NRDC Workshop Final Report

Urban Solutions

Environmental Science and Policy
School of International and Public Affairs
Columbia University
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Figure 1: New York Skyline

CONTENT

EXECUTIVE SUMMARY

The goal of the NRDC's Urban Solutions program entails supporting 25 cities across the United States in developing just and resilient communities by 2020. NRDC seeks to do this through four major themes, namely energy efficiency and clean energy generation, land use and transportation, stormwater and urban resilience, and food and food waste. Urban Solutions leverages three key components: a toolkit of vetted policy options and supporting material for cities, a structured learning network for urban leaders, and on-site staff to help cities bridge the gap between initiative development and implementation. By integrating these four themes into city programs through All-In Initiatives, NRDC anticipates that its partner cities will become more healthy, equitable, and resilient communities.

In the spring of 2015, NRDC became a client for the capstone Workshop in Applied Earth Systems Policy Analysis for Columbia University's Master of Public Administration in Environmental Science and Policy program. A group of ten graduate students engaged in a semester of research on two critical themes of Urban Solutions: stormwater management and food systems security. Specifically, NRDC has tasked the team with working to design the toolkit component of Urban Solutions for both food systems and stormwater management. The goal was to help cities determine essential baseline data before NRDC guides urban leaders toward identifying potential actions to improve city resilience. NRDC did not request vetted policy options for cities, but rather asked the team to focus on the supporting materials that will help guide the data collection and knowledge-building process for cities regarding food systems and stormwater management.

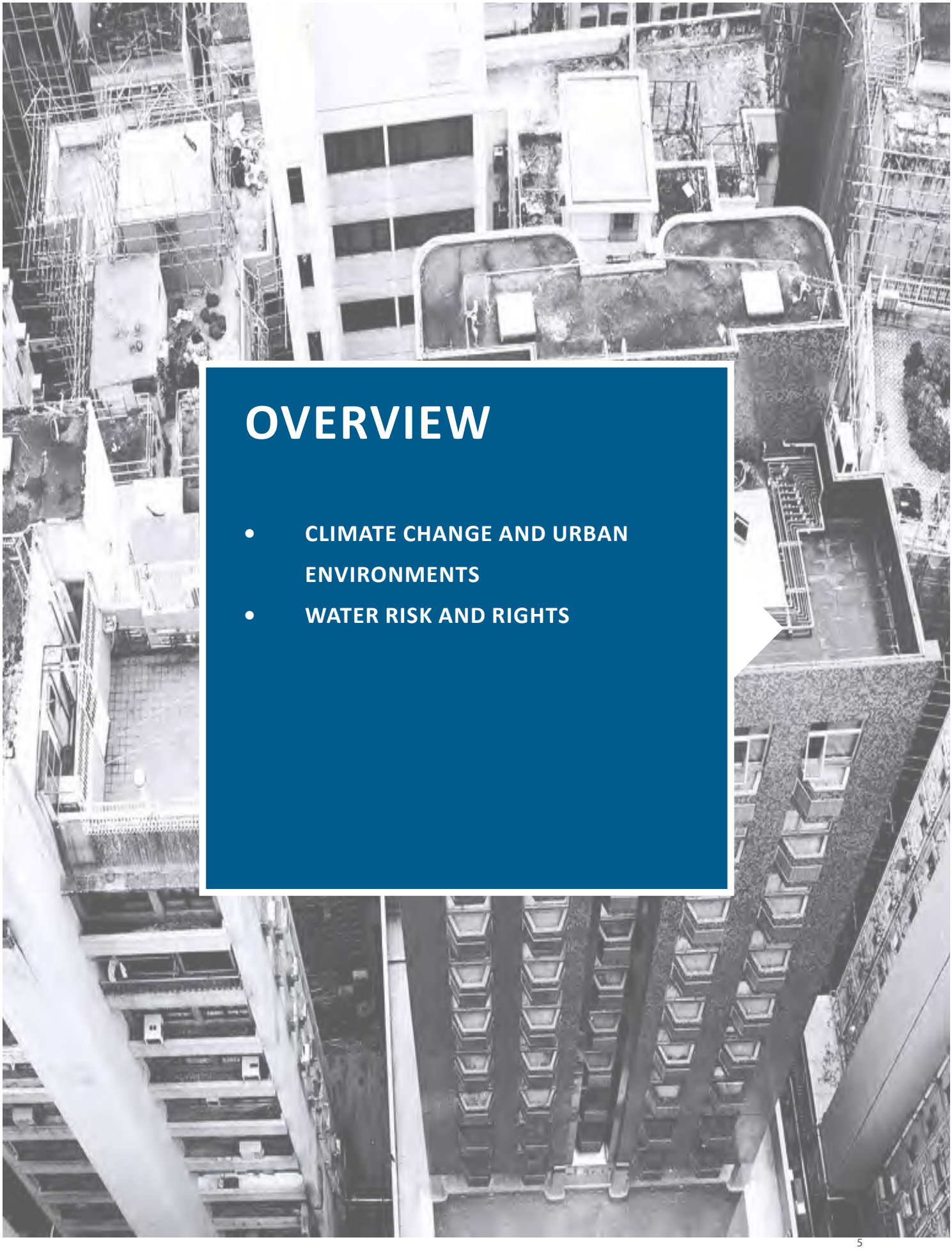
The data collection instrument described in this report is designed for use by the NRDC in their efforts to help cities as a first step in readiness and resilience for climate change impacts; and, in recognition of the growing income inequality throughout urban areas in the context of stormwater management and food systems security. Through the application of this tool, two important pieces of information can be gathered: baseline data for stormwater management and food systems security and gaps in that baseline data. Through an extended collaboration with NRDC staff, cities can then institute initiatives that will ensure a more resilient, equitable, and healthy America.

Figure 2: Farmland 1

The tool was designed with an overarching rationale to incorporate both quantitative and qualitative aspects to help cities gather important data and identify the gaps in information through the data gathering process. Guided by NRDC staff, urban leaders will answer questions pertaining to five main themes identified. These five themes include socio-economic, environmental, risk/vulnerability, preparedness, and infrastructure. The tool's format reflects NRDC's request to the Workshop team to include rationale for the importance of collecting the data, as well as sources to guide cities in collecting data. Publically available data was used to compile and research indicators and metrics, and to identify the five main themes of resilience for both food systems security and stormwater management. In addition, each of the indicators is further categorized into one of three levels of importance: essential, very important, and nice-to-know.

While urban leaders will be responsible for utilizing the tool to identify and address gaps, the tool provides NRDC with the framework to measure cities' readiness in anticipation of climate change. The tool provides clarity into data and data availability for NRDC representatives. All cities will undertake distinct resilience challenges, and this tool has been designed so that it can be useful to every single kind of city. The indicators have been selected to be both general as well as specific, reflecting an overarching set of questions important to all.

The results of our research yielded a comprehensive toolkit with two key components. First, we designed a baseline survey for cities to assess whether they have the basic capability to collect the relevant data needed or have the institutional resources in place such as financing to fund possible future initiatives. Secondly, we designed a knowledge and data collection instrument that serves as the core of the toolkit to help cities assess their baseline knowledge and data. This baseline information will enable cities to understand the problems facing them and highlight any potential gaps in data. The information was comprised of over 100 qualitative and quantitative indicators associated with individual metrics that covered topics including city demographics, food procurement protocols, and green infrastructure developments. We anticipate NRDC utilizing this tool in order to aid in establishing local initiatives to improve equity and resilience throughout urban areas. Although the toolkit presented here comes with challenges to data collection, reliability, accessibility, and availability, we believe this tool serves as a valuable starting point for NRDC as it works to integrate all four major resilience themes into its Urban Solutions' All-In Initiatives.



OVERVIEW

- CLIMATE CHANGE AND URBAN ENVIRONMENTS
- WATER RISK AND RIGHTS

Figure 3: Urban Landscape

Climate Change and Urban Environments

Figure 4: Downtown Los Angeles Skyline

Average global temperatures have already increased by 0.85°C since the 1880s[1], with projections suggesting possible further increases of up to 4.5°C by 2100 in some regions[2]. Beyond merely increasing global temperatures, climate change also increases the likelihood of extreme weather events and places urban centers at greater risk due to greater population density and aging infrastructure.

Over 80% of America's total population lives in urban areas[3]. The United States Census Bureau defines urban areas as "densely developed residential, commercial and other nonresidential areas." This term is further divided into "urbanized areas" with at least 50,000 residents and "urban clusters" with between 2,500 and 50,000 residents. Only 9.5% of Americans live in urban clusters, indicating that most Americans live in highly urbanized areas of at least 50,000 people[4].

As more Americans live in urbanized areas, these areas are also increasing in their size through urban sprawl. Although some cities such as New York City and San Francisco have fairly compact metro areas, others including Atlanta and Houston have large and sprawling metropolises. People living in cities with less sprawl often experience greater economic opportunities, spend less money on housing and transportation, and feel and are safer and healthier than their peers[5]. More compact cities also tend to be more energy efficient and require less surface area per capita than their sprawling counterparts, reflecting the sustainability associated with dense, urban areas.

Cities also face a number of issues related to climate change. For example, the urban heat island effect increases local temperatures in cities. This factor, with rising global average temperatures, warms cities to such an extent that heat is the primary cause of weather-related deaths in the United States. Furthermore, the incidence of asthma and heart attacks increases significantly on days in which temperatures exceed 90°F[6]. In addition, many of America's largest cities are coastal, placing residents in danger of rising sea levels associated with climate change. Current projections suggest that sea levels may rise by 0.6 meters by 2100[7], prompting significant concerns among coastal communities, currently the home to 39% of America's population[8]. While exact effects will vary, poor and primarily coastal populations are at the most risk due to their inability to undertake costly adaptation measures[9].

Unfortunately, the alternative offers severe economic consequences; flooding across Michigan, including Detroit, in August 2014 produced $16.7 million in damages to public buildings and equipment[10]. Furthermore, current crop yields may decline due to rising global temperatures, placing the food security of America's cities at risk. Concerns that the nation's best agricultural lands may become less productive have fueled interest in investigations of food systems security among major urban areas.

Water Risk and Rights

Figure 5: Lake Mead "bathtub ring"

Water risk refers to the possibility that something bad or unpleasant pertaining to either water quantity or quality will occur[11]. Water risk can be further categorized into acute and chronic risk. Acute risk concerns short-term, but potentially more dangerous or extreme, events including hurricanes, tsunamis, or wildfires. These have the potential to cause severe and somewhat unpredictable damage to a city. In contrast, chronic risk refers to long-term concerns that will likely not produce sizeable damage until the future. For example, climate change poses a chronic risk to agriculture given changing weather patterns and average rainfall. In addition, sea level rise poses a chronic risk to coastal areas that may experience long-term flooding.

