but they were often utilized as such regardless. Unfortunately, planted rooftops are still a rarity in the downtown areas of most American cities, which needs to change if our cities are to adapt to the threats of climate change.⁸⁰

ZFarming, specifically rooftop farms and greenhouses, have the potential to transform our cities for sustainable and equitable development through the provision of a plethora of ecosystem services. Ecosystem services are the benefits people receive from

⁷⁹ (Osmundson 1999)

⁸⁰ (Osmundson 1999)

ecosystems and as such are broken down into four different categories. The first are provisioning services, which describe the material outputs from the environment, like food. The most obvious goal of ZFarming and urban agriculture is to provide greater food access to underserved populations and as such community gardening may help improve diet as adults with someone in their household who had participated in community gardening within the last 12 months were 3.5 times more likely to consume five servings of fruit or vegetables a day.⁸¹ The second are regulating services like carbon sequestration and storage, wastewater treatment, and local climate and air quality regulation. The third are habitat or supporting services, which underpin all other services because ecosystems provide living spaces for plants and animals. The fourth and final are cultural services, which are the non-material benefits like aesthetic, spiritual, and psychological benefits that people get from contact with ecosystems. Different forms of ZFarming offer some or all of these ecosystem services within cities⁸².

Some of the most salient services provided by ZFarming, specifically through the focus on rooftop farms are through regulating services. Buildings can change the flow of energy and matter in urban ecosystems, leading to numerous environmental problems, but the addition of vegetation and soil to roof surfaces can severely lessen the negative effects buildings have on urban ecosystems and reduce buildings energy consumption. Some of the services provided include mitigating storm-water runoff, the longevity of the roof membrane, reduction of energy required to maintain indoor climates through

⁸¹ Wolf, K.L., and K. Flora 2010. Mental Health and Function - A Literature Review. *In: Green Cities: Good Health*. College of the Environment, University of Washington.

⁸² "Ecosystem Services". 2016. *The Economics Of Ecosystems And Biodiversity*. Accessed May 8. <http://www.teebweb.org/resources/ecosystem-services/>.

summer cooling and winter insulation, and by mitigating the effects of the urban heat island.⁸³

Storm water management is of vital importance to New York City, where impervious surfaces that are hard and non-porous cover approximately 72% of New York City's 305 square miles.⁸⁴ New York City's sewage system was designed to collect both waste from home and storm water runoff within the same pipes. Heavy rains overburden water management facilities, causing combined sewage overflow into the cities' waterways. Additionally, runoff often carries a toxic mix of pollutants, pesticides, and petroleum residues, which harm wildlife and contaminates both soil and water supplies. To mitigate this effect, the PlaNYC initiative and Green Infrastructure Plan are utilizing green infrastructure to retain and detain some of this runoff.⁸⁵ Green roofs are an important aspect of this plan as they act as storage during rainfall, delaying runoff until after peak rainfall and additionally returning precipitation to the atmosphere through evapotranspiration, which is the sum of evaporation from land surface and transpiration from plants. There are numerous factors that affect the pattern of runoff including the depth of substrate, slope of the roof, and plant communities on the roof. Studies have found that with a 10cm substrate rainwater retention is between 66% and 69%. In more shallow substrates the rain retention ranges from 25% to 100% depending on the set up.⁸⁶ According to New York City's Five Borough Technical Services Division, green roofs

⁸³ OBERNDORFER, ERICA, JEREMY LUNDHOLM, BRAD BASS, REID R. COFFMAN, HITESH DOSHI, NIGEL DUNNETT, STUART GAFFIN, MANFRED KÖHLER, KAREN K. Y. LIU, and BRADLEY ROWE. 2007. "Green Roofs As Urban Ecosystems: Ecological Structures, Functions, And Services". *Bioscience* 57 (10): 823. doi:10.1641/b571005.

⁸⁴ "LTCP Frequently Asked Questions". 2016. *NYC.Gov Department Of Environmental Protection*. Accessed May 9. http://www.nyc.gov/html/dep/pdf/cso_long_term_control_plan/ltcp_faqs_handout.pdf.

⁸⁵ "LTCP Frequently Asked Questions". 2016. *NYC.Gov Department Of Environmental Protection*. Accessed May 9. http://www.nyc.gov/html/dep/pdf/cso_long_term_control_plan/ltcp_faqs_handout.pdf.

⁸⁶ (OBERNDORFER et al. 2007)

can reduce the amount of runoff by 50% to 90%, and during a 1” rainfall 100% water retention is achievable. Additionally, green roofs filter out 95% of the cadmium, lead, and copper and 30% of the nitrogen and phosphorous in storm water.⁸⁷ Another study done by the Pennsylvania State University’s Center for Green Roof Research found that green roofs capture up to 80% of rainfall compared to standard roofs that only capture 24%.⁸⁸

Green roofs can extend the life of a roof by protecting the roofs waterproofing membrane from damaging UV light on conventional darks roofs. The extensive radiation makes the membrane brittle, which makes them more susceptible to damage with the expansion and contraction of the roof due to temperature. Green roofs physically block UV lights from reaching the roof membrane and reduce temperature fluctuations, which can cause thermal expansion and contraction stresses.⁸⁹ As a result, green roofs can extend the life of a roof by 40 to 60 years.⁹⁰

In addition to saving money by extending roof life, green roofs can create energy savings by reducing the amount of heat transferred through the roof, lowering the energy demands on the buildings cooling system. This is especially important for New York as it costs \$15 billion each year to heat and power buildings that are responsible for 80% of the city’s carbon emissions.⁹¹ Green roofs will have the greatest effect on energy consumption for buildings with relatively high roof to wall area ratios (i.e. buildings with

⁸⁷ "NYC Parks Green Roof, A Living Laboratory For Innovative Green Roof Design". 2013. *Nycgovparks.Org*. https://www.nycgovparks.org/pagefiles/53/Citywide-Services-Green-Roof_2.pdf.

