MASTER'S PROJECT

A Policy Analysis to Reduce Climate Risk in Chicago's Most Vulnerable Communities

by

Eileen Gallagher

April 24, 2015

Dr. Elizabeth A. Albright, Adviser

This master's project submitted in partial fulfillment of the requirements for the Master of Environmental Management, Nicholas School of the Environment, Duke University.

Executive Summary

This master's project compares policy options that will most effectively reduce climate risk, specifically flooding, in Chicago's most vulnerable communities. Chicago is expected to receive heavier and more frequent precipitation due to climate change, increasing upwards to 20 to 30 percent more by the end of the century (Hayhoe, et al, 2010). Unfortunately, over the past several decades, the City's century-old combined sewer system has failed to protect communities from flooding (Hayhoe, et al, 2010).

The City's sewer system carries sewage and stormwater in the same underground pipe, and it often exceeds its threshold of 2.5 inches of rainfall per day (USGCRP, 2009). Beyond that, the untreated waste and stormwater overflow into the Chicago River and Lake Michigan – the City's source of drinking water – or onto city streets and into basements (City of Chicago, n.d.b). The City has been investing in infrastructure to combat the increasing frequency of flooding. In 1972, the City unveiled the Tunnel and Reservoir Plan (TARP) to reduce flooding, but several challenges have delayed phases of execution, and it is not expected to be completed until 2029.

Until a more sophisticated sewer system is constructed, green and other gray infrastructure can mitigate flooding risks by capturing stormwater. Recognizing this, City of Chicago established the Green Stormwater Infrastructure Strategy in 2014 and plans to release a Citywide Stormwater Management Plan in 2015. The Strategy designates $50 million to fund green stormwater infrastructure projects over five years for existing and planned capital improvement projects, but these projects are not specifically assigned to communities that are the most vulnerable.

Although flooding is pervasive throughout Chicago, the most vulnerable populations are most at risk. Vulnerability is described as "the propensity or predisposition to be adversely affected… including sensitivity or susceptibility to harm and lack of capacity to cope and adapt" (IPCC, 2014). Experts

increasingly recognize that adapting to climate change, and repairing or rebuilding homes and neighborhoods after extreme weather events, will place an additional stress on vulnerable communities.

Vulnerability can be measured by the Hardship Index, a collection of six socioeconomic indictors, assessing poverty, crowded housing, unemployment, level of education, age (or dependency), and per capita income (City of Chicago, 2014). In 2014, the City of Chicago evaluated its 77 communities using the Hardship Index, finding that there is an unequal distribution of hardship among different racial and ethnic demographics within the City. This inequitable divide suggests that communities that are majority minority are the most vulnerable, and therefore will likely struggle the most to adapt to climate change. But to date, existing policies do not adequately protect vulnerable communities from climate change.

To remedy these challenges, the City of Chicago must institute a sound policy that aims to reduce its climate risk, protect its economy and ensure environmental justice of its most vulnerable communities. Leveraging existing city plans, state initiatives, U.S. presidential executive orders or federal regulations, this project outlines and analyzes three policy options to address the problem in Chicago:

1. *Affirmative Action for Vulnerable Communities* would encourage the City to "engage in good faith efforts" (UVA EOP, 2012) to proactively assign climate adaptation projects under the Green Stormwater Infrastructure Strategy and Citywide Stormwater Management Plan for vulnerable communities, improving conditions for populations that have historically been discriminated against.
2. *Community-based Adaptation for Environmental Justice* would localize federal and state environmental justice acts to mandate financing for vulnerable communities, which are often underrepresented in policymaking, to identify the adaptation project of their choosing, thereby strengthening their capacity to adapt to climate change.

3. *Discounted Premiums for the Poor* expands the existing subsidies offered by the National Flood Insurance Program to cover not only homeowners located in high-risk flood zones but also homeowners under the federal poverty line.

The optimal policy should not exacerbate hardship but rather reduce communities' vulnerability to flooding. Therefore, the three policy options in addition to the status quo are measured against the following goals:

1. *Effectiveness*: The frequency and volume of flooding should decline, measured by whether the number of flood insurance claims will decrease in the most vulnerable communities as identified by the Hardship Index.
2. *Equity*: Stakeholders are not unfairly burdened, measured by (1) whether insurance companies will face surmounting financial pressure due to an increasing number of claims and (2) whether neighboring communities will receive excess stormwater runoff as a result of the policy.
3. *Political feasibility*: Stakeholders support or minimally oppose the policy, measured by (1) whether homeowners in vulnerable communities will tolerate temporary disturbances to install stormwater infrastructure and (2) whether the municipal government will accept budgetary changes.
4. *Efficiency*: Costs to vulnerable communities are minimized, measured by whether costs exceed the moderate amount of flood insurance premiums.

After careful analysis of the three policy alternatives measured against the four aforementioned goals, the City should implement *Affirmative Action for Vulnerable Communities* to address its climate and socioeconomic challenges. By selecting vulnerable communities as recipients of the committed $50 million for green stormwater infrastructure, the City can curtail flooding in vulnerable communities without additional costs to homeowners. And with improved stormwater management infrastructure, the number of flood insurance claims and runoff into neighboring communities will decrease.

There are several other actions the City should take to achieve and maintain political feasibility under this policy. A community-specific needs assessment and a cost-benefit analysis will help to prioritize which stormwater management projects to execute in which of the vulnerable communities. And

collaborative stakeholder engagement from municipal departments, nonprofits and community residents is critical to successfully execute the policy.

Finally, the City must continue to monitor for climate risk and vulnerability as well as evaluate the policy's progress. The municipal government should take an adaptive management approach to administrating the policy, which can connect continuous learning with policy implementation and guide administrators to adjust management processes for maximum impact (Williams et al, 2009). Properly managing and ultimately enhancing vulnerable communities' ability to adapt to a changing climate is critical for the City's economic, environmental and human wellbeing.

Table of Contents

Executive Summary 1
Overview 6
Background and Literature Review 6
Policy Analysis 16
Summary of the Analysis 27
Recommendations 28
Sensitivity Analysis 30
Tables 33
References 38

Overview

Chicago is projected to receive heavier and more frequent precipitation due to climate change, increasing upwards to 20 to 30 percent more by the end of the century (Hayhoe, et al, 2010). Yet, over the past several decades, the City's century-old combined sewer system has failed to protect communities from flooding (Hayhoe, et al, 2010). Although flooding is pervasive throughout Chicago, the most vulnerable populations – identified by socioeconomic status – are most at risk. With a history of limited financial resources and influence in policymaking (Bonorris et al, 2010), these communities that comprise predominantly of minorities struggle the most to repair and rebuild from flooding, affecting both their health and economic wellbeing.

The objective of this master's project is to compare policy options that will most effectively reduce climate risk, specifically flooding, in Chicago's most vulnerable communities. The optimal policy will not exacerbate hardship or poverty but rather reduce communities' vulnerability to flooding. By protecting vulnerable communities, the City will ensure the environmental justice of its residents and mitigate the costly impact of climate change.

Background and Literature Review

Vulnerability in Chicago

In the context of climate change, vulnerability is studied and identified in relation to such social conditions as poverty and inequality (IPCC, 2014). It is described by the Intergovernmental Panel on Climate Change as "the propensity or predisposition to be adversely affected… including sensitivity or susceptibility to harm and lack of capacity to cope and adapt" (IPCC, 2014). Experts increasingly recognize that adapting to a changing climate, and repairing or rebuilding homes and neighborhoods after extreme weather events, will be an additional stress on vulnerable communities. For example, low-

income homeowners could face new financial burdens from flooded basements due to heavier rainstorms, or families may be forced out of their homes if they lack the resources to rebuild. Further, climate change could delay or reverse economic and social progress, leading to environmental and financial insecurity, displacement and conflict (IPCC, 2014).

In a study conducted in 2014, the City of Chicago evaluated its 77 communities using the Hardship Index (City of Chicago, 2014). This index incorporates six socioeconomic indicators that assess poverty, unemployment, level of education, age (or dependency), crowded housing and per capita income (see Table 1). The Chicago communities are ranked zero to 100, where zero refers to the community with the lowest level of hardship and 100 corresponds to the community with the highest level of hardship (see Table 2). The Index indicates there is a wide gap between the lowest and highest ranked Chicago community. For example, the lowest ranked community, the Near North Side, has 13.7 percent of households below the federal poverty line, 6.2 percent unemployment and a per capita income of $88,152 (City of Chicago, 2014). On the other end of the spectrum is Riverdale, the highest ranked community on the Hardship Index, in which 58.4 percent of households are below poverty, 34.8 percent are unemployed and the per capita income is only $8,548 (City of Chicago, 2014).