Beyond acute and chronic risk, risk can also be organized in terms of its causes and effects into four main categories: emergent, persistent, extreme event, and triggered risk. Everyone in every type of built environment is exposed to some type of environment risk, whether immediate or in the future. Emergent risk refers to the effects of burgeoning urban growth or the establishment of new infrastructure or demographic changes. Persistent risk, in contrast, suggests an established, observed, and regular threat, such as an annual monsoon. Extreme risk represents

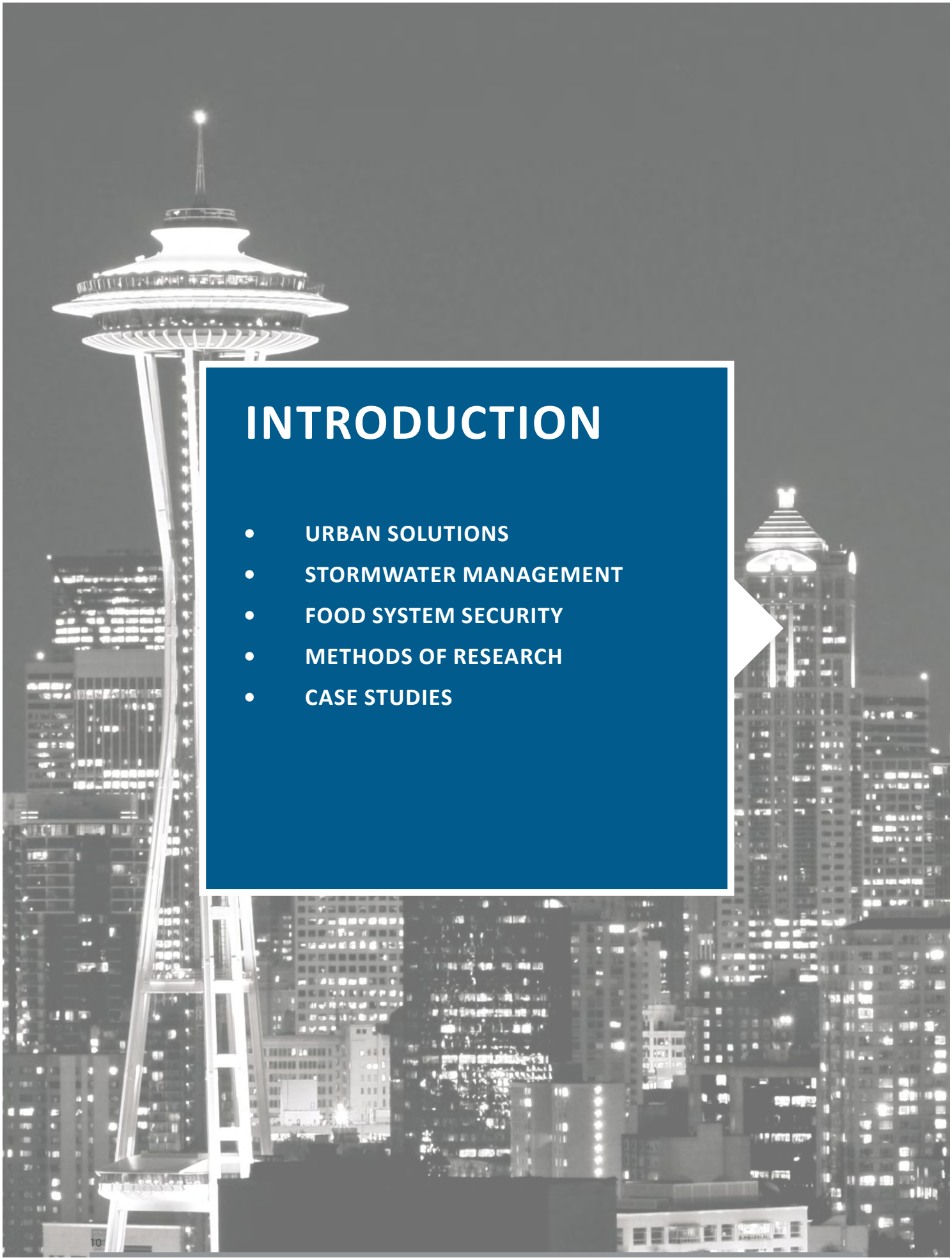
high-impact, low-probability events such as a hundred-year flood. Such events are challenging to forecast and threaten to overwhelm the system in place. Finally, triggered risk refers to events that are brought about due to a disparate action, including earthquakes prompted by hydraulic fracturing[12].

Water risk can be mitigated through implementing stormwater management initiatives. The Ohio River reached its highest point over the past two decades on March 2015 due to snowmelt. However, preparations in the form of precautions and physical infrastructure such as floodwalls, levees, dams, and reservoir prevented significant damage from floods. Nevertheless, a failure to address stormwater management issues can heighten water risk. For example, drought along the Colorado River has shrunk reservoirs to under 50% of their total capacities, forcing federal authorities to reduce water flow into Lake Mead for the first time. Lake Mead serves as the primary source of water for cities and farmland in the Southwest. Restricting water into the lake threatens agriculture and local and regional economies[13].

Further complicating issues of water risk are those of water rights. North American water systems connect through multiple states and countries, causing tension regions during times of water scarcity. The United States Fish and Wildlife Services Division of Water Resources coordinates water rights for residents in Montana, North Dakota, South Dakota, Wyoming, Nebraska, Kansas, Colorado, and Utah who rely upon the Missouri, Colorado, and Platte Rivers. Activities farther upstream, such as the development of dams or polluting of water resources, influence water access and quality further downstream[14].

The various compacts, regulatory guidelines, federal laws, court decisions, and decrees pertaining to the water rights of the Colorado River have collectively become known as the "Law of the River." These legal documents allocate and regulate the river's use among the seven basin states and Mexico. In 1973, the United States and Mexico agreed that the water flowing into the Morelos Dam would be used to water crops in Mexico. Previously, water use upstream in the United States had resulted in highly saline water reaching Mexico. The international agreement known as Minute 242 required the United States to ensure that all water reaching Mexico would not exceed 115 parts per million of salt. The example of the Colorado River illustrates the regional and international complexity of water rights[15].

Water rights also vary based on state. For example, New York State bases its water rights laws on land ownership. Landowners can therefore draw upon groundwater reserves on their own load so long as this extraction does not interfere with the rights of other landowners. However, this can produce tension between landowners because underground water sources do not follow landowner boundaries. The New York State Department of Environmental Conservation determines appropriate rates of extraction through a permitting process. Both individual landholders and public utility companies must use the same permitting process, although with different allowable rates[16].



INTRODUCTION

- URBAN SOLUTIONS
- STORMWATER MANAGEMENT
- FOOD SYSTEM SECURITY
- METHODS OF RESEARCH
- CASE STUDIES

Figure 6: Seattle Skyline

URBAN SOLUTIONS

The Natural Resources Defense Council has developed the Urban Solutions program as its response to the challenges and threats of climate change impacts facing America's cities. More than 60% of all carbon dioxide emissions come from infrastructure and transportation, highlighting the importance of reducing the emissions of highly populated regions. Furthermore, income inequality throughout the United States manifests itself in limited access to healthy food and transportation options in addition to greater exposure to environmental and pollution hazards. Through Urban Solutions, NRDC expects to tackle the twin challenges of climate change and inequality simultaneously[17].

NRDC is working with 25 cities across America with integrated, equitable, and replicable climate response strategies by 2020 in order to ensure that people "live in strong, just and resilient communities that create solutions to climate change."[18] To this end, NRDC is partnering with the 25 cities to identify both universal and site-specific strategies based on funding availability, community cultures, and pertinent local challenges.

While only a few cities across America have implemented comprehensive resilience strategies, NRDC is working to ensure that this number will rise as climate change becomes even more of a local, regional, national, and international priority[19]. Through engagement via the Urban Solutions program, NRDC anticipates that the pursuit of aggressive, realistic, local climate goals will become a business-as-usual approach among mayors across America[20]. A successful Urban Solutions program will entail climate strategies across 25 cities; the on-track reduction of carbon dioxide by 80% by 2050 across ten regions; two states establishing programs similar to California's to reduce carbon; and investments approaching millions of dollars in green infrastructure funded by the private sector[21].

Through Urban Solutions' All-In Initiatives, NRDC aims to identify opportunities for climate change and social equality goals through focusing on energy efficiency and clean energy generation, land use and transportation, stormwater

Figure 7: Wind Turbines

Figure 8: NRDC Urban Solutions Poster

and urban resilience, and food and food waste. NRDC has elected to focus on these four sectors in recognition that only through integrated goals can cities undertake the dramatic improvements in resilience and social justice anticipated through Urban Solutions' implementation[22].

While NRDC has already investigated the issues pertaining to energy efficiency and land use, the organization has asked graduate students in Columbia University's Master of Public Administration in Environmental Science and Policy program to investigate the factors influencing both effective stormwater management and food systems security in the context of climate change in urban areas.

STORMWATER MANAGEMENT

Stormwater is any water in the form of melted snow or rain that is not absorbed by the ground due to either impervious surfaces or supersaturation of soil. Stormwater can collect from lawns, paved streets, or rooftops to form stormwater runoff that often accumulates in nearby waterways[23]. Stormwater management is particularly challenging in urban areas covered by impervious surfaces such as paved streets, parking lots, and compact soils[24]. For example, 72% of New York City is covered by impervious surfaces[25]. As stormwater runoff flows downhill, it accumulates garbage, waste, and toxic substances including pet waste and lawn fertilizers. Without proper management, contaminated stormwater can cause significant damage to local water systems[26]. The runoff that occurs within the first hour of rainfall during a medium to high intensity storm can have a higher contamination concentration than raw sewage[27].

Urban areas with few impervious surfaces can also experience significant problems from stormwater in the form of economic losses due to flooding. Over the past several years, Puget Sound has experienced an annual oil spill equivalent to at least half of the 1989 Exxon Valdez spill. Oil from the roads enters the water via stormwater runoff; the stormwater carries between 6.3 and 8 million gallons of petroleum every year. In contrast, the Exxon Valdez spill consisted of 11 million gallons in total[28].

The infrastructure of several of America's largest cities, including that of New York City, was not designed with long-term stormwater concerns in mind. New York City's Combined Sewer System collects both sewage and runoff in the same pipe. If the local stormwater exceeds the capacity of the system, the pipe's contents are discharged directly into the Hudson River, which feeds into the Atlantic Ocean. This discharge includes all of the water, raw sewage, and pollutants accumulated in the runoff, with significant ecological and human health hazards[29]. Anticipated increases in the frequency, intensity, and duration of extreme precipitation due to climate change raises concerns about cities' abilities to respond to such stormwater crises[30]. Improvements in green infrastructure have alleviated several problems associated with stormwater in urban areas. Both structural and nonstructural Best Management Practices (BMPs), including porous asphalt in parking lots, porous concrete sidewalks, vegetated infiltration beds, and rain gardens, have demonstrated some success in mitigating stormwater challenges[31].

Figure 9: Green Infrastructure in Atlanta

FOOD SYSTEMS SECURITY

A food system includes all of the activities related to the production, processing, distribution, purchase, consumption, and disposal of food[32]. With each step of the food system critical to the successful continuation of the next, a single disturbance can place the entire system at risk. For example, the impacts of climate change can perturb a number of natural cycles and systems, highlighting the need for improved resilience and diversity across the food system.

Food system security concerns primarily affect low-income city residents. Programs that provide food assistance include free or subsidized school lunches or the Supplemental Nutrition Assistance Program (SNAP). For example, as of 2012, nearly 48 million Americans, or 1 in every 7 residents, depend on SNAP for their daily nutritional needs[33]. In addition, 51% of all children qualify for either free or reduced-priced lunches in public schools, the highest rate in the past five decades[34].