⁸⁸ ("Green Roof Benefits, Technical Preservation Services, National Park Service" 2016)

⁸⁹ (OBERNDORFER et al. 2007)

⁹⁰ ("NYC Parks Green Roof, A Living Laboratory For Innovative Green Roof Design" 2013)

⁹¹ "NYC Planning Zone Green Text Amendment". 2012. *NYC.Gov*.

http://www1.nyc.gov/assets/planning/download/pdf/plans/zone-green/zone_green.pdf.

a greater amount of roof area vs. exterior wall area). Green roofs reduce the amount of heat flowing through a building, and thus heat flux, through passive cooling, shading, evapotranspiration, and increasing the insulation and thermal mass. Research in Japan found 50% reductions in heat flux over a year thus burdening cooling systems significantly less. Additionally, a study in Madrid showed that an eight story residential building on average had a 6% reduction in cooling load during the summer. During peak demand, the study found a 10% reduction for the entire building with 25%, 9%, 2%, and 1% for the four floors respectively below the roof. Furthermore, the installation of a rooftop garden can save between 1% and 15% of buildings annual energy consumption.⁹² The efficacy of energy savings depends on the individual building and numerous related factors concerning the construction of the farm/garden.⁹³

One of the most notable regulating services provided by rooftop farms and green roofs is the mitigation of the urban heat island effect (UHI), which is the phenomena of urban regions being significantly warmer than surrounding areas. This is due to the prevalence of dark impervious surfaces on roofs, asphalt, roads, etc. that absorbs solar radiation and reradiates it as heat. For example, during the summer months the daily average temperature for New York City is 7.2 degrees (Fahrenheit) warmer than the surrounding suburbs.⁹⁴ The UHI can be reduced by albedo, i.e. the reflection of incoming radiation away from a surface or by increasing vegetative covering. A regional simulation of 50% roof cover evenly distributed in Toronto found temperature reductions as great as 2 degrees Celsius in some areas. The same results were found concerning New York City

⁹² (Specht et al. 2013)

⁹³ (OBERNDORFER et al. 2007)

⁹⁴ ("Green Roof Benefits, Technical Preservation Services, National Park Service" 2016)

and the UHI mitigating effects of vegetation.⁹⁵ In addition, according to the Environmental Protection Agency, on hot summer days the surface of a conventional rooftop can be 90°F greater compared to a green roof.⁹⁶

The habitat services provided by rooftop farms mostly pertain to creating ecological corridors for insects and avian communities, which have been found in abundance on green roofs. This green rooftop agriculture provides necessary ecological corridors for nesting birds and the support of biodiversity in urban areas.⁹⁷ About 130 species of neotropical migrants, birds with summer breeding grounds in the US or Canada that migrate to Central and South America for winter, pass through New York City while travelling on the Atlantic flyway migratory route. Rooftop gardens and their greater prevalence of biodiversity and insects provide a patchwork of stopover sites for migrating birds, as well as habitats for local species.⁹⁸

The final ecosystem services provided by rooftop farms and access to green space are cultural ecosystem services, which are the non-material benefits received from access to ecosystems. Biophysical ecosystem services are an additional subgroup of cultural services and indicate the ways in which nature functions to alter the physical environment resulting in reduced health risks. For instance, in the immediate short-term nature has been shown to reduce stress, improved cognitive ability, and enhance happiness. The largest body of research has shown a positive correlation between nature and

⁹⁵ Suska, T, S.R. Gaffin, and G.R. Dell'Osso. 2011. "Positive Effects Of Vegetation: Urban Heat Island And Green Roofs". *Sciencedirect.Com*.

<http://www.sciencedirect.com/science/article/pii/S0269749111001539>.

⁹⁶ "Using Green Roofs To Reduce Heat Islands". 2016. *Epa.Gov*. Accessed May 8.

<https://www.epa.gov/heat-islands/using-green-roofs-reduce-heat-islands>.

⁹⁷ (OBERNDORFER et al. 2007)

⁹⁸ Nuwer, Rachel. 2014. "Wildlife Oasis In New York's Concrete Jungle". *The National Wildlife Federation*. <https://www.nwf.org/News-and-Magazines/National-Wildlife/Gardening/Archives/2014/New-York-Green-Roofs.aspx>.

psychological well-being measured in mental restoration, self-esteem, attachment, anger, cognitive function (usually measured in attention span), improve healing times, heart rate, and systolic and diastolic blood pressures. Another experiment showed that the cardiovascular health of elderly individuals improved significantly over a seven-day experiment and blood pressure dropped after exposure to nature. Mere glimpses of nature through a window at home have been shown to immediately improve feelings of life satisfaction and well-being. The environment has a profound effect on our brain, which has been shown through a substantial number of studies indicating that natural scenes evoke positive emotions, facilitate cognitive functioning, and promote recovery from mental fatigue for people in good mental health.⁹⁹

This is mostly accomplished through nature's effect on attention. Attention takes two different forms: directed attention which enables us to focus on demanding tasks like driving, writing, dodging traffic, etc.; and the second is involuntary attention, which comes easily and does not require any mental effort. Nature is vital in attention restorative therapy (ART) because of the difference in the way it commands our attention.¹⁰⁰ This is especially important for urban residents as the constant stimuli of a city can cause the brain to suffer from memory loss and reduced self-control, also known as directed attention fatigue. Exposure to settings that are visually interesting, or have "high visual fascination," like natural environments aid in cognitive function by recovering an individual's capacity to direct attention and by providing the opportunity to

⁹⁹ Shanahan, Danielle F., Richard A. Fuller, Robert Bush, Brenda B. Lin, and Kevin J. Gaston. 2015. "The Health Benefits Of Urban Nature: How Much Do We Need?". *Bioscience* 65 (5): 476-485. doi:10.1093/biosci/biv032.