The level of vulnerability – identified by socioeconomic status or the Hardship Index – varies widely among racial and ethnicity groups across Chicago. Montclaire, the highest ranking white community on the Hardship Index, has a score of 51, meaning that there are 37 other communities with a higher level of hardship and each one is predominately composed of minorities (City of Chicago, 2014; Heartland Alliance, 2013). Reflecting again on the lowest and highest ranked communities, the Near North Side is 76.5 percent white whereas Riverdale is 96.9 percent black (see Table 2) (Heartland Alliance, 2013). This unequal distribution of hardship among different racial demographics demonstrates an inequitable

divide within the City. This suggests that communities comprising predominately of minorities will likely struggle the most to adapt to climate change.

The Impact of Climate Change on Chicago

In the 20th century, the frequency of heavy rains in Chicago doubled on average to twice per year and the number of individual rainy days, short-duration (1-7 days) and week-long heavy rain events increased (Hayhoe et al, 2010). Consequently, studies show that Illinois experienced increased flooding between the 1920s and early 2000s (Hayhoe et al, 2010). Since 2007, Chicago's sewer system has overflowed on 484 days as a result of heavier and more frequent rainfall, flooding city streets and basements (MWRD, 2015a).

Moving forward, Chicago is projected to receive heavier and more frequent rainfall as a result of climate change (Hayhoe et al, 2010). With expected increasing temperatures between 2 and 6 degrees Celsius, the City is projected to receive more rain than snow during the winter (Hayhoe et al, 2010). By the end of the century, Chicago is expected to receive 20 to 30 percent more precipitation during the winter and spring seasons (Hayhoe et al, 2010). Heavy rainfall in a short amount of time and rapid snow melt can put communities at risk of flooding (NOAA, n.d.).

The increased rainfall that is projected as a result of climate change will continue to place stress on Chicago's century-old combined sewer system. The City's combined sewer system carries sewage and stormwater in the same underground pipe, yet the combined system is managed by two distinct entities (USGCRP, 2009). The City's Department of Water Management maintains 4,400 miles of the sewer system, and separately, the Metropolitan Water Reclamation District (MWRD) of Greater Chicago manages over 500 miles of the system (Green Stormwater Infrastructure Strategy, 2014). The stormwater and sewage are sent to treatment plants managed by the MWRD before discharge, but if

the plants are full and do not have additional capacity, the water overflows through combined sewer outfalls (CSO) in 200 different locations throughout the City and region (Green Stormwater Infrastructure Strategy, 2014). Minorities comprise 67 percent of the MWRD CSO service area and 20 percent live below the federal poverty line (EPA, 2011). And although flooding is pervasive throughout the City, the EPA notes "all the waterways affected by CSOs… flow adjacent to an environmental justice area of concern" (EPA, 2011).

Climate Vulnerability as a Case of Environmental Injustice

Globally and within the U.S., scholars have documented injustice among people who are "vulnerable to climate disasters [as a result of their] race, ethnicity, class and gender," and that climate preparedness resources are "unequally distributed by old social divisions" (Mohai et al, 2009). Chicago's old social divisions emerged most conspicuously in the form of housing discrimination starting in the 1930s. Under the National Housing Act of 1934, federal assessments were made on the quality of the neighborhoods' land and infrastructure as well as the race, ethnicity and social class of its residents (Greer, 2014). Based on these assessments and the resulting "level of risk," neighborhoods were either granted mortgages or redlined. Redlining resulted in "arbitrarily denying or limiting financial services to specific neighborhoods, generally because its residents are people of color or are poor" (Chicago Historical Society, 2005). Because African Americans in Chicago frequently were denied equal access to mortgages, they could either only afford, or have access to, low-quality housing that often had unequal access to drinking water, central heating and private toilets (Chicago Historical Society, 2005).

Redlined communities were effectively blocked from access to capital from traditional banks. This "undermined the ability of African Americans to accumulate wealth," (Chicago Historical Society, 2005) ultimately restricting them from achieving the American Dream in which "each man and each woman shall be able to attain to the fullest stature of which they are innately capable… regardless of the

fortuitous circumstances of birth or position" (Adams, 1931). Today's rankings of the Hardship Index are indicative of this plight in that communities with the lowest socioeconomic status comprise minorities (City of Chicago, 2014). And beyond socioeconomic constraints, low-income and minority communities often face environmental risk (Mohai et al, 2009). In Chicago, the aforementioned combined sewer overflows are located largely in communities with low-income and minority populations (EPA, 2011).

Today, there are both federal and state actions to protect minorities from environmental harm and seek environmental justice for all citizens. In 1994, President Clinton signed Executive Order 12898 to "focus federal attention on the environmental and human health effects of federal actions on minority and low-income populations with the goal of achieving environmental protection for all communities" (Federal Register, 1994). In Chicago, Governor Quinn established the Illinois Environmental Justice Act in 2011 that maintains "no segment of the population, regardless of race, national origin, age, or income, should bear disproportionately high or adverse effects of environmental pollution" (IGA, 2011). Further, it established a commission to review concerns of environmental injustice and recommend solutions to the governor. But neither EO 12898 nor the state Act establish new laws or enforceable legal rights of low-income or minority populations (CALFED, n.d.).

Environmental justice is a key component to decreasing a community's climate-induced vulnerability – or the consequences and impact from climate change (IPCC, 2014). But today's pre-existing conditions for minorities in Chicago, which are deeply rooted in the old social divisions of the early 1900s, have unjustly positioned them to be the most vulnerable or unable to adapt to a changing climate (Hirsch, 1998).

Impact of Flooding on Chicago's Communities

Flooding is pervasive throughout Chicago (Green Stormwater Infrastructure Strategy, 2014). The combined sewer system often exceeds its threshold of 2.5 inches of rainfall per day (USGCRP, 2009). Beyond that, the untreated waste and stormwater overflow from the CSOs into the Chicago River and Lake Michigan (City of Chicago; n.d.a.; USGCRP, 2009) – the City's source of drinking water – or onto city streets and into basements (City of Chicago, n.d.b.). Since the system was built in 1856, the City's population has grown by more than 2.6 million people, thereby reaching and often exceeding the system's capacity (BU, n.d.). And to accommodate a larger population, the City has paved roads and erected buildings that reduce permeable ground, which push more stormwater into the overloaded treatment system.

Between 2007 and 2011, insurance companies paid claims to homeowners in 90 percent of Chicago's 59 zip codes (Green Stormwater Infrastructure Strategy, 2014; City-Data, 2012). One of the more recent floods transpired in April 2013. The City's emergency personnel received more than 2,000 calls for flooded basements and more than 500 reports of flooded streets (Cox, 2013). Damages included a sinkhole in the South Deering community that swallowed three cars and injured one person (Gutierrez, 2013). The City's Department of Water Management stated that heavy rains and the saturated ground may have caused the underground water main built in 1915 to break (Gutierrez, 2013). And on the northwest side, families were rescued from their homes by boat – the second time in five years (Wetli, 2013).

Floodwater from the combined sewer system may include toxins, viruses, bacteria and other damaging pollutants, which is in violation of the U.S. Clean Water Act (EPA, 2011). Following Hurricane Katrina in New Orleans, for example, schools and playgrounds were found to have high levels of arsenic in the soil after floodwaters carried toxic chemicals into the community (NRDC, 2007). In Chicago, a survey

conducted by Center for Neighborhood Technology (CNT) found that 13 percent of respondents fell ill subsequent to flooded homes and 84 percent suffered from stress (CNT, 2013b).

In 2014, the Washington Post shared the story of a Southside Chicago homeowner whose basement flooded three times in the past five years. During the floods of April 2013, sewage flowed into her basement, carrying hundreds of eggs that hatched into maggots, infesting her home (Washington Post, 2014). Such experiences have led CNT to assemble a support group to "raise awareness about the problem of urban flooding and advocate for sustainable flooding solutions" (CNT, 2013a).

Further, flooded city streets and basements can disrupt the economy. CNT found that 41 percent of survey respondents lost part of their property and 74 percent missed work to manage repairs (CNT, 2013a). Repairs and clean-up efforts can strain residents' budgets and insurance companies' finances. CNT finds that basement flooding can decrease property values by 10 to 25 percent and nearly 40 percent of small businesses never reopen after a flood (CNT, 2013a).

Between 2007 and 2011, flood insurance policyholders received an average of $4,272 per claim with total claims in the Chicago area amounting to $773 million (CNT, 2013a). The majority of each payout, or 63 percent, is covered by FEMA disaster relief whereas 27 percent is covered by private insurance and 10 percent is covered by the National Flood Insurance Program (NFIP). Despite contributing the least to each payout, NFIP is currently $24 billion in debt following significant payouts after Hurricanes Katrina and Sandy (GAO, 2013).