Beyond availability of food for urban residents, the effects of climate change can negatively impact the security of local food systems. As extreme weather events become more frequent, traditional transportation and distribution methods may no longer be as reliable as in the past. Although the prices of food are unlikely to change on a broad scale, local prices may shift to reflect food availability, particularly during emergencies. Diversification of a city's food supply can prevent food insecurity and improve local resilience in the face of climate change. However, measures should also be taken to promote sustainable and local agriculture, further complicating measures to secure food availability[35].

The historical shift from a nation of rural farmers to a primarily urbanized population has produced a generation of Americans without a strong connection to nature or an understanding of food origins. In response, schools have begun partnering with local farms to help students understand how food reaches their plate. By incorporating fresh food into aspects of the curriculum, schools are also able to convey the importance of nutrition in fresh, healthy meals[36].

Figure 10: Farmland 2

METHODS OF RESEARCH

The development of a resilience tool for urban leaders to respond to both stormwater management and food systems security concerns is the product of a three-fold approach. An initial exploration of background research was followed by extensive data collection on a number of relevant topics. Finally, data were divided into distinct metrics, which comprised major indicators. Indicators throughout this report refer to observable and measureable characteristics that can be used to show changes or progress. They inform and guide management allocation of research and initiative development. In contrast, metrics as defined here refer to discrete measurements that constitute the building blocks of indicators. Each indicator identified throughout this report matches one of five major resilience pillars identified throughout this project: socio-economic, environmental, risk/vulnerability, preparedness, and infrastructure.

The background research conducted for this project consisted of a literature review, an exploration of case studies, and interviews with professionals. The literature review covered both scientific journals as well as newspaper articles to ensure a breadth of perspectives. While scientific journals conveyed the major agricultural impacts of climate change and greater likelihood of extreme weather conditions, newspaper articles offered on-the-ground responses to these threats. The most recent academic piece about shocks to the national food system was published in 1976, whereas similar articles are published daily in newspapers[37].

By considering case studies of stormwater management responses in Baltimore and Philadelphia and those of food systems security in Toronto and several European cities, we investigated strategies currently in place in those regions and their effectiveness. Interviews with professionals, including the head of food resilience for New York City's Office of Sustainability and Columbia professors specializing in hydrology and climatology, have offered an understanding of the methods by which Mayor's Offices have attempted to handle such concerns.

The identified strategies and methods that have been historically utilized to respond to stormwater management and food systems security related issues were then further analyzed to parse out the essential data that would need to be collected. Types of data identified for compilation covered a broad area of topics including average annual rainfall, the amount of money spent on flood related damage, and the amount of food imported into the city. The range of data types served as a basis to form various sets of metrics for each respective area that

would later act as the building blocks of our indicators. These indicators then fit into the five distinct resilience pillars explored further throughout the resilience tool.

Once the indicators and their respective metrics were identified, they were aggregated to create a generalized framework, allowing either urban leaders or NRDC representatives to identify what data is currently available for cities and reveals gaps in data availability. NRDC will be able to explore the implications of this tool as it continues working on its Urban Solutions program.

CASE STUDY

Stormwater management

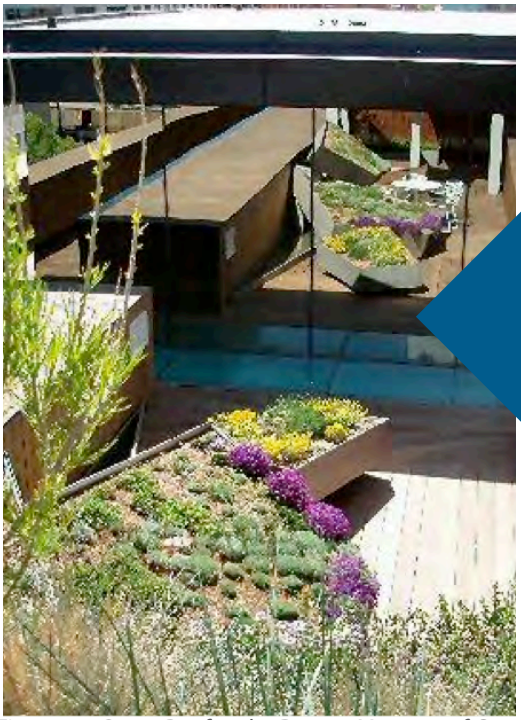


Figure 11: Green Roof at the Denver Museum of Contemporary Art

Denver, a city in the semi-arid west, must adapt and become resilient to storms and flooding while also focusing on the conservation of water resources. Denver has invested in green roofs for urban public spaces, such as at the Denver Museum of Contemporary Art. This green roof provides a green, vegetated area for guests to explore after they have finished viewing the museum's artwork. The only vegetation grown on the roof are plants native to Colorado that require less watering throughout the year as a way to address the issue of water conservation[38]. Among the environmental benefits of green roofs include higher air quality, improved building energy conservation, and reductions in the urban heat island effect. Rain gardens have also become popular throughout the Denver area. These gardens consist of native plants located near paved surfaces or lawns designed to catch runoff. Benefits include reduction of stormwater runoff into neighboring streams or ponds, as well as providing shade and aesthetic benefits. Furthermore, the native, drought-resistant plant types require little to no maintenance after installation[39].

Figure 12: Stormwater Pond at Historic Fourth Ward Park

Atlanta introduced a revised stormwater ordinance in early 2013 that requires new and redeveloped sites to treat the first inch of stormwater runoff with green infrastructure[40]. The city has sought to implement best management practices and green infrastructure throughout the urban area to help make Atlanta one of the top sustainable cities in the nation. Several revisions in the Post-Development Stormwater Management Ordinance include a runoff reduction requirement that promotes green infrastructure, the revision of detention pond requirements by reducing peak flow rates leaving the site by 30%, and the addition of a stormwater concept plan and consultation meeting with the city's staff, among others[41].

St. Louis, unlike most other metropolitan areas, has not established a combined sewer system. Rather than connect stormwater to a waste treatment plant, any gathered rainfall enters nearby bodies of water[42]. The Municipal St. Louis Sewer Department (MSD) collects and treats wastewater runoff. The MSD recently tried to implement a charge on property owners based on proportion of impervious surfaces such as asphalt[43]. However, the Missouri Supreme Court ruled that the charge was actually a tax and violated the Hancock Amendment, an amendment to the Missouri Constitution that limits the government's power to increase taxes without voter approval[44].

Figure 13: MSD crews work on a sanitation line

CASE STUDY

Food System Security

Figure 14: El Cajon Farmers' Market

San Diego's southeastern region is considered to be a "food desert" due to an average poverty rate above 20% and only one supermarket with all of the major departments of traditional grocery stores[45]. Approximately half of the food stores in the region either stock no fruits or vegetables or stock fewer than five items. Through the "Live Well San Diego" initiative, the city has partnered with local not-for-profit organizations on programs to improve access to healthy food and provide economic incentivizes for supermarkets to enter the local market. For example, the implementation of the program "Cilantro to Stores" provides grants and incentives for convenience stores to display and sell fresh produce grown at local farms[46].

Baltimore is the first city in the United States to have a paid staff and food policy director dedicated to increasing fresh food options. Nearly 20% of all Baltimore residents live in a food desert, and more than two-thirds of all adults and over half of all high school students are either overweight or obese. In response to the food desert problem, the Baltimarket offers local residents the opportunity to use library computers to order groceries from a locally owned supermarket. All orders are aggregated and delivered together, reducing transportation costs and allowing the city to subsidize the delivery fee[47].

Figure 15: Get Fresh Baltimore

New Orleans has one of the highest number of food deserts for an urban area in the United States, even before Hurricane Katrina. Since the hurricane, the areas considered food deserts has increased, with some experts believing that food scarcity reflects the low number of full-service grocery stores[48]. The actor Wendell Pierce, famous for his role in The Wire, opened a grocery store called Sterling Farms Grocery with the intention of transforming the store into a chain to increase food availability in underserved areas. However, Sterling Farms Grocery closed after a year due to mismanagement of funds and inventory[49].

Figure 16: Sterling Farms Grocery

USER MANUAL

The Purpose of this Resilience Report:

This report is designed to provide urban leaders with an understanding of the availability of and gaps within data for both stormwater management and food systems security. By providing cities with a tool to identify their baseline data, cities can begin to plan and implement new or additional resilience initiatives.

This report is not designed to assess cities' past resilience actions or to guide urban leaders into establishing programs to improve their performance. Instead, the tool provides insight into what cities understand their stormwater management and food systems security programs to be. By utilizing this tool to recognize gaps in city data, urban leaders can develop the initiatives necessary to fill those gaps in order to establish stronger, healthier, and more resilient cities.

Breakdown of Report:

This report was prepared by graduate students at Columbia University's School of International and Public Affairs through the Master of Public Administration in Environmental Science and Policy program. Students undertook to develop a framework to understand a city's readiness for climate change impacts on food systems security and stormwater management. This tool takes into consideration differences among cities including local climate and weather patterns, socioeconomic breakdown, transportation networks, and economic considerations. The report can thus be used by all cities across America regardless of size or location.

The indicators presented through this report are arranged in order of ease of city implementation and measurement. They have been organized into five major categories: environmental, socio-economic, risk/vulnerability, preparedness, and infrastructure. The indicators for both stormwater management and food systems security fall into these five categories.

Application of Report:

The application of the tool entails a multi-step process. First, urban leaders should complete the survey to gain a sense of their preparedness for answering additional questions and identifying their city's readiness score. The survey serves to provide city leaders with an understanding of available information and what the city should begin to research in anticipation of initiating stormwater management and food systems security resilience measures.

The survey is intended to act as a "primer," one that helps to assess a city's "emotional readiness" and ability to participate in Urban Solutions. "Emotional readiness" refers to a city's willingness and interest in beginning or continuing resilience initiatives. The ability to participate refers to the financial and institutional ability for a city to begin or continue resilience initiatives. A city that ranks poorly for both emotional readiness and ability to participate in Urban Solutions will not be selected by NRDC for the Urban Solutions program. Following completion of the survey, both the NRDC and the city decision-makers can determine the best use of the tool, establish targets for implementation, and identify an overall citywide strategy.

Stakeholder Utility:

This tool is intended for use by both NRDC representatives and urban leaders across the United States with slightly different purposes for each user. NRDC representatives should utilize the tool as a method of determining city resilience in anticipation of climate change impacts. Because NRDC has already identified 25 cities to become partners in its Urban Solutions program, representatives should use this tool to determine how best to aid American cities in assuring climate readiness for both stormwater management and food systems security.

In contrast, urban leaders such as mayors and city council members can glean information about data availability for both stormwater management and food systems security. By rigorously assessing a city's current programs, urban leaders can use this tool as a springboard to develop relevant and personalized options that serve to improve the city's resilience. By offering this tool to those cities beyond NRDC's Urban Solutions program, cities across America will be able to adapt more efficiently to the impacts of climate change on both stormwater and food systems.