¹⁰⁰ Alter, Adam. 2013. "How Nature Resets Our Minds And Bodies". *The Atlantic*. <http://www.theatlantic.com/health/archive/2013/03/how-nature-resets-our-minds-and-bodies/274455/>.

recover from mental fatigue. This was evident in a study of college students who performed better on a test after participating in a nature walk compared to their peers who walked in an urban environment or were sitting in a relaxing room with magazines.¹⁰¹ Cognitive function has been shown to improve after less than ten minutes of viewing photographs of natural settings.¹⁰²

Stress reduction theory helps explain the emotional and physiological reactions to natural spaces, because viewing or being in unthreatening natural environments activates a positive affective response and creates sustained relaxed attention. As a result, individuals experience a decrease in stress, reduced levels of negative feelings, and reductions in elevated physiological conditions like heart rate and blood pressure. In addition, a study using data from both self-rating and physiological indicators of stress including heart rate, muscle tension, skin conductance, and pulse rate (which correlates with systolic blood pressure) found stress recovery from natural settings is remarkably fast. Individuals who viewed natural settings versus built settings experienced more rapid and complete stress recovery in about four minutes. The greater the amount of time spent in urban green spaces and visit frequency were both positively correlated to reported mental restoration from an increase of stay between 0.5-1 hour and 1.0-1.5 hours. The more stress experienced by the individual prior to the visit, the greater the mental restoration and stress recovery.¹⁰³

Lack of ecosystem services is most prominent for low-income populations and racial/ethnic minorities who also often experience disproportionate amounts of chronic stress due to little control over work conditions, higher exposure to violence,

¹⁰¹ (Wolf, 2010).

¹⁰² (Shanahan et al. 2015)

¹⁰³ (Wolf, 2010)

unemployment, and crime. Individuals who experience chronic stress are more likely to suffer from sleep problems, loss of appetite, and stiff muscles, among numerous other physical effects. Long-term sleep deprivation/exhaustion can lead to a milieu of negative health outcomes, including negative effects on cardiovascular and neuro-hormonal systems, memory impairment, increased rates of type II diabetes, and long-term psychological effects that result as another stress response. One study found that exposure to green space creates lower levels of stress, illness, and diseases compared with people of the same socioeconomic status that lacked access, which indicates that green space can reduce socioeconomic inequalities.¹⁰⁴ Research from the UK found that greater exposure to green space had an inverse relationship to the level of stress responses (salivary cortisol) for the unemployed. Other studies have shown that green space helps individuals cope with stress through improved resilience, enhanced self-discipline, and reducing the symptoms of depression.¹⁰⁵

Educational and ecological theory suggests that contact with nature facilitates children's development because outdoor activity encourages children's mental, emotional, and social health through imagination and creativity, cognitive development, and social relationships. Nature provides both a background and objects for children to play and learn, encouraging exploration and building activities that improve problem-solving abilities, the ability to respond to changing contexts, and participation in group decision-making. Younger children utilize plants, sticks, and stones for imaginative play, which is key for social and cognitive development. One study of play found that a cluster of shrubs was the most popular location in an elementary schoolyard because it fostered

¹⁰⁴ (Wolf, 2010).

¹⁰⁵ (Jennings and Gaither 2015)

imaginative transformation into places like a house, spaceship, etc. Furthermore, studies show that childhood ADD symptoms can be reduced through activities in green settings and that time within these settings, “green time”, may be an important supplement to drug based behavioral treatments. Another study found that ADHD children performed better on an object concentration test after exposure to a natural urban setting compared to a less natural setting.¹⁰⁶

Neighborhoods with accessibly green spaces improve social cohesion and interaction. This is by serving as informal meeting places and sites for group and shared activities, which can help impart a “sense of place” and attachment, community identity, and social capital. Residents in more walkable neighborhoods are more likely to know their neighbors and be socially engaged in their community.¹⁰⁷ This can enhance both the emotional and psychological well being of individuals due to a decreased chance of depression, feelings of isolation, and increased self-esteem. One study found a 71% reduction in depressive symptoms after going on a walk in outdoor natural spaces versus only a 45% reduction by those on an indoor walk. These green spaces, especially farms/gardens, effectively serve as a form of ecotherapy as marginalized people can find empowerment, respite from stress, and personal involvement in environmental stewardship all while fostering a sense of community. Effective social support networks have been found to restore feelings of person control and self-esteem by buffering the effects of stress and poor health.¹⁰⁸

Given the plethora of environmental services provided by access to green space within the urban built environment, especially given its efficacy at provided a more

¹⁰⁶ (Wolf, 2010).

¹⁰⁷ (Jennings and Gaither 2015)

¹⁰⁸ (Wolf, 2010).

health and equitable life to riskscape populations, it seems that ensuring that green infrastructure flourishes is a political no brainer. However, as the next chapter explores, there are numerous challenges to implementing rooftop agriculture, which are not politically supported or prohibited by New York City. The lack of policy acts as a development retardant, which needs to be overcome in order to create equitable and sustainable cities that can adapt to the challenges of climate change.

Chapter 4: Politics of Zero-Acreage Farming

Although New York City is increasingly tackling the challenges faced by low-income and minority communities, it still has numerous policy holes that do not facilitate the promotion of urban agriculture, especially rooftop farms. In order to suggest policy changes for the future, it is necessary to examine the existing policies and initiatives in place. Lessons can be learned from the ways in which community activism continues to support urban agriculture and rooftop farms without the support of a political structure.