In 2014, Farmers Insurance Co. filed nine class-action lawsuits against Chicago, arguing that the City is aware that climate change will result in more rainfall but is not establishing the proper adaptation mechanisms to mitigate the risks (Phillips, 2014). Farmers' policyholders sought reimbursement from home damages, lost income and cost of evacuation, which prompted Farmers to take action with the

City (Phillips, 2014). Although Farmers ultimately dropped the charges, claiming that they succeeded in bringing the issue to the City's attention, it's clear that Chicago is and will continue to be affected by climate change and must execute sound adaptation policies and programs (McCoppin, 2014).

Chicago's Climate Adaptation Plans – the Status Quo

The City is and has been investing in infrastructure to combat the increasing frequency of flooding. In 1972, the MWRD unveiled the Tunnel and Reservoir Plan (TARP) "to protect Lake Michigan – the region's drinking water supply – from raw sewage pollution; improve water quality of area rivers and streams; and provide an outlet for floodwaters to reduce street and basement sewage backup flooding" (MWRD, n.d.). TARP consists of "deep rock tunnels and surface reservoirs that capture, convey, and store sewage and stormwater during storms until it can be pumped to existing treatment plants when capacity becomes available" (Green Stormwater Infrastructure Strategy, 2014). Initially, the MWRD estimated a completion date of 1982. But several challenges have delayed phases of execution, and it is not expected to be completed until 2029 – making it a 57-year project.

In 2011, the U.S. Environmental Protection Agency (EPA) raised concerns that the MWRD is in violation of the federally mandated Clean Water Act for releasing untreated sewer overflow (EPA, 2011). Yet the EPA and MWRD agreed to a settlement that includes the 2029 TARP completion date, which drew criticism from several environmental organizations and advocates including the National Resource Defense Council (NRDC), the Environmental Law & Policy Center, Friends of the Chicago River and the Sierra Club among others. This continues to delay Chicago residents' relief from regular flooding and polluted waterways.

In 2014, the City of Chicago released the Green Stormwater Infrastructure Strategy, which complements the gray infrastructure of TARP and aims to reduce flooding from future storms with the planting of

vegetation and by swapping out impervious surface areas with permeable pavement (Green Stormwater Infrastructure Strategy, 2014). The City finds that this Strategy is "creating a platform for economic growth, reducing flooding risk, strengthening neighborhoods, and expanding opportunities for residents to live healthier and more active lifestyles" (Green Stormwater Infrastructure Strategy, 2014). Thus far, existing green infrastructure in Chicago has captured 85 million gallons of stormwater annually (Green Stormwater Infrastructure Strategy, 2014). Forthcoming in 2015, the City will launch a comprehensive Citywide Stormwater Management Plan that will include long-term goals to reduce flooding through the combination of both green and gray infrastructure. But to date, these projects are not specifically assigned to communities that are the most vulnerable.

Policy Opportunities to Protect Vulnerable Communities from Climate Risk

Although flooding is pervasive throughout the City and water infrastructure improvement costs are shared among taxpayers (Green Stormwater Infrastructure Strategy, 2014), the communities with the highest level of hardship suffer the most due to a combination of factors including unemployment or low income that limit or restrict their ability install infrastructure to reduce the risk of flooding or to repair and rebuild after flooding. To remedy these challenges, the City of Chicago must institute a sound policy that aims to reduce its climate risk, protect its economy and ensure environmental justice of its most vulnerable communities as identified by the socioeconomic Hardship Index. Leveraging existing city plans, state initiatives, U.S. presidential executive orders or federal regulations, this project outlines and analyzes three policy options to address the problem in Chicago: (1) *Affirmative Action for Vulnerable Communities*, (2) *Community-based Adaptation for Environmental Justice*, and (3) *Discounted Insurance Premiums for the Poor.*

Affirmative Action for Vulnerable Communities will leverage the existing Green Stormwater Infrastructure Strategy to help reduce flooding in vulnerable communities. As it currently states, the

Strategy will focus $50 million over five years on existing and planned capital improvement projects, but it is not clear if these projects are or will be located in vulnerable communities. And it is unknown whether the forthcoming 2015 Citywide Stormwater Management Plan, which will include long-term goals to reduce flooding by installing both green and gray infrastructure, will allocate or prioritize funding specific to vulnerable communities. Therefore, this policy aims to proactively identify vulnerable communities as recipients of the green and gray infrastructure.

Further, Chicago is at risk of neglecting Presidential Executive Order 12898 and the Illinois Environmental Justice Act of 2011 if it does not ensure federal and state funds protect low-income and minority populations and if considerations to safeguard the communities from environmental hazards are not addressed (Federal Register, 1994; IGA, 2011). To date, the City of Chicago does not have an environmental justice mandate specific to the City's jurisdiction to ensure that municipal funds protect the aforementioned communities. *Community-based Adaptation for Environmental Justice* would localize environmental justice efforts and engage community residents proactively on the climate adaptation opportunities applicable to them. Unlike the first policy of affirmative action, in which the City is required to act in good faith, this policy mandates finances to be allocated to vulnerable communities for climate adaptation.

The third policy option, *Discounted Insurance Premiums for the Poor,* proposes that homeowners below the federal poverty line in Chicago receive discounted flood insurance premiums. Because private insurance companies in Chicago have been under financial stress due to recent floods, this policy recommends that the U.S. government expand its existing subsidized program to cover not only homeowners located in high-risk flood zones but also homeowners under the federal poverty line. Currently, the National Academy of Sciences is studying how to ensure flood insurance affordability among low-income homeowners and will submit its report by September 2015.

Policy Analysis

The objective of this project is to compare policy options that will be the most effective at reducing climate risk, specifically flooding, in Chicago's most vulnerable communities. The optimal policy will not place additional hardship on or exacerbate poverty in the City's most vulnerable communities, but rather it will lessen their risk and impact from the projected increasing heavy rainfall as a result of climate change. By protecting vulnerable communities, the City will make strides to ensure environmental justice for its residents and avoid the costly impact of climate change.

Goals and Criteria

Policy options will be measured against four goals: effectiveness, equity, political feasibility and efficiency. Six associated criteria will help to assess the likelihood of whether the policies will achieve the goals.

Effectiveness – As a primary goal, the optimal policy will be one in which flooding in vulnerable communities declines in terms of both volume and frequency. To measure effectiveness, the policy alternatives will be evaluated on the criterion of whether the number of insurance claims will decrease in the communities with the highest level of hardship. This will ascertain whether vulnerable communities as identified by socioeconomic status measured by the Hardship Index continue to experience flooding. If the number of claims in these communities decreases in the face of heavier rains that are projected for the region, then it can be argued that the policy is effective.

Equity – By definition, this goal seeks the "fair distribution of resources and burdens" among stakeholders (Osterle, 2002). To reach this goal, the policies must not disproportionately harm or benefit one segment of the population. Equity will be measured by two criteria, addressing two particular stakeholder groups: neighboring communities and insurance companies. The first criterion will seek to

ensure that neighboring communities adjacent to the vulnerable communities affected by the policy are not unfairly harmed. One way to measure this is if a neighboring community floods more due to runoff from a vulnerable community that is protected by the policy.

The second criterion will seek to ensure that insurance companies are not unfairly burdened or benefited by a policy. One way to measure this is to gauge whether insurance companies will continue to face surmounting financial pressures due to an increasing number of insurance claims. In 2014, the high number of claims pushed Farmers Insurance Co. to file lawsuits against the City. To avoid similar conflicts and to reach this goal of equity, the policy must avoid disproportional financial burdens on insurance companies. The criterion, or the surmounting financial pressures, will be measured by the level of flooding risk. For example, there is a strong likelihood that flood insurance claims will increase in a community that lacks adequate stormwater management infrastructure. This would add financial pressure to the insurance company, so the policy would not meet the criterion.

Political feasibility – The policy should seek support and reduce opposition from stakeholders. Therefore, it's important to understand and address stakeholders' objectives, concerns and potential challenges associated the policy. To measure political feasibility, the first criterion will assess the likeliness of whether homeowners will tolerate disturbances within their community in an effort to reduce flooding such as the installation of green or gray infrastructure. Construction may temporarily close streets, be noisy and cause visual distractions.

The second criterion will assess support from the mayor's office and municipal departments such as the Department of Water Management to accept the policy. To win their support, the policy must take into consideration specific resources that will be needed such as costs and workload capacity (Meltsner, 1972). If the resources exceed annual budgets, it may sway the mayor's office to block the policy.