THE TOOL

- PRE-IMPLEMENTATION SURVEY
- INDICATORS VOCABULARY
- INDICATORS
- TOOL EVALUATION
- TOOL LIMITATIONS

Figure 17: Puzzle

PRE-IMPLEMENTATION SURVEY

Readiness Survey

I. Overall Readiness and Accountability

1. Do leaders nurture an organizational culture focused on environmental planning and/or food systems security?
   Yes No

2. Is there a commitment from high-level leadership to protect the environment, implement green building practices, and enhance food systems security?
   Yes No

3. Are trainings available to learn more about urban resilience and the measures that can be taken to become more resilient?
   Yes No

4. Does the city's strategic plan contain a section and specific focus on urban resiliency, stormwater management and/or food systems security?
   Yes No

5. Is someone responsible for integrating urban resiliency efforts (stormwater management and/or food systems security) across your agency/organization?
   Yes No

6. Is customer/stakeholder feedback used to make program decisions or program changes?
   Yes No

II. Data Measurement

1. Is data readily available in your organization?
   Yes No

2. If not, is there someone available who knows where to access data?
   Yes No

3. Does the organization gather its own data?
   Yes No

4. Are secondary data sources used?
   Yes No

III. Financial Readiness

1. Are personnel and financial resources allocated to programs that aim to enhance urban resiliency, stormwater management efforts, and/or food systems security?
   Yes No

2. Are financial resources available for programs aimed to enhance urban resilience, stormwater management efforts, and/or food systems security, even if programs have not yet been implemented?
   Yes No

3. If financial resources were available, would the city be interested in implementing innovative urban resilience, stormwater management, and/or food systems security programs?
   Yes No

   Please explain:

IV. Training

1. Have training programs been instituted to inform and engage constituents about stormwater management and food systems resiliency?
   Yes No

2. Have key educational divisions on resilience been instituted?
   Yes No

3. If not, are resources (human and financial) available to institute training programs of this type?
   Yes No

V. Stakeholder Collaboration

1. Are other stakeholders i.e. community-based organizations (CBOs), non-profit organizations, and/or local, state, federal agencies actively engaged in the urban resilience development?
   Yes No

2. Are other stakeholders i.e. community-based organizations (CBOs), non-profit organzations, and/or local, state, federal agencies actively engaged in city-wide training programs?
   Yes No

3. Are other stakeholder i.e. community-based organizations (CBOs), non-profit organizations, and/or local, state, federal agencies actively engaged in financing city-wide initiatives?
   Yes No

INDICATORS VOCABULARY

Active Participation
Active participation is not the same as material participation. Active participation is a less stringent standard than material participation. For example, you may be treated as actively participating if you make management decisions in a significant and bona fide sense. Management decisions that count as active participation include approving new tenants, deciding on rental terms, approving expenditures, and similar decisions[50].

Community
A group of people living in the same place or having a particular characteristic in common; a feeling of fellowship with others, as a result of sharing common attitudes, interests, and goals[51].

Constant Dollars (Real Dollars)
Constant or real dollars are terms describing income after adjustment for inflation. The Dictionary of Business and Economics defines constant dollar values and real income as shown below[52].

Constant Dollar Value (Real Dollar Value)
Constant-dollar value (also called real-dollar value) is a value expressed in dollars adjusted for purchasing power. Constant-dollar values represent an effort to remove the effects of price changes from statistical series reported in dollar terms. The result is a series as it would presumably exist if prices were the same throughout as they were in the base year-in other words, as if the dollar had constant purchasing power[53].

Cost
The price of something; the amount of money that is needed to pay for or buy something; loss or penalty incurred, especially in gaining something[54].

Current Dollars
Current dollars is a term describing income in the year in which a person, household, or family receives it. For example, the income someone received in 1989 unadjusted for inflation is in current dollars[55].

Discharge
The volume rate of water flow, including any suspended solids or biologic material, which is transported through a given cross-sectional area[56].

Equity
Fairness or justice in the way people are treated[57].

Extreme
Reaching a high or the highest degree; very great[58].

Flooding
Arrive in overwhelming amounts or quantities; cover or submerge (a place or area) with water[59].

Food Desert
There are many ways to define which areas are considered "food deserts" and many ways to measure food store access for individuals and for neighborhoods. Most measures and definitions take into account at least some of the following indicators of access - accessibility to sources of healthy food, as measured by distance to a store or by the number of stores in an area, individual-level resources that may affect accessibility, such as family income or vehicle availability, neighborhood-level indicators of resources, such as the average income of the neighborhood and the availability of public transportation[60].

Food System
A sustainable community food system is a collaborative network that integrates sustainable food production, processing, distribution, consumption, and waste management in order to enhance the environmental, economic, and social health of a particular place[61].

Food System Innovation
Earle and Earle (2000) defined the innovation spectrum as "new to the world", "product improvements" and "cost reductions". They then defined three broad levels of innovations: incremental, major and radical. Product platforms were then used to group similar products. Changes to products made within a platform are "derivative" changes. It is also possible through radical changes to form new platforms of products[62].

Green Infrastructure
Green infrastructure uses vegetation, soils, and natural processes to manage water and create healthier urban environments. At the scale of a city or county, green infrastructure refers to the patchwork of natural areas that provides habitat, flood protection, cleaner air, and cleaner water. At the scale of a neighborhood or site, green infrastructure refers to stormwater management systems that mimic nature by soaking up and storing water[63].

Green Space

Open space is any open piece of land that is undeveloped (has no buildings or other built structures) and is accessible to the public. Open space can include: green space (land that is partly or completely covered with grass, trees, shrubs, or other vegetation), green space includes parks, community gardens, and cemeteries, schoolyards, playgrounds, public seating areas, public plazas, vacant lots. Open space provides recreational areas for residents and helps to enhance the beauty and environmental quality of neighborhoods. But with this broad range of recreational sites comes an equally broad range of environmental issues. Just as in any other land uses, the way parks are managed can have good or bad environmental impacts, from pesticide runoff, siltation from overused hiking and logging trails, and destruction of habitat[64].

Herbicides

Herbicides are chemicals used to manipulate or control undesirable vegetation. The most frequent application of herbicides occurs in row-crop farming, where they are applied before or during planting to maximize crop productivity by minimizing other vegetation[65].

Impervious Surfaces

Perhaps the most defining characteristic of urban streams is the increase in the amount and rapidity of stormwater or surface runoff to those systems. Impervious surfaces associated with urbanization reduce infiltration and increase surface runoff, altering the pathways by which water (and any associated contaminants) reach urban streams. Common impervious surfaces include: roads, parking lots, rooftops, driveways and sidewalks, and compacted soils[66].

Infrastructure

The underlying foundation or basic framework (as of a system or organization); the system of public works of a country, state, or region; also, the resources (as personnel, buildings, or equipment) required for an activity[67].

Land Use

Land use is the human use of land; land use involves the management and modification of natural environment or wilderness into built environment, such as settlements and semi-natural habitats, such as arable fields, pastures, and managed woods[68].

Local Agriculture Production

Terms such as “local food,” “local food system,” and “(re)localization” are often used interchangeably to refer to food produced near its point of consumption in relation to the modern or mainstream food system (Peters et al., 2008). The New Oxford American Dictionary (NOAD) defines a “locavore,” which was NOAD’s 2007 word of the year, as a local resident who tries to eat only food grown or produced within a 100-mile radius. This 100-mile radius measure is not, however, a standard for local markets. For example, Durham et al., (2009) found that many consumers disagree with the 100-mile designation for fresh produce[69].

Municipal Solid Waste
Municipal Solid Waste (MSW)—more commonly known as trash or garbage—consists of everyday items we use and then throw away, such as product packaging, grass clippings, furniture, clothing, bottles, food scraps, newspapers, appliances, paint, and batteries. This comes from our homes, schools, hospitals, and businesses[70].

Organic
Organic agriculture produces products using methods that preserve the environment and avoid most synthetic materials, such as pesticides and antibiotics. USDA organic standards describe how farmers grow crops and raise livestock and which materials they may use. Organic farmers, ranchers, and food processors follow a defined set of standards to produce organic food and fiber. Congress described general organic principles in the Organic Foods Production Act, and the USDA defines specific organic standards. These standards cover the product from farm to table, including soil and water quality, pest control, livestock practices, and rules for food additives[71].

Overflow
To flow over the edge or top of (something); to be completely filled with something; to flow over bounds; to fill a space to capacity and spread beyond its limits[72].

Panic Buying
The action of buying large quantities of a particular product or commodity due to sudden fears of a forthcoming shortage or price increase[73].

Pervious Surfaces
Permeable pavement is an alternative to asphalt or concrete surfaces that allows stormwater to drain through the porous surface to a stone reservoir underneath. The reservoir temporarily stores surface runoff before infiltrating it into the subsoil. The appearance of the alternative surface is often similar to asphalt or concrete, but it is manufactured without fine materials and instead incorporates void spaces that allow for storage and infiltration. Underdrains may also be used below the stone reservoir if soil conditions are not conducive to complete infiltration of runoff[74].

Pesticides
A pesticide is any substance or mixture of substances intended for: preventing, destroying, repelling, or mitigating any pest. Though often misunderstood to refer only to insecticides, the term pesticide also applies to herbicides, fungicides, and various other substances used to control pests. Under United States law, a pesticide is also any substance or mixture of substances intended for use as a plant regulator, defoliant, or desiccant[75].

Poverty Line
A measure of income level issued annually by the Department of Health and Human Services. Federal poverty levels are used to determine your eligibility for certain programs and benefits[76].

Poverty Guidelines
The poverty guidelines are the other version of the federal poverty measure. They are issued each year in the Federal Register by the Department of Health and Human Services (HHS). The guidelines are a simplification of the poverty thresholds for use for administrative purposes — for instance, determining financial eligibility for certain federal programs[77].

Poverty Thresholds
The poverty thresholds are the original version of the federal poverty measure. They are updated each year by the Census Bureau. The thresholds are used mainly for statistical purposes — for instance, preparing estimates of the number of Americans in poverty each year[78].

Readiness
Willingness to do something; the state of being fully prepared for something; immediacy, quickness, or promptness[79].

Real Income
The purchasing power of the income of an individual, group, or nation, computed by adjusting money income to price changes. A comparison between incomes earned during 1970 and 1980, for example, would be pointless unless 1970 and 1980 price levels were identical. Using a price index showing, for example, that average consumer prices increased by 50 percent between those years, it becomes clear that $1,000 in 1980 bought what $667 bought in 1970. Thus, even if total income actually doubled, real income would double only if prices remained constant[80].

Resilience
The resilience of any system depends on the interconnectedness and functional diversity of multiple subsystems. For example, in decentralized systems, functions are distributed so that a malfunction or disturbance in one area does not necessarily have a critical impact on other system components. More resilient systems are able to absorb larger shocks without changing in fundamental ways. While natural systems tend to be inherently resilient, poorly designed human systems are often brittle and vulnerable to a variety of disruptions[81].

Risk
The possibility that something bad or unpleasant (such as an injury or loss) will happen; someone or something that may cause something bad or unpleasant to happen; a chance that an investment (as a stock or commodity) will lose value[82].

School District
A geographical unit for the local administration of schools[83].

Status
The position of affairs at a particular time, especially in political or commercial terms; the relative social, professional, or other standing of someone or something[84].

Storm Surge
Storm surge is an abnormal rise of water generated by a storm, over and above the predicted astronomical tides. Storm surge should not be confused with storm tide, which is defined as the water level rise due to the combination of storm surge and the astronomical tide. This rise in water level can cause extreme flooding in coastal areas particularly when storm surge coincides with normal high tide, resulting in storm tides reaching up to 20 feet or more in some cases[85].