One of the main deterrents to urban agricultural production is the high cost of land, which only gets higher closer to Manhattan's core. Zoning and planning policies do not facilitate growth in urban agriculture, because city zoning is dominated by the principle that the most profitable and "highest and best use" of land. Commercial and residential zones predominate and are taxed at very high rates.¹⁰⁹ Ground based urban agriculture is often time-insecure as unused urban open spaces and brownfields are often earmarked for future development.¹¹⁰ Rooftop farming, on the other hand, has potential due to the number of unused flat roofs available. However, there are specific challenges to ZFarming include the suitability for the building, the size of the space, weight bearing

¹⁰⁹ Angotti, T. 2015. "Urban Agriculture: Long-Term Strategy Or Impossible Dream?". *Public Health* 129 (4): 336-341. doi:10.1016/j.puhe.2014.12.008.

¹¹⁰ (Specht, 2013).

capacity, accessibility, logistics for infrastructure (water, energy, etc), and the necessity of retrofitting. Other issues include zoning and building regulations, permission processes, floor-to-area ratios, maximum allowable building heights, and fire and energy codes.¹¹¹

Often greenhouses in particular are not legal because they violate height restrictions and floor-to-area ratios. However, New York City's Department of City Planning amended a zoning resolution for greenhouses that comply with certain regulations to be exempt from the height and floor area limitations if the greenhouses are educational and food production oriented.¹¹² The Department of City Planning made a Citywide zoning text amendment, with the help of research done by Green Codes Task Force, that removes zoning impediments to the construction and retrofitting of green buildings. The law allows for greenhouses on non-residential buildings by making greenhouses exempt from limitations on floor area and building height. Greenhouses cannot exceed 25 feet in height, must be set six feet from the roof edge, and must include practical measures to limit water consumption. The proposal does not allow for greenhouses on top of residential buildings because it avoids the temptation to improperly convert rooftop greenhouses for residential use. There are numerous amendments concerning green construction, but the ones most pertinent to the construction of green roofs/rooftop farms is allowing green roofs anywhere below the parapet regardless of

¹¹¹ Thomaier, Susanne, Kathrin Specht, Dietrich Henckel, Axel Dierich, Rosemarie Siebert, Ulf B. Freisinger, and Magdalena Sawicka. 2014. "Farming In And On Urban Buildings: Present Practice And Specific Novelties Of Zero-Acreage Farming (Zfarming)". *Renewable Agriculture And Food Systems* 30 (01): 43-54. doi:10.1017/s1742170514000143.

¹¹² (Thomaier et al. 2014)

building height. A guardrail no more than 30% opaque would be allowed up to 3'6" above the top surface of the roof.¹¹³

The most direct government policy aimed at aiding the widespread implementation of green roofs and farms is the Green Roof Tax Abatement. The law appeared in 2008 and gave an abatement of \$4.50 for every square foot on a green roof that covered at least 50% of the rooftop, with a maximum benefit of \$100,000. This legislation was renewed and amended in 2013 and extends the application deadline to March 15, 2018. The amount of abatement increased to \$5.23 per square foot up to \$200,000. However, if you go to the City's main green roof page it still says the program has expired and does not include the information from the legislative renewal and amendment.¹¹⁴ According to New York City's Five Borough Green Roof, the cost of green roof installation can be as little as \$7 per square foot but usually averages out around \$25-\$35 per square foot. The rooftop farm portion of their massive 30,000 foot green roof project costs \$15 per foot and weighs on average 18 pounds per foot.¹¹⁵ This indicates that the tax abatement has the potential to save significant start up costs, but needs to be more comprehensive to incentivize more widespread rooftop farm implementation. This is even more pertinent as a recent study by the Urban Design Lab at Columbia University identified 3,200 acres of commercial, industrial, and public building roofs as having potential for farming.¹¹⁶

¹¹³ "NYC Planning Zone Green Text Amendment". 2012. *NYC.Gov*.
http://www1.nyc.gov/assets/planning/download/pdf/plans/zone-green/zone_green.pdf.

¹¹⁴ Lovece, Frank. 2014. "Green-Roof Tax Break Extended". *Habitatmag.Com*.
<http://www.habitatmag.com/Publication-Content/Green-Ideas/2014/2014-January/State-Extends-Green-Roof-Tax-Break>.

¹¹⁵ ("NYC Parks Green Roof, A Living Laboratory For Innovative Green Roof Design" 2013)

¹¹⁶ Funkhouser, David. 2012. "Opening The Door To More Rooftop Farming?". *Blogs.Ei.Columbia.Edu*.
<http://blogs.ei.columbia.edu/2012/02/03/opening-the-door-to-more-rooftop-farming/>.

Two of the biggest political frameworks in New York City to tackle issues concerning sustainability and justice are PlaNYC developed by Mayor Bloomberg and its updated version by the Mayor de Blasio's administration, OneNYC. PlaNYC had numerous goals, none of which included any concrete policy initiatives, subsidies, or abatements related specifically to rooftop farms. OneNYC is a similar story, but it does recognize the need for greater environmental justice and includes green roofs as part of numerous other green infrastructure solutions that can sequester water from rainfall and help prevent combined sewage overflow in the city. OneNYC does include vague policy stances concerning urban agriculture as well. The biggest accomplishment of OneNYC thus far has been planting 950,000 trees and six million square feet of reflective rooftop added to New York's urban landscape.¹¹⁷

OneNYC outlined sustainability through an intergenerational justice standpoint; "sustainability means the activities we undertake today will not compromise the present generation's or future generations' ability to meet their own needs. It is grounded in the recognition that people, economic development, and the environment are interconnected, and for any to thrive, all must thrive together." This is clearly reverberated through their planned future policies and stances. The first plan that is the most salient for green roofs is called the New York City Green Infrastructure Program and is led by the Department of Environmental Protection (DEP), which is investing over \$900 million dollars throughout a ten year period in green infrastructure practices. These practices include curbside gardens, green roofs, and storm water "greenstreets." The city outlined 3,400 green infrastructure projects in 2011 and finally broke ground on them in 2016. Thus far

¹¹⁷ The City of New York., 2016. *One New York: The Plan For A Strong And Just City*. New York City: The City of New York Mayor Bill de Blasio.

they have completed 500 projects and an additional 2,900 are in construction.