Efficiency – Finally, the policy should minimize the costs of climate change to the residents living in vulnerable communities to avoid exacerbating poverty. Costs can include coping, repairing or rebuilding from damages caused by flooding. Standard or moderate costs include paying insurance premiums, which can start as low as $176 per year on average (FEMA, 2015b). The criterion for efficiency will measure whether costs are significant, exceeding the standard or moderate amount of insurance premiums. Significant costs could include home repairs not covered by insurance, tending to illness and taking a leave of absence from employment due to illness, home repairs or lack of transportation as a result of the impact from climate change. To achieve efficiency, the policy should avoid significant costs.

Analyzing the Alternatives

The status quo and three policy alternatives – (1) *Affirmative Action for Vulnerable Communities*, (2) *Community-based Adaptation for Environmental Justice*, and (3) *Discounted Insurance Premiums for the Poor* – are assessed independently in comparison to the aforementioned goals and criteria. A policy matrix illustrates this assessment (see Table 3). Cells are coded high, medium or low, to indicate whether that policy will meet the criterion, and thereby, the goal. Then, for each criterion, cells are shaded green or red to indicate which policy is the most favorable or least favorable, respectively, of the alternatives. Unshaded cells indicate policies that are neither the most favorable nor most unfavorable.

Status Quo

To summarize the status quo, climate change is projected to increase precipitation in Chicago by 20 to 30 percent by 2100 (Hayhoe et al, 2010). Its sewer system is more than a century old and lacks the capacity to withstand a growing population, less permeable ground and the influx of precipitation. Since 2007, the sewer system has overflowed on 484 days (MWRD, 2015a), and the City continues to be at risk

of flooding. The status quo will result in vulnerable communities identified by socioeconomic status, which is measured by the Hardship Index, continuing to suffer the most from climate change.

Effectiveness (LOW) – As more frequent and heavier rainfall is projected for Chicago, the aging combined sewer system is expected to continue to exceed its threshold of 2.5 inches of rainfall per day (USGCRP, 2009). This will cause the sewer system to overflow and flood city streets and basements (City of Chicago, n.d.b.). The status quo does not guarantee that vulnerable communities will receive gray or green infrastructure to better manage stormwater. Therefore, there is a strong likelihood that vulnerable communities will continue to experience flooding. As a result, the number of insurance claims will not decrease, which is the criterion used to measure this goal. Thus, the status quo is not effective.

Equity (LOW, LOW) – Neighboring communities and insurance companies will continue to be disproportionately affected. Neighboring communities will continue to receive runoff since flooding is pervasive throughout Chicago, and insurers will continue to face an increasing number of claims and payouts to repair from damages.

Political Feasibility (MEDIUM, MEDIUM) – Capital improvement projects are not guaranteed for vulnerable communities. Therefore, under the status quo, homeowners in vulnerable communities will likely not experience temporary disturbances caused by the construction or installation of green or gray infrastructure. However, under the status quo, sewer pipes are at risk of breaking under the increased stress of more frequent and heavier rainfall. For example, heavy rains caused pipes to burst in the South Deering community in 2013 causing a sinkhole that swallowed three cars and injured one person (Gutierrez, 2013). Threats of similar damage may cause homeowners in vulnerable communities to not accept the status quo.

Under the status quo, the mayor's office and municipal departments will not need to enact or manage a new policy; however, they may need to address future challenges that the communities face as a result of increasing precipitation due to climate change (e.g., calls to emergency personnel for damages caused by flooding or evacuation from flooded homes).

Efficiency (LOW) – Vulnerable communities will continue to face flooding risks and therefore could incur significant costs to repair from damages under the status quo. Between 2007 and 2011, at least 90 percent of Chicago's 59 zip codes suffered from flooding damages (Green Stormwater Infrastructure Strategy, 2014; City-Data, 2012). On average in the U.S., the damages caused by one inch of floodwater in a 1,000 square foot-home is equal to $10,600 in losses (FEMA, 2015). This amount, which excludes costs due to illness or job absenteeism, exceeds the per capita income of the two highest ranked communities on the Hardship Index (City of Chicago, 2014a). And between 2008 and 2012, the average payout per claim in the U.S. amounted to more than $38, 000 (FEMA, 2015). Due to the significant nature of these costs, the status quo is not efficient.

Affirmative Action for Vulnerable Communities

In the U.S., affirmative action policies have sought to improve opportunities or conditions for populations of individuals that have been historically discriminated against such as minorities, women and people with disabilities (NCSL, 2014). Affirmative action policies require institutions to "engage in good faith efforts" to proactively seek minorities, women and people with disabilities for open positions or enrollment, but the policies do not enforce placement of these underutilized groups (UVA EOP, 2012). Efforts of good faith include but are not limited to removing barriers that have historically excluded underutilized populations and ensuring there is equal representation of different populations within the applicant pool (UVA EOP, 2012).

This policy, *Affirmative Action for Vulnerable Communities,* proposes that the City of Chicago proactively seeks stormwater management projects for the most vulnerable communities identified by the Hardship Index. As discussed in the Background and Literature Review section of this paper, the majority of minority populations in Chicago live in communities with the highest level of hardship, having been predisposed to housing discrimination since the 1930s. Whereas the existing affirmative action policies aim to improve the conditions and opportunities in education and employment for underserved populations, this policy seeks to improve living conditions through green and gray stormwater management for Chicago's most vulnerable communities in the face of climate change.

The stormwater management projects will be funded and managed under the auspices of the five-year Green Stormwater Infrastructure Strategy and the forthcoming 2015 Citywide Stormwater Management Plan. To date, the City has not identified or announced the communities that the Strategy and Plan will target, so this policy will encourage the City to take "positive, construction action… to compensate for past discriminatory practices" that have placed minorities on the frontlines of environmental harm in Chicago (UVA EOP, 2012). The positive, constructive action that the City will take is expanding its efforts to proactively select vulnerable communities to be the recipients of stormwater management projects. (UVA EOP, 2012).

Using the Hardship Index as a guide to identifying vulnerable communities, Chicago's municipal departments including the Department of Water Management and the Chicago Sustainability Office will identify and recommend communities that should receive stormwater infrastructure. This will help to ensure equal representation of income, race and ethnicity in the City's pool of applicants. To align with the filing of the City's Annual Financial Analysis on July 31 of each year, the municipal departments will submit their recommended communities and corresponding budgets to the Office of Budget and Management by early summer. To date, the Green Stormwater Infrastructure Strategy has allocated $50

million over five years, but the budget for the Citywide Stormwater Management Plan has not been released yet. The City Council holds one public hearing before voting on a final budget by December 31, and the budget and its associated activities are enforced on January 1 (City of Chicago, n.d.c.).

Effectiveness (HIGH) – To date, affirmative action policies have not been established to address the discrimination in the context of climate change. However, it has been argued that affirmative action policies are "one of the most effective tools for redressing the injustices caused by our nation's historic discrimination against people of color and women…" (ACLU, n.d.). For example, a study conducted by the University of California, Berkeley, found that between 1974 and 1980, affirmative action successfully increased the number of employed women in the U.S. by 2.8 percent for African Americans, 33 percent for Hispanics and 9 percent for Caucasians (Leonard, 1984). Thus, it can be inferred that affirmative action will increase the selection of vulnerable communities by the City to receive improved stormwater management systems under the Green Stormwater Infrastructure Strategy and Citywide Stormwater Management Plan.

To reach the goal of effectiveness, the number of insurance claims issued from vulnerable communities must decrease. Under this policy, the flooding risk will decrease with the installation of green and gray stormwater infrastructure, thereby decreasing the number of claims filed.

Equity (HIGH, MEDIUM) – This policy will not disproportionately harm neighboring communities. As more vulnerable communities receive green and gray stormwater infrastructure, runoff into neighboring communities will decrease (EPA, 2012). Insurance companies will receive fewer claims as the green and gray stormwater infrastructure will reduce flooding (Green Stormwater Infrastructure Strategy, 2014). Separately, insurers will not be harmed under this policy unless homeowners decrease or cancel flood insurance as the risk reduces.

Political Feasibility (HIGH, MEDIUM) – Because homeowners are looking to decrease flooding and the associated costs, they are likely to accept temporary disturbances caused by the installation and construction of green and gray infrastructure. Municipal departments and the mayor's office may support the policy as the costs associated with the Green Stormwater Infrastructure Strategy have already been approved. But, the mayor's office may block the policy if shifting the funds to vulnerable communities affects a previously planned capital improvement project that is accompanied by political gain.

Efficiency (HIGH) – Vulnerable communities will not incur significant costs with the installation of green and gray infrastructure as the costs are covered by the City. Homeowners will maintain the standard costs of insurance premiums.