Supplemental Nutrition Assistance Program (SNAP)
SNAP offers nutrition assistance to millions of eligible, low-income individuals and families and provides economic benefits to communities. SNAP is the largest program in the domestic hunger safety net. The Food and Nutrition Service works with State agencies, nutrition educators, and neighborhood and faith-based organizations to ensure that those eligible for nutrition assistance can make informed decisions about applying for the program and can access benefits. FNS also works with State partners and the retail community to improve program administration and ensure program integrity[86].

Sustainable
Able to be used without being completely used up or destroyed; involving methods that do not completely use up or destroy natural resources; able to last or continue for a long time[87].

System
A group of related parts that move or work together; a form of social, economic, or political organization or practice; harmonious arrangement or pattern[88].

Urban
In, relating to, or characteristic of a city or town[89].

Water Table
The level below which the ground is saturated with water[90].

Watershed
A watershed is the area of land where all of the water that is under it or drains off of it goes into the same place. John Wesley Powell, scientist geographer, put it best when he said that a watershed is: "that area of land, a bounded hydrologic system, within which all living things are inextricably linked by their common water course and where, as humans settled, simple logic demanded that they become part of a community." Watersheds come in all shapes and sizes. They cross county, state, and national boundaries. In the continental US, there are 2,110 watersheds; including Hawaii Alaska, and Puerto Rico, there are 2,267 watersheds[91].

INDICATORS

Socio-Economic

Indicator:	1. Food Access & Equity **(Essential)**
	Metrics
	● What are the available government food services in the city and how are these services distributed? - How many households receive this assistance? ● How many franchised eating establishments are located in the city? ● Are there food deserts in the city? ● Are there opportunities available in underserved communities to consume fresh and healthy food? If so, what opportunities? ● What is the average distance (in miles) a resident travels to a grocery store?
	Rationale:
	Underserved populations are most vulnerable to shocks in the food system, and so improving food accessibility is a critical component of strengthening a city's overall resilience.
	Sources:
	1) SNAP Participation and Cost Data https://catalog.data.gov/dataset/supplemental-nutrition-assistance-program-participation-and-cost-data
Indicator:	2. Division of Ownership **(Essential)**
	Metrics
	● Is the city's main electricity provider publicly or privately controlled/owned? - If there is more than one operator, is there cooperation/coordination between the companies/operators? - Are there fees incurred by users for energy production, distribution, and/or consumption? If so, who pays and how are fees decided and implemented? ● Is the water treatment in the city publicly controlled or privately owned? - If there is more than one operator, is there cooperation/coordination between the companies/operators?

- Are there fees incurred by users for stormwater management or water treatment? If so, who pays and how are fees decided and implemented?

- Are food distributors publicly or privately owned?
  - If there is more than one operator, is there cooperation/coordination between the companies/operators?
  - Are there fees incurred by users for food distribution? If so, who pays and how are fees decided and implemented?
- Are the food markets and delivery methods publicly controlled or privately owned? How is the food transportation process controlled?
  - If there is more than one operator, is there cooperation/coordination between the various companies /operators?

Rationale:

This indicator evaluates the entire markets in the city for energy, food, and water management. These questions provide insight on who are the stakeholders, what is their position in the field, and who should coordinate for emergency and resilience plans.

Indicator: 3. Community Outreach & Engagement **(Essential)**

Metrics

- Are there any food systems innovations (i.e. vertical or urban agriculture) currently taking place in the city?
- Are there any stormwater management innovations (green infrastructure, design/development, citizen science, research/monitoring) currently taking place in the city?
- Are there any community outreach or public incentives to change eating habits?
- Does the city have any social media campaigns regarding food policies, education, nutrition training, etc.?
  - Is participation in these campaigns measured? How?
  - If yes, has change/progress been measured?
- Does the city have social media campaigns regarding stormwater management?
  - Is participation on these campaigns measured? How?
  - If yes, has change/progress been measured?
- Does the city help incubate or scale up new initiatives? If so, how? What is the focus and can they be scaled for a wider audience?

Rationale:

Important to know how a city educates citizens and promotes the topics of food systems and stormwater management. Education is an important factor in ensuring longevity and sustainability of the city's initiatives.

Indicator:	4. Local Agricultural Production **(Important to Know)**
	Metrics
	● How many farms are in the local region (local defined by Congress as within 400 miles)? (specific number) ● What percent provide food locally and what percent ship to outside markets? ● What percent of the city's food is locally grown? ● Are farmers required to install stormwater contamination prevention methods from pesticides/herbicides/fertilizers? ● Are farmers required to install prevention methods from pesticides/herbicides/fertilizers seeping into the drinking water supply?
	Rationale:
	Understanding where food comes from and what kind of food is provided to the city helps the city assess where they should focus their efforts to plan for disasters. It is also beneficial to know if farming chemical products have ever compromised the water supply so the city can plan to mitigate this risk.
	Sources:
	1) USDA Major Land Uses http://www.ers.usda.gov/data-products/major-land-uses.aspx 2) USDA Overview of Chemical Inputs in Agriculture http://www.ers.usda.gov/topics/farm-practices-management/chemical-inputs.aspx 3) USDA Pesticide Data Program https://catalog.data.gov/dataset/pesticide-data-program-2008
Indicator:	5. Food Programs in Schools **(Important to Know)**
	Metrics
	● How many students are in the public school system? What percentage of these students (by school) receive free or subsidized lunch? ● Do school programs have subsidies for specific foods in school lunches? (i.e. a dairy or meat subsidy) ● How does the city bid for school food providers/vendors and what agency is responsible for food procurement and contracts? ● What kind of food storage capacity is present in the schools and who has oversight responsibility for this?
	Rationale:
	Schools are seminal anchor institutions in cities and comprise purchasing pathways to increase people's access to fresh and healthy food. Understanding how schools contribute to the overall nutrition of the youth demographic in a city is a crucial component in identifying vulnerabilities in a city's food system.

	Sources:
	1) National School Lunch Assistance Program https://catalog.data.gov/dataset/national-school-lunch-assistance-program-participation-and-meals-served-data 2) 2012 School Lunch Dietary Guidelines http://www.gpo.gov/fdsys/pkg/FR-2012-01-26/pdf/2012-1010.pdf
Indicator:	6. Demographic Data **(Nice to know)**
	● What percentage of the population is below the poverty line? ● What is the minimum wage in the city? - How does this compare to the living wage in the city? ● What is the average age of the population? What percentage is elderly? What percentage is under the age of 5 years old? ● What is the income range of the population? ● What is the per capita income of the population?
	Rationale:
	To understand population composition by answering who is most likely to be affected negatively by inequitable access to the city's resources. Knowing this should help the city provide more equitable solutions.
	Sources:
	1) Poverty, Population, Unemployment and Education by County https://catalog.data.gov/dataset/county-level-data-sets 2) MIT Poverty in America Living wage calculator http://livingwage.mit.edu
Indicator:	7. Community Partnerships **(Nice to know)**
	Metrics
	● Does the city have an inventory of city partnerships with local farms. i.e. Farmers markets, schools, community gardens? ● What percentage of schools are partnered with local farms? - What kind of partnerships? (i.e. school lunches, field trips, etc.) - Characterize these schools- are there specific areas or communities that have more partnerships?
	Rationale:
	If there are any partnerships already taking place the city could combine efforts to aggregate a bigger impact for food security. These kinds of partnerships can also provide services that the city may not be able to provide, but that is still important for citizens to utilize.

Infrastructure

Indicator:	1. Sewage/ Stormwater System **(Essential)**
	Metrics
	● What are some of current problems, or limitations in the municipal sewage system? - What are the causes of the problems? (i.e. age of sewage system, specific events, etc.) - What are the most common repairs associated with the municipal sewage systems? - How has the city responded to these issues? ● Does the city have a schedule for routine maintenance of the municipal sewage system? ● How often does the city inspect, clean, and repair municipal sewage systems? ● At what volume of water does the stormwater management system overflow? ● How many sewer overflows occur monthly/seasonally/annually? ● How many tons of sewer overflow occurred monthly/seasonally/annually?
	Rationale:
	Identifying the quality of the current sewage system is a necessary baseline to mitigate system overflows and flooding.
Indicator:	2. Food Management & Distribution **(Essential)**
	Metrics
	● How does the city measure food quantities being shipped in and out of the city? - Weight or volume on pallets? Or by surface area of pallets? - How much food (in tons) enters the city on a daily basis? - What are the percentage breakdowns of food entering the city in regards to the nutritional pyramid? (i.e. grains, produce, processed foods, etc.) ● How is food delivered to the city? - Specify the delivery by mode of transportation (truck, train, boat, train) and the percentage breakdown for each mode. ● What is the approximate monthly number of deliveries of food to the city's major distribution centers? ● What types of infrastructure are utilized to expedite the food delivery system? ● How much municipal, city government agencies, public schools and/or hospitals food waste ends up in landfills?

	- What percentage is food packaging? ● What percentage of food distribution centers/grocery stores/markets' food supply is discarded as waste? ● Does the city have programs in place to reduce food waste or recycle food? (i.e. is food waste transferred to energy/fertilizer or distributed to food banks) ● Are there commercial or municipally owned composting centers in the region?
	Rationale:
	Knowledge about the volume and types of food imported into the city is essential for readiness and resilience planning, particularly for more vulnerable populations. Mapping out food delivery and distribution lends itself to identifying bottlenecks and vulnerabilities in the food system. Similarly, identifying food waste issues could point to inefficiencies in the food system.
	Sources:
	1) USDA Grain Transportation Report http://www.ams.usda.gov/AMSv1.0/gtr 2) U.S. Department of Commerce Commodity flow survey (type, value, weight, mode of transportation) https://catalog.data.gov/dataset/commodity-flow-survey 3) USEPA Materials Discarded in the U.S. Municipal Waste Stream 1960 to 2009 https://edg.epa.gov/metadata/catalog/search/resource/details.page?uuid=%7BE5DE559C-4258-496E-AA1D-71FCBA48161F%7D
Indicator:	3. Green Infrastructure **(Essential)**
	Metrics
	● What types of green infrastructure comprise the city's stormwater management plan? - Identify the number of green roofs, rain barrels, bioswales, etc. ● What kind of infrastructure policies are in place to redirect stormwater from residential areas?
	Rationale:
	Green infrastructure policies can prevent flooding and are key components of any stormwater management plan.
	Sources:
	http://water.epa.gov/infrastructure/greeninfrastructure/

Indicator:	4. Green Spaces & Urban Agriculture **(Important to know)**
	Metrics
	● What is the percentage coverage of green spaces within the city? ● What percentage of the urban area is made up of pervious/impervious surfaces? ● What percentage of permeable surfaces is used for urban agriculture? ● What is the average distance (in miles) a resident travels to reach a park or green space? ● Are there policies that promote the implementation green spaces within the city?
	Rationale:
	Green spaces and urban agriculture are innovative stormwater management responses that provide numerous co-benefits. Policies that encourage the implementation of these initiatives will improve a city's resilience and will likely improve the quality of life in a community.
	Sources:
	USGS Land Cover Database http://raster.nationalmap.gov/arcgis/rest/services/LandCover/USGS_EROS_LandCover_NLCD/MapServer

Environmental

Section Rationale: Understanding the environmental baseline of the region will help the city assess what kinds of potential or imminent risks are present. The topography, geography, and climate factors will influence the urban planning process.