Unfortunately, this does not include data on the type of projects that have been completed so the number of newly installed green roofs is unknown.¹¹⁸ In addition the DEP has a grant program for private property owners in New York City's combined sewer areas who are interested in building blue roofs, rain gardens, implementing porous pavement, or installing green roofs. The minimum requirement for grant eligibility is to manage one inch of storm water runoff from contributing to the surrounding impervious area. If selected, the DEP will provide funds for both the design and construction of the green infrastructure system with up to \$6 million dollars being available per year.¹¹⁹ That is the extent of the political framework to encourage the implementation of green roofs and rooftop farms, although numerous other projects are outline in OneNYC that are concerned with green space access, food security, and community agriculture.

One such example is the Community Parks Initiative, which invests in improving programming by redesigning neighborhood parks. Many of New York City's parks were designed 50-100 years ago and require significant investment to meet changing demands. Many park resources vary in quantity and more than 200 parks have received less than \$250,000 each in capital investment over the last 20 years. By planning for these open spaces as a unified system the city aims to increase quality and efficiency, enhance park access, and improve neighborhood connections. Significant investment is driven by data in an equity-focused framework by determining which parks have received little capital investment, and are located in areas of high need based on neighborhood characteristics

¹¹⁸ (The City of New York 2016)

¹¹⁹ "Grant Program For Private Property Owners". 2016. *Nyc.Gov*.

http://www.nyc.gov/html/dep/html/stormwater/nyc_green_infrastructure_grant_program.shtml.

like poverty, density, and population growth. NYC Parks and Recreation Department has completed designs for 35 comprehensive full-site renovations which began construction in 2016. In addition, NYC Parks made high-impact, immediate improvements, like new pavement and plantings, to 60 parks and playgrounds that serve 500,000 people in targeted neighborhoods. The long-term goal is to impact more than three million New Yorkers across 24 community districts that have low-income, growing, and dense neighborhoods. Another initiative, called Parks Without Borders aims to make park entrances and boundaries that directly interact with the surrounding community more welcoming. NYC Parks plans to accomplish this by improving fences and gates, while adding other amenities like public art, benches, and improved landscaping. However, the amount of money and time frame were not included in the OneNYC plan.¹²⁰

Urban agriculture has a featured spot in the OnceNyc plan but also is very vague. First, urban agriculture is characterized as playing a small but critical role in communities that are underserved by quality, affordable, and fresh foods. It allows opportunities to engage in growing local produce, educates children about nutrition, and offers training in food preparation, gardening, and retailing skills as well as opportunities for workforce development. The plan states that it will support school gardens, larger scale urban farming ventures, and establish food-producing gardens at NYC Housing Authority cites (NYCHA) through its Gardening and Greening program. The Gardening and Greening program is essentially a garden judging competition and offers free seeds, flowering bulbs, and other garden resources to NYCHA residents citywide. The plan goes on to state that it will study emerging urban agriculture opportunities, like vertical farming, to

¹²⁰ (The City of New York 2016)

activate the use of underutilized light industrial space and offer community programming.¹²¹

Fortunately, Mayor Bill De Blasio is following through on his outlined goals in OneNYC by starting a new initiative to attempt to tackle the prevalence of food deserts in twelve New York City neighborhoods. The Building Healthy Communities initiative is a multimillion public-private dollar partnership, which plans to build more urban farms, expand school gardens, and establish community-center farmers markets and culinary programs. As De Blasio has stated: “Our neighborhoods must be able to offer access to healthy food, opportunities for physical activity and safe, vibrant public spaces.”

Unilever, a multinational company, has pledged 4.1 million to the initiative. Additionally, the Laurie M. Tisch Illumination Fund and The New York State Health Foundation have pledged 500 thousand, and the initiative will be using funding from the Department of Parks and Recreation as well as other agencies. Urban farms will be constructed on NYCHA sites in East Harlem, Brooklyn’s Canarsie section, The South Bronx, and Staten Island within the next three years while other neighborhoods will receive funds to maintain pedestrian plazas, establish farmers markets, and install outdoor exercise areas. Each of the communities were chosen based on their levels of obesity and diabetes, as well as population density, and crime levels. Engaged communities are safe communities, which is why the urban farm workers will mainly come from Green City Force; an AmeriCorps program that enlists 18-24 year olds who are currently unemployed or at a dead end job and who have their GED. They get paid \$1000 a month to either work on the farms or to raise housing resident’s awareness of energy efficiency. The produce from the farms, which includes collard greens, celery, cucumbers, cabbage, and other assorted

¹²¹ (The City of New York 2016)

vegetables and herbs, will be free of charge for the public housing residents as long as they volunteer at the farm or bring a bag of compost for which they will receive an equal weight back in produce. The urban farms will additionally have cooking classes to teach the residents how to cook their produce. This entire model is build off of Red Hook Farm's highly successful model and is anchored by the City Office of Strategic Partnerships.¹²²

In 2008, the NYC Department of Health and Mental Hygiene (DOHMH) began an initiative to try to tackle the prevalence of food deserts by increasing access to fruits and vegetables in neighborhoods with the lowest reported fruit and vegetable consumption and the highest obesity rates. In order to accomplish this the DOHMH established 1,000 permits for Green Carts, which are privately owned and operated mobile fruit and vegetable vendors. These carts are meant to increase fresh produce availability specifically in East and Central Harlem, South Bronx, North and Central Brooklyn, and portions of Queens and Staten Island. The initiative was not as successful as intended, because Green Carts were found in neighborhoods that already had multiple healthy stores nearby due to economic incentives that may push vendors to locate in more trafficked and less produce deprived areas. They certainly are still providing supplemental access to fresh fruits and vegetables, but may not be serving the neediest neighborhoods.¹²³

¹²² Kanno-Youngs, Zolan. 2016. "Creating Oases In New York City'S 'Food Deserts'". *WSJ*. <http://www.wsj.com/articles/creating-oases-in-new-york-citys-food-deserts-1449108001>.