Community-based Adaptation for Environmental Justice

The second policy suggests that the City of Chicago mandates that communities with the highest level of socioeconomic hardship receive annual funds to vote on and implement an adaptation project of their choosing. Unlike the first policy of affirmative action, in which the City is required to act in good faith to consider vulnerable communities to equalize the applicant pool, this policy mandates finances to be allocated to vulnerable communities for climate adaptation. Further, this policy broadens the adaptation opportunities to include such projects as tree planting to reduce urban heat island effect, whereas the first policy focused solely on stormwater management to reduce flooding.

In a 50-state survey of environmental justice legislation, policies and cases, low-income and minority populations were found often to be underrepresented in environmental decision making particularly on proposed activity that will impact their community, environment or health (Bonorris et al, 2010). To

address this challenge, this policy would engage community residents proactively on the climate risks and adaptation opportunities applicable to them.

Through a participatory process and building on cultural norms, community-based adaptation "identifies, assists and implements community-based development activities that strengthen the capacity of local people to adapt to living in a risker and less predictable climate" (Ayers and Forsyth, 2009). Coupled with education and awareness-building of the risks and adaptation opportunities associated with climate change, this policy can not only engage community members but also help with mitigating future climate risks (Ayers and Forsyth, 2009).

Logistically, the City would select communities annually based on their level of hardship and coincide with an annual climate risk assessment across the City. The Office of Sustainability would oversee the project in collaboration with other departments including the Department of Water Management. Annual budgets would be assigned by July 31 of each year and allocated on January 1 of the following year. Within the given budget, the community adaptation project would be voted on by community residents, and local engineers, construction companies and landscapers can apply to execute the project. Remaining funds by the end of the year would be returned to the City.

Effectiveness (MEDIUM) – This policy could reduce flooding risks, thereby decreasing the number of insurance claims filed in vulnerable communities, so long as the climate adaptation project selected by the community favors stormwater capture. For example, if the community opts to plant trees to reduce heat island effect, the project may not be as effective as installing a combination of bioswales and permeable pavement to capture stormwater.

Equity (MEDIUM, MEDIUM) – This policy will not disproportionately harm neighboring communities. For example, neighboring communities may receive less runoff if the vulnerable community installs

infrastructure to manage its stormwater. Similar to the first policy of affirmative action, insurers will not be harmed under this policy unless homeowners decrease or cancel flood insurance as the risk reduces.

Political Feasibility (HIGH, LOW) – Political feasibility of this policy depends on the criterion. Because homeowners will be engaged in the process and vote on the adaptation program to be implemented in their community, they will likely support the temporary disturbance caused by construction. On the contrary, the mayor's office and municipal departments may block the policy as it incurs new costs by falling outside of existing and planned capital improvement projects, and the municipality will have limited control of which project is selected.

Efficiency (MEDIUM) – Vulnerable communities will not incur significant costs so long as the community implements an adaptation project that captures stormwater to reduce costly flooding risks. Homeowners may maintain the standard costs of insurance premiums.

Discounted Insurance Premiums for the Poor

The third policy proposes that homeowners below the federal poverty line in Chicago receive discounted flood insurance premiums. Urban flooding in Chicago is covered predominantly by the U.S. government. Between 2007 and 2011, 73 percent of flood insurance claims were covered by FEMA and NFIP, whereas 27 percent was covered by private insurance companies (CNT, 2013b). To date, homeowners in high-risk flood zones have received subsidized federal flood insurance premiums (FEMA, 2014a). Because private insurance companies in Chicago have been under financial stress due to recent floods (Phillips, 2014), this policy recommends that the U.S. government expand its existing subsidized program to cover not only homeowners located in high-risk flood zones but also homeowners under the federal poverty line. Currently, the National Academies of Sciences is studying how to ensure flood insurance affordability among low-income homeowners and will submit its report by September 2015 (FEMA, 2014b).

Effectiveness (LOW) – Discounted premiums will not prepare homeowners or communities for more frequent or heavier precipitation. Therefore, it will not reduce flooding in vulnerable communities or the number of claims filed. Further, while the discounted premiums will target homeowners below the poverty line, vulnerable communities at large, those with high Hardship Index ratings, may not be affected since the Index accounts for more than poverty.

Equity (LOW, LOW) – Neighboring communities and insurance companies will continue to be disproportionately affected. Neighboring homeowners and communities will continue to receive runoff as discounted insurance premiums will not reduce instances of flooding. Insurers will continue to receive flood claims due to heavier and more frequent rainfall projected for the region.

Political Feasibility (MEDIUM, HIGH) – Under this policy, homeowners in vulnerable communities will likely not experience temporary disturbances caused by the construction or installation of green or gray infrastructure. However, similar to the status quo, sewer pipes are at risk of breaking under the increased stress of more frequent and heavier rainfall. In light of these risks, homeowners may not accept this policy as the only solution to combat flooding.

The mayor's office and municipal departments will support the policy as it does not place direct costs on their department. However, similar to the status quo, the City may need to address future challenges that the communities face as a result of increasing precipitation due to climate change including calls to emergency personnel for damages caused by flooding.

Efficiency (MEDIUM) – The policy targets homeowners below the poverty line and not necessarily vulnerable communities at large, therefore vulnerable communities may incur significant costs. Further, discounted insurance premiums may not offer complete coverage for damages. Several accounts have emerged following Hurricane Sandy, for example, in which homeowners either did not receive 100

percent of the insurance payouts due to them or coverage did not cover all of the damages, leaving homeowners facing surmounting debts (Alfonsi, 2015).

Summary of the Analysis

Affirmative Action for Vulnerable Communities most favorably addresses the goals of effectiveness and economic efficiency. Under the Green Stormwater Infrastructure Strategy and the Citywide Stormwater Management Plan, vulnerable communities will decrease their risk of flooding, thereby decreasing the number of insurance files claimed for damages. And, it will not impose new, significant costs on these at-risk communities. Remaining with the status quo will be the least effective and thereby the most costly to vulnerable communities.

Although flooding may decrease under the *Community-based Adaptation for Environmental Justice*, it is not guaranteed that vulnerable communities will select a climate adaptation project that captures stormwater and therefore the effectiveness of this policy is at risk. Homeowners may receive payouts to repair or rebuild with an emphasis on climate adaptation under the third alternative, *Discounted Insurance Premiums for the Poor*, but this would transpire after damaging floods, putting homeowners at health and economic risk.

Affirmative Action for Vulnerable Communities best meets the goal of equity by ensuring neither neighboring communities nor insurers are harmed or disproportionately benefited by the policy. Neighboring communities will receive less runoff with the installation of green and gray infrastructure, and the insurance companies will receive fewer flood claims. Remaining with the status quo will be the least equitable for neighboring communities as they will continue to receive stormwater runoff in the face of more frequent and heavier precipitation. *Discounted Insurance Premiums for the Poor*, while favorable to low-income populations, will harm insurance companies in addition to the federal

government. Between 2007 and 2011, Chicago residents received $773 million in insurance payouts with 27 percent, or nearly $209 million, covered by private insurance companies and the remaining paid by FEMA and NFIP (CNT, 2013b). This exorbitant cost drove Farmers Insurance Co. to file lawsuits against the City in 2014 (Phillips, 2014), and NFIP is currently $24 billion in debt (GAO, 2013). Offering premium discounts will place additional financial strain on federal agencies and private insurance companies, risking insolvency.

Political feasibility may be the hardest to ascertain of the four goals. Homeowners in vulnerable communities will favor *Community-based Adaptation for Environmental Justice* as it grants them ownership of the adaptation project; whereas the municipal government may find this policy alternative the least favorable. The uncertainty to secure funding positions this alternative as "politically unacceptable" with too much opposition and too little support (Bardach, 2012).

Recommendations

To date, existing policies do not adequately protect vulnerable communities from climate change. Low-income and minority populations in Chicago are and will continue to be disproportionately burdened by flooding caused by heavier and more frequent precipitation. Chicago's century-old combined sewer system frequently overflows most often through one of its 200 outfalls, which either are located in or directly impact vulnerable populations (EPA, 2011). Upgrades to the sewer system will not near completion until 2029.

Until a more sophisticated sewer system is constructed, green and alternative gray infrastructure can mitigate flooding risks by capturing stormwater. Recognizing these opportunities, the City of Chicago has established the Green Stormwater Infrastructure Strategy in 2014 and plans to release a Citywide Stormwater Management Plan in 2015. The Strategy designates $50 million to fund green stormwater

infrastructure projects over five years for existing and planned capital improvement projects, but these projects are not specifically allocated to or guaranteed for communities that are at the greatest risk and least able to recover.