Environmental Theme Sources:
1) National Geophysical Data Center – Digital Elevation Models https://catalog.data.gov/dataset/digital-elevation-models-from-noaa-ngdc
2) Climate data https://catalog.data.gov/group/climate5434
3) NOAA Climate at a Glance http://www.ncdc.noaa.gov/cag/
4) National Weather Service – River Flood Inundation Map http://water.weather.gov/ahps/
5) NCDC Storm Events Database https://catalog.data.gov/dataset/ncdc-storm-events-database

Indicator:	1. Geographical, Ecological, and Ecosystems Profile **(Essential)**
	Metrics
	● What are the different elevation levels within the city? Which areas of the city are located in drainage basins? ● Is the city located within a coastal area? ● What kind of ecosystem was historically present prior to urbanization? (For instance, was the urban area composed of a mixture of wetlands, swamps and grasslands or dry or temperate landscape?) ● What percentage of the previously reported historical ecosystem has been altered? ● What is the status of green, natural, or restored habitats that are currently under municipality protection? - What is the listing of protected status (i.e. protected by local, state, or federal legislation) - How much land (in acres) is set aside for either preservation or conservation programs? - What percent of land cover does vegetation cover? ● Are there any remediation or restoration plans currently in effect for non-protected areas? ● What percentage of the urban area lies above/below sea/river/stream level? What is the average height above sea/river/stream level? ● What is the total surface area of the local watershed? - What rivers, tributaries, lakes or other bodies of water contribute to the watershed of the area? - What is the annual minimum, maximum and average daily flow of these waterbodies? ● What is the average discharge levels into rivers, tributaries, lakes, other bodies of water for the following conditions? (report in cubic feet per second) - Monthly - Seasonal - Annual

- Under normal conditions
- Under average flooding conditions
- Under extreme flooding conditions

● What is the average depth (in feet) of the water table?
● What is the total volume of water withdrawn/collected from the following sources in cubic meters per year?
- Surface water
- Ground water
- Rain water (i.e. collection/ storage methods such as rain barrels)
- Waste water
- Municipal water supplies

Indicator: 2. Average Rainfall/Precipitation & Flood Frequency **(Essential)**

Metrics

● What is the seasonal and annual average amount of precipitation? (report in inches)
- What is the average rainfall (annual, seasonal, and monthly)?
- What quantity of rainfall historically causes stormwater overflows?
- How often do stormwater overflows occur seasonally and annually?

● What is the frequency of flooding over the following time intervals: 1 Year, 10 Years, 50 Years, and 100 Years?
- Of these flooding events, which can be classified as: a 50 year flood, 100 year flood, and 500 year flood?

● On average, how many storms/tropical systems have produced storm surge in the past ten years?

Preparedness

Indicator: 1. Best Management Practices **(Essential)**

Metrics

● Has the city implemented stormwater management best practices (i.e. permeable pavement, grass swales, etc.) that are applicable to the city's current stormwater management system?
● Have they been implemented?
● How many gallons of stormwater have been diverted from the sewage system through these practices?
● Has infrastructure that can provide co-benefits for stormwater management (i.e. parks, landscaped medians, etc.) been identified or mapped?

		Rationale:
		Identifying co-benefits of stormwater management infrastructure allows city planners to address multiple environmental and socio-economic issues, and in doing so, improve the city's resilience.
		Sources:
		http://www.epa.gov/greeningepa/stormwater/best_practices.htm#best_practices
	Indicator:	2. Climatological Factors **(Essential)**
		Metrics
		● Has the city identified areas that are most vulnerable to physical climate change impacts? - Has the city established predictive patterns for changing environment in order to mitigate future climate change impacts? - Does future sea level rise, or flooding from rivers and streams, pose risks to the city? Has the city factored these risks into city planning documents? ● Are there zoning laws in place to ensure development is limited in those areas most vulnerable to sea level rise and flooding from rivers and streams?
		Rationale:
		Sea level rise and increased severity of storms will have a negative impact on urban areas. These risks are important to understand for future city planning programs to ensure urban infrastructure will be implemented most effectively and be preventative.
		Sources:
		1) USGS National Shoreline Long-term Change Rates: https://catalog.data.gov/dataset/usgs-map-service-national-shoreline-change-long-term-shoreline-change-rates 2) USGS Dynamic Regional Climate (climate change modeling) http://regclim.coas.oregonstate.edu:8080/thredds/ 3) USGS Coastal vulnerability to sea-level rise http://coastalmap.marine.usgs.gov/cmgp/rest/services/National/coastal_vulnerability_index/MapServer
	Indicator:	3. Food Management & Distribution **(Essential)**
		Metrics

	● Has the city established contingency plans to distribute and manage supply food in a crisis or emergency situation? ● Does the city have an early warning system for flooding? - What percentage of distribution centers/grocery stores is enrolled in the early warning system? ● If transportation options are disrupted during a crisis, how long can the city feed every resident without new inputs of food? ● What city-wide food storage is in place? Are there food reserve locations within a proximity of the city that allows for distribution throughout the city? - If not, are there plans to build any? ● What is the average food storage capacity in the city's grocery stores, supermarkets, and restaurants? ● Historically, in times of panic buying, has the municipal government implemented rations on food or was it left to the private owners to regulate? ● Does the city keep historical data on food shortages? - Has the city changed or implemented policies in response to these historic events?
	Rationale:
	Food supplies and distribution are essential services. Identifying vulnerabilities and potential responses to disruption will strengthen the city's overall food system.
	Sources:
	1) "U.S. Fire Administration Emergency Response and Response- Information and Analysis Center http://www.usfa.fema.gov/operations/ops_cip_emr-isac.html 2) USDA Food Assistance in Disaster Situations http://www.fns.usda.gov/disaster/food-assistance-disaster-situations"
Indicator:	4. Food Distribution Centers and Energy Security **(Essential)**
	Metrics
	● Has the city established contingency plans in the event of power outages due to storms or other natural disasters? - Are there measures in place to protect critical equipment (i.e. machinery lifted at least two feet off the ground)? - Is there backup manual equipment available?
	Rationale:
	Energy is a critical input of both food distribution and stormwater management. Identifying strategies to supply power during storms or other natural disasters is critical to keep both sectors running.
	Sources:

	FEMA Coastal Critical Facilities database http://www.coast.noaa.gov/digitalcoast/dataregistry/#/critical facilities
Indicator: 5. Institutional/Organizational Infrastructure **(Essential)**	
	Metrics
	● Has the city established programs or regulations in place to address issues related to urban resiliency and sustainability? ● Does the city have specific municipal departments or offices to address issues related to urban resiliency and sustainability? ● Is there a program in place to identify areas that are prime for alternative land use plans? (i.e. Zoning readjustments or buy-back programs to implement "Blue belts" for coastal protection) ● Are there specific stormwater management solutions according to specific land use areas? ● Does the city have targeted regulations to mitigate flooding for areas that are at risk of flooding? (i.e. levees and water catchment) ● Are food policy strategies integrated across municipal institutions and departments, like disaster management and transportation?
	Rationale:
	Programs and institutions that target urban readiness and resilience at a municipal level indicate the city's commitment to these issues, and may serve as invaluable hubs to coordinate initiatives across the city. Similarly, planning documents that incorporate stormwater and flooding risks are preventative strategies to reduce a city's overall risk.
	Sources:
	National Transportation Dataset https://catalog.data.gov/dataset/usgs-national-transportation-dataset-ntd-downloadable-data-collectionde7d2
Indicator: 6. Food Insecurity **(Important to Know)**	
	Metrics
	● Has the city already identified food insecurity issues? - If so, what are some of the main drivers of food insecurity in the city? (i.e. poverty, unemployment, homeownership, etc.) ● What is the percentage of households, on an annual basis, in your city that are food insecure? ● What services are in place to address the food insecurity? ● Has the city identified food insecurity issues within the food services industry? ● What percentage of jobs in the city are employed in a food related industry? What percentage is in: urban agriculture and production, food processing and manufacturing, food and distribution? ● Does the city work with private industry to plan for events like storms or

	other disasters, epidemics, or public health situations or labor disputes?
	Rationale:
	Urban resilience in terms of food insecurity means that a city needs to deeply understand the main drivers of hunger among their citizens. Once this is accomplished, the city can become more resilient by designing policies and developing partnerships to address root causes born of poverty.
	Sources:
	1) Food Availability (per capita data system) https://catalog.data.gov/dataset/food-availability-per-capita-data-system 2) USDA Food Security in the United States http://www.ers.usda.gov/data-products/food-security-in-the-united-states.aspx 3) http://www.ers.usda.gov/data-products/commodity-consumption-by-population-characteristics.aspx
Indicator:	7. Water Quality **(Nice to know)**
	Metrics
	● How often is the city found not in compliance with city/state/federal regulatory agency water quality standards? ● Where does the city obtain it's drinking water? ● Is recreational water tested for contaminants? ● What are major contaminants in the local bodies of water? ● Are there remediation plans in place? ● Have water quality indicators been measured at stormwater outflows into various water bodies? - How frequently have these measurements occurred? What is the amount of dissolved solids? (in ppm or ppb) - Is temperature taken regularly?
	Rationale:
	Poor stormwater management may create new or exacerbate pre-existing water quality issues in the city. To mitigate the environmental and health risks associated with poor water quality, cities should perform regular tests and address instances of poor water quality.
	Sources:
	1) Centers for Disease Control and Prevention Public health tracking network https://catalog.data.gov/dataset/usgs-us-topo-map-collection 2) US Forest Serve Forest to Faucets (watersheds and surface drinking water) http://apps.fs.fed.us/ArcX/rest/services/EDW/EDW_ForestsToFaucets_01/MapServer 3) USGS National Water Quality Index: http://waterdata.usgs.gov/nwis/qw
Indicator:	8. Community & Communications For Food Security **(Nice to know)**

Metrics	
● Does the city have partnerships or collaborations to address food security issues and/or the distribution of food in a crisis? ● Does the city have communication methods in place to inform residents about having individual food reserves and individual disaster preparedness plans? ● Does the city have a communication strategy to contact the residents in the event of an emergency?	
Rationale:	
Establishing information sharing networks are crucial to informing residents and creating collaborative, innovative approaches to address issues.	