¹²³ Li, Kathleen Y., Ellen K. Cromley, Ashley M. Fox, and Carol R. Horowitz. 2014. "Evaluation Of The Placement Of Mobile Fruit And Vegetable Vendors To Alleviate Food Deserts In New York City". *Preventing Chronic Disease* 11. doi:10.5888/pcd11.140086.

Another program was implemented in 2009 as part of the Bloomberg administrations health push, known as the Food Retail Expansion to Support Health (FRESH). This initiative was designed to combine both zoning and financial incentives to support the establishment and retention of grocery stores in underserved communities across all five boroughs.¹²⁴ There are particular designated areas that are FRESH eligible for developers to either renovate existing space or construct new space for full-line grocery stores. These developers have to meet other criteria like; provide a minimum of 6000 feet of retail space for general line of food and non-food products for home preparation, consumption, and utilization. At least 30% of retail space has to be for perishable goods that include dairy, fresh produce, fresh meat, etc. and at least 500 feet of the store has to be solely for fresh produce.¹²⁵ The zoning incentives and financial incentives help to ensure that grocery stores locate in previously underserved locations, but is simply creating greater access a holistically effective method for reducing obesity and diabetes in lower-income areas?¹²⁶

A New York Times article published in May of 2015 challenges the efficacy of Bloomberg's FRESH initiative, because simply installing a supermarket in an underserved area does not fix underlying challenges to ensuring healthy food consumption patterns among residents. For example, in 2011 a 17,000 square foot supermarket opened in Morissania, Bronx an area considered a food desert. The FRESH program aided the development with the city paying nearly 40% of construction costs, and perceived access to healthy food did indeed improve. However, according to a study

¹²⁴ (Li et al. 2014)

¹²⁵ "FRESH- Food Retail Expansion To Support Health". 2016. *Nyc.Gov*. <http://www.nyc.gov/html/misc/html/2009/fresh.shtml>.

¹²⁶ (Li et al. 2014)

published in 2015 authored by an associate professor of medicine at New York University, neither purchasing nor consumption changed. The actual cost of food and residents previous habits of shopping and eating are much more powerful forces in determining what products are purchased, rather than convenience. An additional study found that no more than a tenth of the variation people bought could be explained by the availability of a grocery store. The education level of the shoppers was much more predictive of purchasing habits as well as the influence of poverty. In general, healthier fresher foods are more expensive than processed food, take more time and resources to cook, and last for fewer days. Improving people's diets will require making food not only accessible and affordable, but must also rely on changing people's perceptions and habits about diet and health.¹²⁷

There are a plethora of organizations in New York City focused on food security, CSAs, alternative food networks, urban farming, food education, and social justice. For example, Food Bank for New York City conducts various free workshops for people of all ages, including nutrition education classes that emphasize smart purchasing choices and healthful cooking lessons.¹²⁸ Just Food, an organization that supports community led projects that increase access to locally grown food in underserved NYC neighborhoods, also trains volunteers to teach their neighbors how to select, store, and preserve fresh produce. Just Foods's goal is to create legal infrastructure for community food programs and develop messaging, marketing, and outreach to promote training and services throughout NYC. Just Food's helps nearly a quarter million New Yorkers access services

¹²⁷ Sanger-Katz, Margot. 2015. "Giving The Poor Easy Access To Healthy Food Doesn'T Mean They'Ll Buy It". *Nytimes.Com*. <http://www.nytimes.com/2015/05/09/upshot/giving-the-poor-easy-access-to-healthy-food-doesnt-mean-theyll-buy-it.html>.

¹²⁸ (Segal 2010)

and local food every year.¹²⁹ There is also the Department of Health's initiative called Eat Well and Play Hard in Child Care Settings program, which provides a curriculum and training about nutrition and physical activity to childcare providers for children under five; an effective early prevention strategy but does not solve current food desert issues. Another initiative is aimed at encouraging New York residents to use Food Stamps, called Health Bucks, at participating farmers markets. If you spend \$5 EBT at a farmers market you receive \$2 for of a Health Buck coupon starting from July through November (Health Bucks, 2016). Also the Healthy Bodega Initiative using advertisements in bodegas to encourage residents to buy 1% milk, fruits, and veggies.¹³⁰

GrowNYC is another organization that has done a lot of impressive work through numerous sustainable services and has specifically impacted the urban agriculture movement through the creation of gardens and rooftop farms. They focus heavily on recycling services, education, composting, green spaces and gardens, and education. Every year they choose 1-3 large-scale projects to invest in through their Open Space Greening program. Thus far they have created over 60 gardens in prior years by providing soil, trees, flowers, garden furniture, design advice, and significant technical and material assistance. In 2012 they helped create a rooftop farm, called Via Verde, on a modern affordable housing project in the South Bronx. GrowNYC estimates that every 10 x10 plot produces an average yield of 100lbs of fruit and vegetables annually. In it's first season of production the farm produced an assortment of organic, heirloom herbs, vegetables, and edible flowers. They collected and distributed 1,000 pounds of food for

¹²⁹ Katz, Ruth. 2016. "Just Food: Building Health And Sustainable Food System For NYC". *Hunger Action NYS*. Accessed May 11. <http://hungeractionnys.org/JustFood-05.pdf>.