For Chicago to reduce its climate risk, protect its economy and to ensure environmental justice, the City must institute a policy that implements sound adaptation strategies to meet the needs of its most vulnerable communities as identified by the socioeconomic Hardship Index. Of the alternatives illustrated in the matrix, the City should implement *Affirmative Action for Vulnerable Communities* to address its climate and environmental justice challenges. By selecting vulnerable communities as recipients of the committed $50 million for green stormwater infrastructure, the City can effectively curtail flooding without adding costs to low-income and minority populations. This will also reduce the negative impacts on neighboring communities and flood insurance companies by reducing runoff and decreasing the number of claims.

Political feasibility will be the hardest to ascertain for all policy options with regards to acceptance by the municipal government. To be supported by policymakers, the economic, safety and political impact of shifting funds from existing or planned capital improvement projects to vulnerable communities must be understood and addressed. For example, policymakers may oppose shifting funds from a project that aims to safeguard personal safety in a non-vulnerable community by replacing an aging pipe that is at high risk of breaking. Or, stakeholders may be hesitant to shift funds from a project in a community that is home to wealthy political donor.

The first step to address stakeholders' concerns is to identify the capital improvement projects that the Green Stormwater Infrastructure Strategy and forthcoming Citywide Stormwater Management Plan propose to tackle. To date, the projects that the Strategy plans to undertake for all five years have not yet been identified or released to the public. Identifying and assessing the projects in addition to

conducting needs assessments in communities that rank high on the Hardship Index will help to uncover priorities. Next, a cost-benefit analysis will help to prioritize and convince stakeholders of which projects to execute and in which communities. Since studies have shown that climate change can exacerbate poverty, affecting the economy at large, there is a strong likelihood that the cost-benefit analysis will suggest that affirming climate action for vulnerable communities will equate to several benefits that exceed costs.

These steps should be conducted by an interagency committee including representatives from the Office of Sustainability, the Department of Water Management, MWRD and the Chicago Housing Authority among others. And the City should engage community organizations and residents including the Little Village Environmental Justice Organization, the Environmental Law and Policy Center, and the Center for Neighborhood Technology for their expertise, experience and support.

Finally, the City must continue to monitor for climate risk and vulnerability as well as evaluate the policy's progress. And if necessary, Chicago must course correct or adapt its efforts to ensure the City and its most vulnerable populations are protected from environmental harm in the face of climate change.

Sensitivity Analysis

After careful review of the policy analysis, different decision makers may place different weights on the criteria, seeking amendments to one policy or opting for a different alternative. For example, although *Affirmative Action for Vulnerable Communities* is considered the optimal policy, achieving political feasibility among stakeholders may be the most challenging, as described above. If the decision maker is most concerned with receiving mayoral support of budget addendums, the decision maker may prefer the third policy, which places the financial responsibility to repair from flooding on the federal

government rather than the financial responsibility for better stormwater management on the municipal government. However, if the decision maker primarily aims to empower local residents within vulnerable communities to choose the adaptation project that best fits the need of the community, then the decision maker would prefer the second policy of *Community-based Adaptation for Environmental Justice*.

There are other factors to consider when executing and managing the optimal policy. Although flooding is pervasive throughout Chicago, there are different stormwater management needs in every community. For instance, one community may have a large number of impermeable paved parking lots, whereas another community may be adjacent to the river that often overflows. Needs assessments in each community must be completed so that the proper green and gray infrastructure is installed to best manage stormwater. And, if the needs assessment finds that a vulnerable community is at risk of flooding due to runoff from a wealthier community upstream, then installation of better stormwater management in the wealthier community may be the solution. This would conflict with the optimal policy, *Affirmative Action for Vulnerable Communities*, which aims to proactively assign stormwater management infrastructure for vulnerable communities; however, it could still effectively reduce the community's flooding risk.

Finally, if the policy is not meeting its goal to reduce flooding in vulnerable communities, or in the event of unforeseen circumstances that can affect the policy's rate of success, such as pipes bursting, causing significant immediate damage, or unexpected long periods of little to no precipitation, the City of Chicago should take an adaptive management approach to administration. Adaptive management connects continuous learning with policy implementation, which can help guide administrators to monitor for impact and adjust management processes as necessary (Williams et al, 2009). Properly

managing and ultimately enhancing vulnerable communities' ability to adapt to a changing climate is critical for the City's economic, environmental and human wellbeing.

Tables

Table 1: The Six Indicators Comprising the Hardship Index

INDICATOR	DESCRIPTION
Poverty	percent of households living below the federal poverty level
Unemployment	percent of persons above the age of 16 that are unemployed
Education	percent of persons above 25 years of age without a high school diploma
Age	percent of the population that is under 18 or older than 64
Crowded Housing	percent of housing units with more than one person per room
Per Capita Income	sum of tract-level aggregate incomes divided by the total population

Source: City of Chicago, 2014a

Table 2: Hardship Index of Chicago's 77 Communities[1] (U.S. Census data 2008-2012)

	COMMUNITY AREA NAME	PERCENT HOUSEHOLDS BELOW POVERTY	PERCENT OF HOUSING CROWDED	PERCENT AGED 16+ UNEMPLOYED	PERCENT AGED 25+ WITHOUT HIGH SCHOOL DIPLOMA	PERCENT AGED UNDER 18 OR OVER 64	PER CAPITA INCOME (USD)	HARDSHIP INDEX[2]	RACE AND ETHNICITY[3]	RACE AND ETHNICITY PERCENTAGE
	Average U.S. Community	10.9	3.2	9.3	14.2	37.2	28051		White[4]	77.7
	Chicago	19	4.7	12	19.8	33.8	27940		White	46.4
1	Riverdale	58.4	4.8	34.8	24.8	51	8548	98	Black	96.9
2	Fuller Park	57.7	4.4	34.1	34.9	41.2	9372	97	Black	93.4
3	South Lawndale	29.5	17.2	14.3	54.8	33.2	10867	96	Latino	83.3
4	Gage Park	22.3	15.8	16.3	53.2	39.4	12252	94	Latino	89.3
5	West Englewood	33.5	6.4	35.9	27.8	41.2	11115	93	Black	97.6
6	West Garfield Park	40.9	9.4	25.6	24.9	42.2	11238	92	Black	97.1
7	Englewood	44.4	4	23.6	27.6	42.8	12255	91	Black	98.4
8	New City	29.1	11.1	19.8	41	40.3	13230	89	Latino	53.1
9	Washington Park	41.3	4.7	24.6	26.3	43.7	12868	88	Black	98.4
10	East Garfield Park	40.6	8.9	18.2	24.7	43.8	12922	87	Black	93.6
11	Humboldt Park	33.4	13.8	15	34.6	38.8	13588	85	Latino	51
12	North Lawndale	39.6	7.3	17.6	28.2	41.3	12752	84	Black	92.3
13	Brighton Park	22.6	13.8	12.9	44.4	39.5	13545	83	Latino	82.7
14	Lower West Side	26.6	10.7	14.1	41.9	33.7	16303	82	Latino	82.3
15	Armour Square	36	6.9	13.1	34.1	37.7	17491	80	Asian	69
16	Oakland	40	0.9	29.8	19.9	40	20056	79	Black	92.3
17	Chicago Lawn	25.2	7.2	14.3	31.9	40.4	13684	78	Black	54.2
18	East Side	20	8.1	12.7	34.9	44.3	15929	76	Latino	79.8

[1] Source: City of Chicago, 2014a; Average U.S. Community data pulled from downloadable PDF linked on the site (link provided in Reference section)
[2] Scores are standardized for Chicago's 77 communities and cannot be compared to scores outside of the City (Source: City of Chicago, 2014b)
[3] Except for the Average U.S. Community, Source: The Heartland Alliance, 2013
[4] Source: USA QuickFacts, 2013