Risk/Vulnerability

Indicator:	1. Flooding & Population Risks **(Essential)**
Metrics	
● What percentage of the population lives in a flood zone? - Characterize the demographics of those populations. ● What percentage of homeowners located in a flood zone have flood insurance? How much does flood insurance cost relative to the average household income of high-risk flooding areas? ● What are the costs of stormwater damage, including flooding, on a seasonal basis for public property and private property? ● What programs are available to prevent property damage or pay for repairs? ● Do new or planned buildings follow the guidelines of the National Flood Insurance Program (NFIP)? - If the city is within a coastal area, has the city implemented shoreline management policies? Outline the policies and initiatives that are in place.	
Rationale:	
Costs associated with flood damage can be enormous. Knowing what part of the population is vulnerable to flood damage can help to target flood mitigation initiatives to achieve the greatest impact.	
Sources:	
National Climate Assessment on climate change and transportation http://nca2014.globalchange.gov/report/sectors/transportation#statement-10194	

Indicator:	2. Travel & Access **(Essential)**
Metrics	
● On an annual average, how often are public transit service disruptions caused by flooding and other consequences of poor stormwater management? ● What routes and corridors are most vulnerable to floods and stormwater? ● Are alternate routes in the event of disruption clearly established and accessible for commuters? ● What percentage of essential infrastructure directly related to transportation (travel, power plants, major grid infrastructure) resides in flood prone areas?	
Rationale:	
Travel routes are essential for emergency transportation as well as in everyday life. It is crucial to evaluate the damage potential to public routes and how quickly the city can fix such problems.	
Indicator:	3. Superfund Sites **(Important to know)**
Metrics	
● How many superfund sites are located with the city? - How many of the superfund sites have a direct environmental effect on water quality? (i.e. leach into an open water source) ● Are any superfund sites located in proximity to residential areas? If so, do they pose a risk to residents? ● Are there similar socio-economic features among residents in these areas? Characterize the demographics of those populations.	
Rationale:	
Superfund sites can negatively affect the water supply, particularly during storms when there is flooding. Assessing the location of superfund sites can help to evaluate the risk for water contamination.	
Sources:	
1) USEPA CERCLIS (Superfund) Site information http://www.epa.gov/enviro/facts/cerclis/search.html 2) USGS National Water Quality Data http://waterdata.usgs.gov/nwis/qw	

*N.B Specific sources have been provided on a select number of indicators to guide the data collection process and provide additional context. Publicly accessible data sources have been provided, as well as references for some indicators that are less intuitive. Local governments may also have additional resources for the NRDC to utilize, which could be accessed through NRDC's contacts with each city.

TOOL EVALUATION

In order to determine the feasibility of the tool, we sought to determine how easily information could be found for four major cities across the United States: Los Angeles, Salt Lake City, New York City, and Atlanta. These four cities span multiple regions, climates, and urban cultures and therefore represent a number of American cities.

Locating Water Quality and Combined Sewer Overflow Data

A brief study was conducted to see if water quality and combined sewer overflow information could be easily obtained from open source data in order to determine if the proposed tool could be successfully implemented in various cities in the United States. While each city considered here followed similar national standards of water quality, each sought to respond to the challenges associated with water quality and combined sewer overflow in distinct ways. Each city's plans are therefore presented individually.

New York

Water Quality

The New York City Department of Environmental Protection recognizes 4 major water quality indicators: fecal coliform bacteria, Clorophyll "a," dissolved oxygen, and secchi transparency. The New York State Department of Environmental Conservation (NYSDEC) measures these four indicators to determine if water reaches quality compliance standards.[92]

New York City has detailed records of water quality reports located through the NYC Department of Environmental Protection New York Harbor Water Quality Report (2010). The city divides its regional areas into four sections: Inner Harbor Area, Upper East River – Western Long Island Sound, Jamaica Bay, and Lower New York Bay – Raritan Bay. The report provides information both about decade-long trends for each of the four quality indicators up to 2010 and about whether the indicator exceeds, reaches, or fails to meet with compliance standards. For example, the amount of fecal coliform in the Upper East River has decreased steadily over the past two decades due to "ongoing upgrade of wastewater treatment facilities and capture of combined sewer overflows (CSOs)."[93] The report also includes detailed graphs of the Harbor-wide improvements efforts on the four parameters over four time periods. The study concluded that the dissolved oxygen levels have remained at record highs while the fecal coliform is still far below NYSDEC compliance standards, while the other two indicators have remained stable.[94]

Combined Sewer Overflow

The New York City Environmental Protection Agency's website details real-time concerns pertaining to the city's combined sewer overflow system and public safety standards. The online map includes information on discharge area locations along New York Harbor in addition to the amount of rain required to flood the sewer system. For example, a storm that brings 0.6 inches of rain per hour will generate a CSO advisory along the Bronx River for twelve hours[95]. Storm advisories are based off of rainfall data and CSO prediction models.[96]

Los Angeles

Water Quality

Los Angeles released its most recent comprehensive water quality report in 2013 based on data samples collected between 2010 and 2013. The city tests its water quality levels against national Environmental Protection Agency standards on parameters including radium, aluminum, copper, and lead levels. Los Angeles County also publicly posts its annual water quality reports on the Los Angeles County Waterworks website.[98]

Combined Sewer Overflow

The California Environmental Protection Agency has developed an interactive Sanitary Sewer Overflow (SSO) Incident Map that indicates all CSOs across California since December 2014. These CSOs are further categorized by severity of overflow.[99] For example, a Category 3 CSO refers to any discharge of sewage below 1,000 gallons that does not reach any surface water or drainage channel. [100]

Salt Lake City

Water Quality

Salt Lake City's Public Utilities website reports on the city's most recent water quality data. Local compliance standards are based on those determined by the Environmental Protection Agency and include measurements of hormones (not detected in the 2014 water quality report), strontium, and chromium.[101]

Combined Sewer Overflow

Salt Lake City's highly comprehensive Sanitary Sewer Management Program (SSMP) reveals the city's plan to reduce Sanitary Sewer Overflows. The 130-page report aims to "provide a plan and schedule to properly manage, operate and maintain all parts of the sanitary sewer collection system to reduce and prevent SSO's, as well as minimize impacts of any SSO's that may occur." The 2009 document incudes information on how the plan will begin to reduce SSO's by 2013. In addition, Salt Lake City utilizes the ArcGIS program to develop open source maps that indicate areas prone to flooding in addition to public utility project locations.[103]

Atlanta

Water Quality

Like most of these other cities, Atlanta's water quality reports comply with Environmental Protection Agency standards. The City of Atlanta Department of Watershed Management conducted the last study of water quality in 2013 to test for lead, copper, and chlorine, among others. The Chattahoochee River is the city's only local water source. Water from the river is treated at the Chattahoochee Water Treatment Plant, which, combined with the Hemphill Water Treatment Plant, processes 75% of Atlanta's water.[104]

Combined Sewer Overflow

Atlanta is currently implementing a plan to eliminate EPA water quality violations due to combined sewer overflows. This plan includes the use of tunnels to reduce CSOs and the separation of several sewer systems. The CSO area includes 19 square miles of urban land, and discharge from the CSOs averages 5 billion gallons per year. The CSO report includes information on the frequency, duration, and volume from each discharge station across the city. Atlanta plans to undertake a variety of measures to control CSOs including sewer separation, outfall relocation with treatment of water, and partial separation of the sewer system with storage areas and treatment of contaminated water.[105]

Locating Drought and Food Pricing Data

A brief study was conducted to see if the effect of local climate conditions such as drought on food pricing could be easily obtained from open source data in order to determine if the proposed tool could be successfully implemented in various cities in the United States. Unlike the information pertaining to water quality and combined sewer overflows that varied from city to city, the information pertaining to drought and food pricing proved consistent across regions and cities. Therefore, the challenges pertaining to locating this information are presented uniformly rather than individually by city.

The United States Department of Agriculture (USDA) Economic Research Service publishes data annually on products, food prices, and drought in addition to the Consumer Price Index and Food Price Outlook data. This information provides a summary of market basket prices and measures economy-wide inflation. This data reveals that food-at-home prices have increased domestically by 2.9% since February 2014.[106] An investigation into the effect of drought on food prices indicates a correlation between rising food prices and higher levels of drought the southwestern and southern regions of California. Most of this increase was observed through beef prices, which increased 23.6% between 2013 and 2014.[107]

Although food prices have increased in recent years, it is difficult to discern whether drought alone has prompted this change. The most severe and extensive drought in the past 25 years occurred in 2012 with significant consequences for American agriculture. While drought and other climate change impacts have the potential to affect food prices at the retail level, and especially in the crop and livestock sectors, uncertainty in forecasting does not suggest whether these impacts will be exclusively negative or exclusively positive. The USDA, which had originally predicted increasing food prices, has since retracted that statement, and today claims, "the impact of drought on retail food prices will be smaller than initially forecast[ed]…. The inflationary pressure of the drought has been offset by factors such as decreased exports of many U.S. agricultural products, a stronger U.S. dollar, low energy price inflation, and decreased prices for many commodities not affected by the drought."[108]

Across the United States, predictions for the remainder of 2015 suggest little to no increase in food prices. The primary variables used to predict food prices are oil, eggs, and drought. However, unanticipated factors unrelated to climate may influence these prices. For example, egg prices may increase across California due to Imposition 2, a statewide mandate requiring all producers to use larger cages for laying hens.[109]

Publically available data for food prices and climate is available for all cities through either federal or state portals. However, climate change, drought, and other weather patterns are difficult to measure and analyze effectively on a short-term basis. Moreover, direct causation cannot be determined without a consideration of locale-specific political, economic, and social factors.

TOOL LIMITATIONS

Time Frame: We developed indicators and metrics for food systems security and stormwater management across the United States over the course of a four-month semester. The time constraints in place prevented a full and comprehensive assessment of all other resilience tools available from other sources. With only four months, we could not consider all framework options or integrate all of the best possible aspects into this tool.

Comprehensive, Not Exhaustive, Tool: The five themes identified throughout this tool cut across both food systems and stormwater management (infrastructure, environmental, risk/vulnerability, preparedness, and socioeconomic). However, the list of indicators represents a comprehensive, although not exhaustive, list for both stormwater management and food systems security. Many indicators initially considered were not ultimately selected for use in the tool, although the tool covers 35 distinct topics with over 100 associated qualitative and quantitative metrics.

Ranking: Any ranking of indicators provided by this framework or by NRDC staff is inherently subjective in nature, and the importance of different indicators can vary by region or city. The most important resilience indicators for New York City may differ from those for Chicago based on local climate, city culture, or current initiatives in place.

Differences Among Cities: Our research revealed that different cities respond to resilience challenges in distinct manners. For example, New York City incorporates food security into the Office of Recovery and Resiliency, whereas Jacksonville runs most of its food programs out of the Department of Health. Therefore, the tool needed to be broad enough to meet the needs and obligations of every city, while also being narrow enough to meet city resilience needs for both stormwater management and food systems security.

Tracking Progress: This tool does not provide an exact recommendation on how to track city progress, leaving that decision up to NRDC representatives. However, we do recommend that NRDC develop an internal method of identifying any progress or changes in city resilience over the course of implementing the Urban Solutions program.

RECOMMENDATIONS TO NRDC

Utilization of Data

Once cities accumulate their baseline data for stormwater management and food systems security, they must determine how to utilize this data in constructing policies that foster a more resilient community. This tool provides NRDC with the opportunity to help urban areas understand, redesign, and improve their adaptation initiatives based on city-specific data. Because this tool only serves to identify gaps in currently available data, NRDC must embrace its role as an interactive guide for urban leaders to interpret and evaluate data in order to improve urban resilience. The following recommendations offer suggestions for NRDC's next steps in implementing this tool into its Urban Solutions program.

Food Systems Security Forum

In recognition of the limited available of specific data on food systems security, NRDC could serve as a national leader in organizing forums to convene individuals and institutions working on food systems and resilience issues. Through the creation of a knowledge network of practitioners, NRDC can help to begin conversations on gathering more comprehensive and publicly available data on various aspects of food systems security. For example, NRDC could organize discussions among distinct municipal offices such as public health, resilience, and education in order to begin citywide and national conversations about the importance of food systems security in building healthier, stronger, and more resilient urban communities. This will ideally fill gaps in data availability, improve accessibility of data, and create a cohort of stakeholders or representatives with expertise in food systems security. These partnerships should be established across public, private, and social sectors to ensure comprehensive involvements from all parties involved.