¹³⁰ (Segal 2010)

the PS 43 local school and the Neighbors Together food pantry. Some other food was distributed to the Via Verde garden club member residents. GrowNYC will provide ongoing programming for two years, which includes monthly workshops in the community room, equipped with a full kitchen, allowing residents to engage in many gardening and food preparation/tasting demonstrations, as well as take home recipes.¹³¹

Sustainable South Bronx is another notable organization that has a green workforce serving underprivileged populations and providing long-term opportunities through green infrastructure. Founded in 2003, the Bronx Environmental Stewardship Training Academy (BEST) is their flagship program that addresses both economic and sustainability issues in the community by preparing New Yorkers for full-time employment, and simultaneously teaching skills related to protecting the environment, restoring urban green spaces, and bringing NYC's buildings to a higher, greener standard. Sustainable South Bronx runs a social enterprise program called SmartRoof, LLC. SmartRoof employs BEST graduates for work and has served a variety of clients on numerous projects. In 2011, they built a 10,000 square foot green roof on top of ABC Carpet and Home's South Bronx warehouse. They've also installed roofs on a Sims Metal Management building, Alfred E. Smith High School, and on the non-profit, Rocking the Boat, located on the South Bronx waterfront. In April 2012, Sustainable South Bronx was one of two green work forces contracted by the city to implement the NYC CoolRoofs initiative, which paints white reflective roofs to promote energy

¹³¹ "Grownyc Annual Report 2012 | OPEN SPACE GREENING". 2016. *Grownyc.Org*. Accessed May 12. <http://www.grownyc.org/annual-2012/open-space-greening/>.

efficiency. Through the contract, BEST graduates cleaned over 450,000 square feet of roof space and coated 265,000 square feet of roof space in white paint.¹³²

Sustainable South Bronx and GrowNYC are two ideal organizations that are tackling the intersection of issues concerning food justice, poverty, health access, and green space. These organizations have done impressive work despite a lack of supportive legislative framework. New York City only boasts of two laws that directly impact green roofs, which is unacceptable if Mayor de Blasio's administration is earnest in the justice and sustainability goals outlined in OneNYC. Green roofs, rooftop farming practices, and broader ZFarming initiatives need to be incentivized through the political framework if any meaningful improvement is expected within the remediation of co-occurring justice issues in New York City.

Chapter 5: Conclusion; Unifying Two Cities Through Rooftop Horticulture

The data indicating the prevalence of food deserts and the necessity for alternative food systems and the corresponding and compounding negative health effects paint an obvious image of two cities existing within New York: one city of rampant abundance characterized by movies, shows, and American culture at large, and the other, of compounding injustice. These differences can be overcome through the efficiency and environmental services provided by productive green spaces in and on buildings. Cities worldwide have recognized the benefits to urban agriculture on buildings and have already implemented policies to expand their implementation and use. The additional psychological benefits to having increased access to nature in urban areas makes the adaptation of policies that ensure development, subsidies, and aid in building and

¹³² "Smart Roofs Sustainable South Bronx Addressing Economic And Environmental Issues In The South Bronx". 2013. *Ssbx.Org*. <http://www.ssbx.org/smart-roofs/>.

retrofitting urban areas for green farming infrastructures, necessary. This form of urban agriculture is a common sense solution to a myriad of interlocking environmental issues; we just need the policies and politics to catch up.

The substantial information gap that currently exists must be addressed in order to inform the needed dialogue on urban agriculture policy and how it intermingles with a cohort of injustices. An international review of the literature on urban green spaces found that only four papers, excluding an analysis of national reports or local planning documents, on the health effects of urban green spaces were published in the U.S. between January 2000 and October 2013.¹³³ It would be beneficial to have a comprehensive listing of negative health disparities within lower-socioeconomic and minority populations and how those disparities correlate directly to spatial aspects of available greenspace, pollution centers, traffic, tree canopy cover on streets, prevalence of healthy versus unhealthy food stores, etc. There also needs to be more comprehensive data on the current prevalence of greenroofs and farms, as well as their output, the communities they serve, practices that work well, etc. Essentially, urban agriculture and the plethora of environmental services it provides require an intersectional analysis with environmental planning and economic sectors, land use, and zoning practices. The lack of coherent interdisciplinary policy frameworks, which should guide practitioners and investors, is one of the main limiting factors in rooftop horticulture. Future frameworks should take into consideration policies for food security, climate change adaptation, comprehensive planning legislation, building regulations and overall the multi-functionality of rooftop horticulture.¹³⁴

¹³³ (Jennings and Gaither 2015)

¹³⁴ (Specht et al. 2013)

One way this can be accomplished through a comprehensive food policy and food policy council as a basis for reforms in land use and tax policies. Two New York City elected officials have proposed a broad food policy agenda and there have been some incremental reforms, but New York City's government has not moved aggressively to attack any of these issues. Although the city's land use, zoning, and tax policies may not directly prohibit green roofs and rooftop farming, they certainly do not support them. Urban planners traditionally look to comprehensive land use plans in order to propose future land uses, but New York remains the only city in the United States that has never had a comprehensive plan. Zoning is the major tool for controlling land use through its regulations on building floor area, setback, height and open space on private land, and thus affects the shape of our built environment. However, zoning is only one piece of the puzzle, without favorable financing and subsidies, tax incentives, and other infrastructure that encourages the growth of a distribution network and technical support.¹³⁵ Technical support is especially important as rooftop farms require an interdisciplinary nature that has not previously been required of contractors, architects, community leaders, farmers, etc.¹³⁶