19	South Chicago	28.2	5.7	17.3	26.8	42.3	16273	75	Black	73.9
20	Hermosa	19	7.6	12.3	42.1	36.4	15226	74	Latino	87.5
21	Austin	26	6.3	22.1	26.1	38.1	16289	73	Black	86.2
22	Auburn Gresham	25.3	4.8	26.3	18.8	42.7	15759	71	Black	98.9
23	Belmont Cragin	18.7	10.8	13.1	37	36.9	15472	70	Latino	75.4
24	Archer Heights	12.6	7.8	17.3	33.8	40.9	16536	69	Latino	73.6
25	West Elsdon	11.7	7.9	16.7	37.4	37.8	16855	67	Latino	77.4
26	West Pullman	23.7	4.1	18.5	20.8	43	15956	66	Black	95
27	Greater Grand Crossing	28.8	4	20.7	16.7	42	17686	65	Black	98.1
28	South Deering	25.9	5.2	12.8	22.4	40.3	15393	64	Black	60.8
29	Burnside	25.7	7.1	19.6	14.7	38.9	15451	62	Black	99.5
30	Woodlawn	30.3	2.7	21.7	18.1	37.2	19471	61	Black	89.6
31	McKinley Park	18.2	8	13.4	32.2	35	17273	60	Latino	59.2
32	Grand Boulevard	29.3	2.5	22.2	18.2	40.9	23638	58	Black	93.7
33	West Lawn	14	6.3	9.1	33.1	40.5	16689	57	Latino	77.7
34	Albany Park	18.5	10.8	10	35.6	32.4	20496	56	Latino	53.2
35	South Shore	30.7	3.3	18.6	15.1	36.4	19460	55	Black	97.4
36	Roseland	19	3.4	18.7	17.1	42.2	17912	53	Black	98.3
37	Chatham	24.9	2.3	22.2	13.7	38.9	20087	52	Black	99.1
38	Montclaire	16.2	7	12	28.1	37.6	21117	51	White	61.2
39	Pullman	21.6	1.4	19.4	15.4	40.8	20032	50	Black	85
40	Washington Heights	16	1	18.7	14.3	42.2	20313	48	Black	98.5
41	Bridgeport	17.8	5.3	13.8	24.5	32.5	22939	47	White	47.1
42	Douglas	28.2	1.9	17.1	14.2	31.3	23182	46	Black	74.4
43	Hegewisch	13.5	4.7	11.4	18.7	41.3	21878	44	Latino	51.9
44	West Ridge	15.8	7.4	9.1	20	38.6	23737	43	White	53.5
45	Avondale	14.5	5.2	9.3	22.6	30.4	20896	42	Latino	62.2
46	Avalon Park	15.4	0.7	16.1	12.4	40.3	24101	41	Black	98
47	Portage Park	12.1	4.6	12.3	19.6	34.6	23700	39	White	66.9
48	Rogers Park	22.6	7.7	7.9	17.9	27.3	24248	38	White	54.8

49	Ashburn	10.1	4.4	10.2	17.8	37.4	22432	37	Black	52.3
50	North Park	12.9	4.3	8.8	16.6	39.1	25895	35	White	58.1
51	Calumet Heights	10.6	1.6	20	10.2	43.3	30234	34	Black	96.5
52	Clearing	7.4	3.1	11	19.1	36.8	24526	33	White	71.9
53	Irving Park	11	5.7	10.4	22.1	31	27509	32	White	62.9
54	Garfield Ridge	8.6	2.5	10.4	17.9	38.2	26362	30	White	74.4
55	Morgan Park	13	0.7	14.9	9.5	39.5	27209	29	Black	61
56	Dunning	10.2	4.9	9.1	16.7	33.8	26836	28	White	85.4
57	Kenwood	21.7	2	11.7	10.8	34.9	35204	26	Black	70.2
58	Jefferson Park	7.7	2.1	11.5	11.5	34.5	27303	25	White	83.9
59	Logan Square	16.9	2.8	8	15	26.5	30417	24	White	71.5
60	O'Hare	13.2	2.2	6.3	11.6	28.9	27000	23	White	85.3
61	Norwood Park	5.3	2.1	8.1	11.8	40.3	31994	21	White	89.4
62	Uptown	22.3	3.6	8.5	12	21.8	34687	20	White	60.9
63	Edgewater	18	4	9.2	8.9	23.5	33893	19	White	64.6
64	Hyde Park	19.3	1.7	8	5.3	27.3	38864	17	White	53.1
65	Near West Side	20.3	3.7	10.2	10.5	22.3	43745	16	White	49.8
66	Lincoln Square	9.9	2.9	6.9	13.1	25.5	36990	15	White	70.5
67	Mount Greenwood	3.5	1.4	7.7	4.7	36.3	34725	14	White	93.1
68	Forest Glen	6.9	1.5	6.2	5.3	40.7	42601	12	White	79.7
69	West Town	15.3	2	6	13	22.4	41705	11	White	74.1
70	Beverly	3.9	0.6	7	4.4	39.3	40029	10	White	64.7
71	Edison Park	3.5	1.2	6.9	8	34.9	39936	8	White	97.3
72	Near South Side	11.8	1.4	5.1	8.6	22.6	60096	7	White	50.6
73	North Center	7.4	0.3	4.6	4.5	25.3	56909	6	White	89.6
74	Lake View	10.7	0.9	4.7	2.8	17.1	59238	5	White	87
75	Loop	12.2	1.7	4.8	3.3	14.2	66394	3	White	69.9
76	Lincoln Park	11.8	0.7	4.7	4	20.6	73130	2	White	87.9
77	Near North Side	13.7	1.7	6.2	2.8	23.3	88152	1	White	76.5

Table 3: Matrix of Policy Alternatives Analyzed per Criterion

GOALS	CRITERIA	STATUS QUO: FLOODING	ALTERNATIVE 1: AFFIRMATIVE ACTION FOR VULNERABLE COMMUNITIES	ALTERNATIVE 2: COMMUNITY-BASED ADAPTATION FOR ENVIRONMENTAL JUSTICE	ALTERNATIVE 3: DISCOUNTED INSURANCE PREMIUMS FOR THE POOR
Effectiveness: Frequency and volume of flooding declines in vulnerable communities	The number of insurance claims filed from communities with the highest level of hardship decreases.	LOW: Filed claims will not decrease.	HIGH: The number of claims filed will decrease as green and gray infrastructure will reduce flooding.	MEDIUM: The number of claims filed may decrease as long as the community installs infrastructure to capture stormwater.	LOW: Insurance will not decrease flooding risks so claims may increase. And more homeowners may purchase premiums at the discount, increasing the number of potential claims.
Equity: All parties share the burden and benefits of the policy	Neighboring communities are not harmed as a result of the policy.	LOW: Neighboring communities will continue to receive runoff.	HIGH: Neighboring communities will not be harmed. Runoff may decrease.	MEDIUM: Neighboring communities may not be harmed so long as the adaption project captures stormwater.	LOW: Neighboring communities will continue to receive runoff.
	Insurers are not unfairly benefitted or harmed by policy.	LOW: Insurers will continue to face an increasing number of claims and payouts.	MEDIUM: Insurers may receive fewer claims filed from the affirmed communities. But homeowners may decrease or cancel flood insurance if the risks reduce.	MEDIUM: Insurers may receive fewer claims if adaptation project captures stormwater. But homeowners may decrease or cancel flood insurance if the risks reduce.	LOW: Insurers will receive more claims due to more policyholders at the discounted premium.
Political Feasibility: There is sufficient support from critical stakeholders to enact policy	Support from homeowners in vulnerable communities to tolerate temporary disturbances (e.g., construction) in neighborhoods.	MEDIUM: Communities won't experience disturbances unless pipes break due to stress or if they're included in a capital improvement project or TARP.	HIGH: Homeowners may accept temporary disturbances to reduce flooding.	HIGH: Homeowners may support temporary disturbances since they voted on the adaptation project to be implemented.	MEDIUM: Communities won't experience disturbances unless pipes break due to stress or if they're included in a capital improvement project or TARP.
	Support from municipal departments to pass the policy. Additional resources (e.g., finances) are not required.	MEDIUM: No need for more resources except to potentially manage more emergency calls for flooding.	MEDIUM: They may block the policy if shifting the funding to vulnerable communities affects capital improvement projects that accompany political gain.	LOW: They may block the policy as funds likely exceed existing budgets and/or will be redirected from other programs.	HIGH: They may support the policy as it is no cost to the City.
Efficiency: Policy doesn't increase costs	Vulnerable communities do not incur significant costs as a result of the policy.	LOW: Communities will continue to face flooding risks and therefore incur costs.	HIGH: Communities will not incur new costs as the City's infrastructure projects will be paid by taxpayers.	MEDIUM: Communities may not incur costs as long as the project captures stormwater to reduce flooding.	MEDIUM: Communities will continue to face flooding risks and therefore incur costs, but some will receive discounted premiums.