Renewed Focus on Green Infrastructure

Research into successful and unsuccessful stormwater management practices reveals the importance of green infrastructure and zoning/re-zoning policies. NRDC could promote the establishment of urban policies that favor green infrastructure and re-zoning. A focus into the area of infrastructure resilience will produce the most cumulative impact across many sectors given the importance of structures, buildings, and zoning on city resilience.

Full Integration into Remaining Sectors

In order to ensure full integration with the other Urban Solutions program areas, NRDC could undertake a comprehensive understanding of the connections and partnerships necessary for All-In Initiatives. While this tool identifies the connections between food systems security and stormwater management, it does not integrate these two program areas into either energy efficiency or land use. In addition, we recommended investigating the role of partnerships across public, private, and civil sectors (similar to the food system consortium suggestion). NRDC should be aware of each city's distinct method of government, such as the various city departments responsible for all aspects of the All-In Initiatives.

Data Visualization

Publishing data visualized into graphs, maps, or charts for the use of the public and policymakers allows for a rapid understanding of complicated material. Making data available to the public increases resident engagement in civic issues and offers the opportunity for citizen-sponsored recommendations in light of obtainable information. In recognition of the importance of data visualization, most cities undertake extensive forays into collecting and analyzing data[110]. While data can be visualized in a number of diverse ways, such as GIS mapping or bar graphs, most visualizations provide an interpretation only of the data available at the exact moment of its creation. For example, a map of a city's topography may provide baseline information about areas above and below sea level. Such static data visualizations would not provide up-to-date information about flooded areas around a city after a major storm. However, the expansion of smart phone technology allows for the collection of images and event analyses. Partnering city mapping with the flexibility of direct community input can provide much-needed information during emergencies or other fluctuating conditions. NRDC could encourage cities to expand their data visualization efforts to include both static and dynamic data in light of the data gathered through the use of this tool.

Incorporation of Unstructured Data

Unlike traditional data that measures or categorizes information, unstructured data involves gathering information on how people react through social media, notes, emails, images, and open-ended surveys, among other forms.[111] Projections suggest that nearly 80% of new data produced is classified as unstructured data.[112] Through incorporating software programs such as Computer Assisted Qualitative Data Analysis (CAQDIS), cities can utilize a coding scheme to divide data into subsets through examinations of textual information.[113] NVIVO, a popular data categorizing software, offers a visual exploration and explanation of relationship between nodes in order to search for, sort, and store information by common attributes. NRDC could introduce cities to the possible options for incorporating unstructured data into their publicly available data and incorporating residents' reactions and beliefs into policy decisions.

SUGGESTIONS TO WEIGH INDICATORS

Survey Weighing:

Through internal assessments of the survey's utility, we have developed two options for weighing answers to the city's initial survey responses. Each option offers distinct merits and challenges. However, we leave it up to NRDC to ascertain which option the organization believes is the best for its own uses.

Option 1:

Cities could receive two distinct scores with one based on the number of positive responses and one based on responding to the survey at all. Therefore, a city that fills out the entire survey with every answer as "no" would receive a score of 0% for current stormwater and food systems resilience initiatives but a score of 100% for cultural readiness. By filling out the survey at all, cities declare themselves interested in becoming more resilient. These cities may be ideal locations for NRDC to introduce Urban Solutions.

Option 2:

Points can be based on a Likert scale of strongly disagree, disagree, neutral, agree, strongly agree, and not applicable. Therefore, when cities answer the survey, NRDC can gain an understanding of how cities assess their own resilience. For example, when cities answer the first question ("Do leaders nurture an organizational culture focused on environmental planning and/or food systems security?"), the respondents can provide additional information beyond a mere yes/no response in the form of "strongly agree," "agree," etc. However, because every city may have a different interpretation of the Likert scale, NRDC may experience some inconsistencies among different cities.

Indicator Weighing:

Similar to our weighing of the survey, through internal assessments of the indicators, we have developed two options for weighing responses to the indicators. Each option offers distinct merits and challenges. However, we leave it up to NRDC to ascertain which option the organization believes is the best for its own uses.

Option 1:

Cities could be assessed by each of the five themes before aggregating the points into a final score. Therefore, NRDC could identify which of the five themes needs improvement. Cities could receive distinct scores for stormwater management and food systems security, but NRDC could also utilize this score assessment to target the particular challenges facing a city. For example, a city could have instituted excellent stormwater management initiatives pertaining to infrastructure, but receive a lower score for stormwater preparedness. Therefore, NRDC could focus its efforts in that particular city on stormwater preparedness rather than devoting a city's resources to infrastructure.

Option 2:

NRDC or the cities themselves could assess each indicator via the Likert scale using a scale of strongly disagree, disagree, neutral, agree, strongly agree, and not applicable. Cities could be measured on a 1 to 5 scale (with any non applicable indicators not considered) for each indicator. Therefore, NRDC could identify which specific indicators require improvement in each category rather than considering each category as a lump sum.

Long Term Vision of Tool:

Determine Baseline Data: We anticipate NRDC using this tool to identify the essential baseline data for food systems security and stormwater management for all cities involved in the Urban Solutions program. This tool will help NRDC assess city readiness for intervention initiatives. By providing this baseline information, NRDC will be able to aid urban areas to ensure greater resilience against future climate change impacts.

Assist within Cities: Using the baseline data gathered through the use of the tool, NRDC will be able to work within target cities to identify what additional data is necessary as well as to provide policy recommendations to improve city resilience. By integrating stormwater management and food systems security with the previous work NRDC has done in the other two Urban Solutions sectors, NRDC will be able to implement All-In Initiatives across American cities.

Recognize Interconnections and Parallels for All-In Initiatives: Through internal analyses of the interconnections among the four major resilience sectors comprising the All-In Initiatives, cities and the NRDC will be able to implement crosscutting initiatives to improve urban resilience. The five themes identified for both stormwater management and food systems security can and should be viewed as interconnected, but NRDC should seek to incorporate all four resilience sectors for the greatest benefit to city resilience.

CONCLUSION

The tool developed for Urban Solutions serves to highlight the level of interconnectedness and complexity involved among various systems that eventually determine city resilience. NRDC can collaborate with cities through the use of this tool to gather baseline data and identify any data gaps. The incorporation of five crosscutting resilience themes, 35 indicators, and over 100 metrics into a usable and useful tool will aid both city leaders and NRDC representatives into taking initial steps to develop stormwater management and food systems security initiatives.

In addition to the identification of themes, indicators, and metrics, we have also proposed recommendations for NRDC in the form of suggestions for survey and indicator weighing, the utilization of data, and a long-term vision for the tool's use. This report therefore serves only as the first component of the incorporation of all four resilience themes identified through the Urban Solutions model. We foresee NRDC using this tool to help urban areas across America become more equitable and more resilient.

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BIOS

Jessica Cunningham graduated from Saint Joseph's University in 2011 with a Bachelor of Arts in Political Science. Upon graduation, she worked as a project coordinator for ESF Dream Camp Foundation, which provides summer camp and after school programs for underprivileged children in Philadelphia, PA, and Hartford, CT. Jessica then moved to Criterion Search Group as a project manager where she assisted in completing 25+ retained searches in healthcare, finance, education, the arts, foundations, and nonprofits. She eventually decided to follow her passion to lead a more mindful and sustainable lifestyle and enrolled at Columbia University to learn how to incorporate these principles into her future career.

Alisha Sunderji completed her Bachelor of Arts and Science degree from McMaster University in Canada, where she explored diverse subjects ranging from art history to physics. She collaborated with the Departments of Engineering and Peace Studies for her thesis to examine how complex systems can inform environmental decision-making. Alisha brings a background in bioethics research, particularly on topics related to community engagement in global health projects, to her consultancy work with NRDC.

Shannon Craig**,** a New York State native and avid rower, left the Empire State to attend Loyola Marymount University, where she earned a Bachelor of Science in Environmental Science degree in 2012. Upon her graduation, she moved back and enrolled at New York University for a Master of Science in Environmental Health Sciences, with a concentration in Environmental Toxicology. Immediately following her NYU graduation, she began the MPA in Environmental Science and Policy program at Columbia. She looks forward to transitioning from student to environmental professional.

Alyssa Fico graduated from Manhattanville College in 2012 with a dual degree in Biology and K-12 Biology Education. She taught science and reproductive health for two years in a public school in the South Bronx before entering Columbia University to pursue her passion for environmental science and policy. She hopes to bring her extensive experience in GIS mapping and environmental data analytics to a career in applied science.

Ying Lian received her Bachelor of Environmental Design from the University of Colorado at Boulder in 2012 where she gained both teaching assistantship and internship experience. As a visual display intern at Anthropologie, she designed a presentation that was judged to be that year's best winter display. After college, Ying worked for both non-profit and for-profit art organizations in Los Angeles and Beijing, China. She hopes to pursue positions in environmental

Rebecca Miller started the program at Columbia one week after her graduation from Yale College, where she earned a Bachelor of Arts in History, with a concentration in Environmental History. Her senior thesis focused on the tension rooted in the diverse perspectives of individuals and groups that impeded the creation and implementation of coherent local environmen- policies regarding the closure of a landfill in 1960s Washington, D.C. Rebecca's investigation increased her interest in waste management issues as well as in the ways that local city governments can both disrupt and advance environmental policies.

Grace Rousseau taught secondary science for 26 years prior to coming to Columbia University. As a result of working with urban youth, she developed an interest in fostering the integration of sustainability principles within diverse, global communities. Her experiences provide the basis for strong, practiced skills in communication, planning, research and assessment. Grace has written published curriculum, served as a teaching fellow for technology integration, and worked abroad as a Peace Corps volunteer and for the Teachers for Global Classrooms initiative. Her studies at Columbia extend her skills into the areas of program management and data analysis. She intends to work more directly on projects in the public sector to encourage the growth of sustainability into established practice. Grace previously completed a M.Ed. in Curriculum and Instruction with an emphasis in Science from the University of Minnesota.

Tom Pellicano graduated from CUNY Baruch College with a major in Political Science and a minor in Law and Policy. His interest in meteorology and climatology drew him to enroll in the MPA in Environmental Science and Policy program. He looks forward to pursuing opportunities in sustainability initiatives and energy diversification in urban settings upon his graduation from Columbia.

Erin Percifull earned her degree in Environmental Science and Policy from the University of West Florida. She then worked in a water quality lab on stormwater assessment studies in the Gulf of Mexico and served as a manatee photo identification intern with the Florida Fish and Wildlife Conservation Commission. The Florida native left the Sunshine State for the Big Apple in 2010 to complete a year of service as an AmeriCorps/NYC Service Civic Corps member with the New York City Housing Authority (NYCHA). While there, she provided technical assistance to promote the Authority's sustainable environmental strategic plan. Most recently, Erin worked at The Nature Conservancy for 3 years as a member of the Development staff and the Urban Conservation staff.

Barbara Pualani brings a Bachelor's degree in Political Science and extensive experience working in the public sector at all levels of government, including the State Department and the Office of the Mayor in New York City, to her consultancy work for NRDC. Before matriculating at Columbia, she spent 27 months as a Peace Corps volunteer in the Dominican Republic where she spearheaded an improved cook stove project that aimed to enhance energy resources and improve the overall health of impoverished families.

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