There are many methods for increasing the framework for policies that support the financial feasibility of green roofs and farms. Given the greater level of organization and cooperation necessary between landlords/owners especially regarding regulations, roof access, and safety issues concerning green roofs, there should be a formalized green roof specialist position on zoning and planning boards.¹³⁷ In addition, the formation of a

¹³⁵ (Angotti 2015)

¹³⁶ (Thomaier et al. 2014)

¹³⁷ (Thomaier et al. 2014)

green roof incentive administration could streamline processes for building permits, perform research and data collection on existing rooftop horticulture and their performance, and create a comprehensive list of available building space that is approved to carry the additional weight load of green roofs.¹³⁸

Financial incentives need to be a primary part of future policy in order to make rooftop horticulture financially appealing. The Green Roof Tax Abatement is New York City's one initiative that acts as a direct incentive, but it is not enough to entice property owners. Changing the abatement to a tax credit may prove to be more effective, because it would allow for credit transfer enabling not-for-profit organizations and building owners not paying property taxes to benefit from the incentive. A transferrable tax credit would guarantee income to third-party investors who could help finance part of the rooftop horticulture project. An administration process could aid by creating an efficient credit process transfer.¹³⁹ The tax abatement could also be sufficiently increased making the installation of rooftop agriculture more appealing.

In addition, the City could create a storm water tax similar to the existing taxes in Germany, which are based on the amount of impervious surface and water runoff from buildings. A storm water tax would make parties like private landowners, corporations, etc. pay their fair share of the cost of human and environmental damage caused by combined sewage overflow and the polluted effluent that harms surrounding water systems. The revenue from the tax could be used to help finance green roofs and urban rooftop agriculture projects. Additionally, buildings that do have rooftop horticulture

¹³⁸ Crauderueff, R, E Dalski, and S Margolis. 2012. "New York City Green Roof Tax Abatement Policy Lessons". *S.W.I.M NYC*. http://swimmablenyc.info/wp-content/uploads/2013/01/SWIM-Green-Roof-Assessment_paper.pdf.

¹³⁹ (Crauderueff, Dalski and Margolis 2012)

would receive tax reductions that are proportional to the amount of retained water. In the case that all storm water is retained through a buildings green infrastructure, the tax reduction could reach up to 100%.¹⁴⁰

Additionally, green roofs and rooftop agriculture should be mandatory for all new construction sites. Government funding collected from the stormwater tax could offset the higher cost of green roof installation. Installing green horticulture makes economic sense, because long-term savings offsets the initial high cost through improved building efficiency. The University of Michigan tested this theory by performing a valuation study on a 2,000 square meter green roof over with an estimated lifespan of 40 years. The study found that a green roof would save about \$200,000, of which, nearly two-thirds would come from reduced energy costs. The economic benefits of any individual green roof will, however, depend on its design, geographic location, surroundings, and the building itself.¹⁴¹

In order to remediate some of the negative effects of long-term exclusionary zoning, New York could create a regional tax sharing system like the one managed by The Metropolitan Council in Minneapolis-St. Paul. Essentially, commercial and industrial taxes that are disproportionate within certain municipalities would be taken and redistributed more equitably to municipalities with a lower tax base. The revenue could be used to finance urban rooftops on schools, hospitals, public housing units, etc in order to give more vulnerable populations access to the ecosystem services provided by rooftop agriculture. This kind of policy would ensure that public health, urban planning, and

¹⁴⁰ "Green Roof Policies". 2016. *International Green Roof Association*. http://www.igra-world.com/green_roof_policies/index.php.

¹⁴¹ ("Green Roof Benefits, Technical Preservation Services, National Park Service" 2016)

environmental law work together to reform the inequitable development, metropolitan fragmentation, and health disparities created by exclusionary zoning and environmental injustice.¹⁴²

Further tax subsidies, loans, and abatements should be available for the creation of urban agriculture, specifically in riskscapes, given the vast potential for health benefits in these areas. This could be based off of the Bronx Environmental Revolving Loan Fund, which has been providing low interest loans funded through the New York Power Authority since 2006. The loans are given to implement energy efficient technologies that improve air and water quality and save energy. The maximum loan amount is \$100,000 with a 10-year term and only 1-3% interest rate. This loan has funded 13 green roofs in the Bronx, totaling about 40,000 square feet.¹⁴³ Some of the government funding that goes to the FRESH program could be diverted to fund loans for the creation of urban agricultural spaces. In addition, those diverted funds could be used to create rooftop farms and greenhouses on already existing supermarkets and stores to bolster local food networks.

Finally, the expansion of green collar jobs within riskscapes has huge potential for providing economic opportunity in underserved areas in tandem with the creation of greater access to green space and food. Sustainable South Bronx's BEST program is an excellent model for green jobs training, which should be expanded upon to include urban farming training and positions. The Green City Force through Americorps is another successful job training model, which has compounding positive benefits for entire

¹⁴² (Wilson, Hutson and Mujahid 2008)

¹⁴³ Loveland, Sara. 2010. "Green Roof Incentives And Partnerships". *EPA-DC Green Works*. https://www.epa.gov/sites/production/files/2014-07/documents/green_roof_incentives_partnerships_the_2010_resource_guide-saraloveland.pdf.

communities. Creating rooftop agricultural and urban agricultural spaces is vital for underserved communities, but is only effective with community involvement and work.

The current injustices faced by low-income and minority residents are an unacceptable stain on America's greatest city and the antithesis to the American value of equal opportunity. These policy suggestions have the potential to amend the historical injustices and unite the two distinctly separate cities within New York. Amending the paradox between injustice and abundance hinges upon the holistic adaptation of equitable and sustainable policies that will ensure the health of all citizens. As such, rooftop agriculture could play a vital role in the remediation of disparate impacts faced by low-income and minority residents, and the mitigation of the ever-looming impacts of climate change.

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