References

ACLU. (n.d.). Affirmative action. Retrieved from https://www.aclu.org/racial-justice/affirmative-action

Adams, J. T. (1931). *The Epic of America*. New York: Little, Brown, and Company

Alfonsi, S. (2015, March 1). The storm after the storm. *CBS 60 Minutes*. Retrieved from http://www.cbsnews.com/news/hurricane-sandy-60-minutes-fraud-investigation/

Ayers, J. and Forsyth, T. (2009). Community based adaptation to climate change. *Environment: Science and Policy for Sustainable Development*, *51* (*4*), 22-31. http://eprints.lse.ac.uk/24188/1/Ayers_Forsyth_Community_based_adaptation_to_climate_change_2009.pdf

Bardach, E. (2012). *A practical guide for policy analysis: The eightfold path to more effective problem solving* [Kindle version]. Retrieved from Amazon.com

Bonorris, S.; Jung, D. J.; and Targ, N. (2010). Environmental justice for all: A fifty state survey of legislation, policies and cases (fourth edition). *American Bar Association and Hastings College of the Law*. http://gov.uchastings.edu/public-law/docs/ejreport-fourthedition.pdf

BU. (n.d.). Population history of Chicago from 1840-1990. http://physics.bu.edu/~redner/projects/population/cities/chicago.html

Bureau of Labor Statistics (BLS). (2014). Economy at a glance. Retrieved from http://www.bls.gov/eag/eag.us.htm

CALFED. (n.d.). Questions and answers regarding environmental justice and Executive Order #12898. Retrieved from http://www.calwater.ca.gov/content/Documents/environmental_justice/Questions_and_Answers_on_Environmental_Justice_April2002.pdf

Center for Neighborhood Technology. (2013a). Fighting urban flooding: Searching for solutions. Retrieved from http://www.cnt.org/2013/10/18/fighting-urban-flooding-searching-for-solutions/

Center for Neighborhood Technology. (2013b). The prevalence and cost of urban flooding: A cast study of Cook County, IL. Retrieved from http://www.cnt.org/media/CNT_PrevalenceAndCostOfUrbanFlooding.pdf

City-Data. (2010). Chicago, Illinois (IL) zip code map – locations, demographics. Retrieved from http://www.city-data.com/zipmaps/Chicago-Illinois.html

City of Chicago. (2014a). Census data - Selected socioeconomic indicators in Chicago, 2008 – 2012. https://data.cityofchicago.org/Health-Human-Services/Census-Data-Selected-socioeconomic-indicators-in-C/whqj-2xn9

City of Chicago. (2014b). Selected socioeconomic indicators in Chicago, 2006-2010. Retrieved from https://data.cityofchicago.org/api/assets/A02C1C5F-8D89-466C-8492-B1FED3DA4C87

City of Chicago. (n.d.a.) Combined sewers. Retrieved from http://www.cityofchicago.org/city/en/depts/bldgs/supp_info/combined_sewers.html

City of Chicago. (n.d.b.). Basement flooding partnership. Retrieved from http://www.cityofchicago.org/city/en/depts/water/supp_info/basement_floodingpartnership.html

City of Chicago. (n.d.c.). Budget process. Retrieved from http://www.cityofchicago.org/city/en/depts/obm/provdrs/city_budg.html

Cox, T. (2013, April 19). Even Deep Tunnel couldn't control flooding, City finds. *DNAinfo*. Retrieved from http://www.dnainfo.com/chicago/20130419/albany-park/even-deep-tunnel-couldnt-control-flooding-city-finds

EPA. (2011). Metropolitan Water Reclamation District of Greater Chicago Settlement. Retrieved from http://www2.epa.gov/enforcement/metropolitan-water-reclamation-district-greater-chicago-settlement#ej

EPA. (2012). Stormwater management best practices. Retrieved from http://www.epa.gov/greeningepa/stormwater/best_practices.htm

EPA. (2013). Climate change, impact on the Midwest. Retrieved from http://www.epa.gov/climatechange/impacts-adaptation/midwest.html.

Federal Register. (1994). Executive Order 12898 of February 11, 1994. Retrieved from http://www.archives.gov/federal-register/executive-orders/pdf/12898.pdf

FEMA. (2014a). National Flood Insurance Program reform: Frequently asked questions. Retrieved from https://www.fema.gov/region-vi/national-flood-insurance-program-reform-frequently-asked-questions

FEMA. (2014b). Homeowner Flood Insurance Affordability Act. Retrieved from http://www.fema.gov/media-library-data/1396551935597-4048b68f6d695a6eb6e6e7118d3ce464/HFIAA_Overview_FINAL_03282014.pdf

FEMA. (2015a). The cost of flooding. Retrieved from https://www.floodsmart.gov/floodsmart/pages/flooding_flood_risks/the_cost_of_flooding.jsp

FEMA. (2015b). Policy rates. Retrieved from https://www.floodsmart.gov/floodsmart/pages/residential_coverage/policy_rates.jsp

GAO. (2013). National Flood Insurance Program: Continued attention needed to address challenges. Retrieved from http://www.gao.gov/products/GAO-13-858T

Gutierrez, T. (2013, April 18). Giant sinkhole swallows 3 cars on South Side. *ABC News*. Retrieved from http://abc7chicago.com/archive/9070084/

Hayhoe, K., VanDorn, J., Croley II, T., Schlegal, N. and Wuebbels, D. (1010). Regional climate change projections for Chicago and the US Great Lakes. *Journal of Great Lakes Research, 36, 2*, 7-12. http://www.sciencedirect.com/science/article/pii/S0380133010000559

Heartland Alliance. (2013). Social IMPACT Research Center's analysis of the U.S. Census Bureau's 2000 Decennial Census and 2007-2011 5-year American Community Survey. Retrieved from http://www.scribd.com/doc/119824310/Chicago-Neighborhood-Indicators-2011

Hirsch, A. (1998). *Making the second ghetto: Race & housing in Chicago 1940-1960*. Chicago: The University of Chicago Press.

IGA. (2011). Public Act 097-0391. Retrieved from http://www.ilga.gov/legislation/publicacts/fulltext.asp?Name=097-0391

Intergovernmental Panel on Climate Change (IPCC). (2014). 19.1.2 Conceptual framework for the identification and assessment of key vulnerabilities. Retrieved from http://www.ipcc.ch/publications_and_data/ar4/wg2/en/ch19s19-1-2.html

Leonard, J. (1984). The impact of affirmative action on employment. *Journal of Labor Economics, 2*, *4*. http://isites.harvard.edu/fs/docs/icb.topic98848.files/leonard.pdf

Meltsner, A. (1972). Political feasibility and policy analysis. *Public Administration Review, 32, 6*, 859-867.

Metropolitan Planning Council (MPC). (2008). Demographics. Retrieved from http://www.metroplanning.org/uploads/cms/documents/olympicsenglewooddemographics.pdf

MWRD. (n.d.) Tunnel and Reservoir Plan. Retrieved from https://www.mwrd.org/irj/portal/anonymous/tarp

MWRD. (2015a). Waterway reach definitions for CSO exhibit. Retrieved from http://www.mwrd.org/irj/portal/anonymous?NavigationTarget=navurl://eec9b2f677d42e0dea742ba5e2b45713

NCSL. (2014). Affirmative action – overview. Retrieved from http://www.ncsl.org/research/education/affirmative-action-overview.aspx

NOAA. (n.d.). Storm weather 101 – Flood types. Retrieved from https://www.nssl.noaa.gov/education/svrwx101/floods/types/

NRDC. (2007). Rebuilding New Orleans. Retrieved from http://www.nrdc.org/health/effects/neworleans.asp

NRDC. (2012). Memo: Comments concerning Consent Decree lodged December 14, 2011 in United States, et al. v Metropolitan Water Reclamation District of Greater Chicago, Civil Action No.

1:11-cv-08859. Retrieved from http://switchboard.nrdc.org/blogs/aalexander/MWRD%20CD%20CommentsFINAL.pdf

Osterle, A. (2002). Evaluating equity in social policy: A framework for comparative analysis. *Evaluation, 8(1)*, 46-59.

United States Census Bureau. (2014). State and county QuickFacts. Retrieved from http://quickfacts.census.gov/qfd/states/17/1714000.html

USA QuickFacts. (2013). Retrieved from http://quickfacts.census.gov/qfd/states/00000.html

U.S. Global Change Research Program (USGCRP). (2009). Global climate change impacts in the United States, 2009 report. Retrieved from http://downloads.globalchange.gov/usimpacts/pdfs/climate-impacts-report.pdf

UVA. (2012). Office of Equal Opportunity Programs. Retrieved from http://www.virginia.edu/eop/AA%20Plan%20FAQs%205-1-09.html

Wetli, P. (2013, April 18). Crews transport residents by boat as heavy rains flood northwest side. *DNAinfo*. Retrieved from http://www.dnainfo.com/chicago/20130418/albany-park/chicago-river-locks-opened-avoid-repeat-of-2008-flood-along-north-branch

Williams, B. K., Szaro, R. C., and Shapiro, C. D. (2009). Adaptive management: The U.S. Department of the Interior technical guide. Retrieved from http://www.doi.gov/archive/initiatives/AdaptiveManagement/TechGuide.pdf