RESILIENCE METRICS FOR GREEN STORMWATER INFRASTRUCTURE

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GREEN STORMWATER INFRASTRUCTURE

Source: US Environmental Protection Agency

Source: Philadelphia Water Department
DEFINING RESILIENCE

• “Infrastructure resiliency is the ability to gracefully degrade and subsequently recover from a potentially catastrophic disturbance that is internal or external in origin
  — Source: American Society of Civil Engineers (ASCE) and National Science Foundation (NSF) researchers under the Resilient and Sustainable Infrastructure (RESIN)

• In the context of flooding, resilience is the capacity of a system (community, society, or environment), to adapt, resist, and/or recover from the flood in order to maintain or achieve an acceptable level of functioning.

• In the context of resilience building: resilience is the potential to absorb and cope with impacts of climate shocks and extremes in the short-term, and to reorganize, and redevelop, preferably to an improved state in the longer term
  — Source: Engel, et. al. (2014)
FRAMEWORKS FOR RESILIENT INFRASTRUCTURE

• United Nations International Strategy for Disaster Reduction’s (UNISDR) 2005 Hydogo and 2015 Sendai Framework:
• UNISDR’s Making Cities Resilience campaign of 2013
• World Bank’s Global Facility for Disaster Risk Reduction - 2013
• United Kingdom Department for International Development’s resilience framework
EXAMPLES OF RESILIENCE INDICES

1. Coastal Resilience Index
2. Argonne National Laboratory Resilience Index
3. Social Vulnerability Index
4. Baseline Resilience Indicator for Communities (BRIC)
5. Community Assessment of Resilience Tool (CART)
6. Resilience Capacity Index (RCI)
7. Community Disaster Resilience Index (CDRI)
8. Center for Risk and Economic Analysis of Terrorism Events Economic Resilience Index (CREATE – ERI)

1. United Nations Development Program (UNDP) Disaster Risk Index (DRI)
2. Inter-American Development Bank Disaster Deficit Index (DDI)
3. Interagency Standing Committee (IASC) In-Country Team Self-Assessment Tool for Natural Disaster Response Preparedness
4. United Nations University Institute for Environment and Human Security, World Risk Index
Helping cities around the world become more resilient to the physical, social, and economic challenges that are a growing part of the 21st century.

Source: 100 Resilient Cities
100 RESILIENT CITIES

Source: 100 Resilient Cities
ARUP – CITY RESILIENCE INDEX

BASIS OF ASSESSMENT AND MEASUREMENT

For example:
- Health & Well-being: Infrastructure & transport. The four dimensions address factors related to people, organisations, place, and knowledge in a city.

For example:
- Maintain human vulnerability: Sustainable recovery.

For example:
- Protect livelihoods following a shock.

16 DIMENSIONS

12 GOALS

52 INDICATORS

156 PROMPT QUESTIONS (AVERAGE OF 4 PER SUB-INDICATOR)

QUALITATIVE
Analyses the adequacy of the mechanisms and processes in place to achieve the outcomes articulated by the indicators.

Scored on a linear scale between 1 and 5, based upon considered worst-case and best-case scenarios relevant to the particular area of city performance.

For example:

WORST CASE: The majority of small businesses are under-funded to respond to the high risk hazards facing the city. The city’s resilience strategy is not well-executed. The city’s government does not have enough resources, and a local bank is unable to secure the needed funds to ensure the resilience outcomes are sustained. Following a major shock event...

BEST CASE: Assessments have been undertaken to ensure that high risk hazards facing the city are minimised. There are plans in place to encourage small businesses and banks to offer affordable loans to small businesses that could withstand high risk hazards facing the city...

QUANTITATIVE
Identifies quantitative metrics that can be used by cities as proxies for past and current performance in relation to the indicators.

Scored on relevant city data to specific indicators using a globally applicable metric of resilience. A score from 1 to 5 is then assigned, based on a standardised performance scale.

For example:
- percentage of buildings with insurance or cover for high-risk hazards relevant to the city: 15
Source: Resilient Los Angeles, March 2018

Source: Atlanta Resilience Strategy, 2017
EXAMPLES FROM 100 RC – ATLANTA

• Vision 3 – Building our future city - today

TARGET 3.4
Create 500 new acres of publicly accessible green space by 2022. The City will create 500 new acres of publicly accessible green space by 2022. Public open spaces foster civic connection and build social capital while improving environmental health and increasing opportunity for physical activity. However, according to the 2009 City of Atlanta Project GreenSpace assessment, only 41 percent of Atlantans live in areas where they can safely walk to a nearby park, and many of Atlanta’s existing parks are smaller than the national threshold for a full-service park. Since Project GreenSpace was published, the city worked to open new parks and green space but there is still a critical need for accessible greenspace. In Action 3.4.1, the City will construct the Proctor Creek Greenway trail to increase public greenspace and transit access, catalyze economic development, and create a healthy livable environment for an area of the city which faces considerable environmental and economic challenges. Action 3.4.2 creates a funding strategy to support and ensure a more equal distribution of greenspace throughout the city. Action 3.4.3 expands the functions of the City of Atlanta Tree Recompayment Fund to better protect and grow Atlanta’s tree canopy.

TARGET 3.5
Install sustainable energy- and water-efficient infrastructure improvements in public spaces as well as around 500 homes and businesses each year.

The City will work with local organizations, businesses, and private-property owners to install water- and energy-efficient systems in order to manage drought, stormwater flooding, and rising energy costs to ensure a sustainable future for the city. For instance, most commercial entities, such as restaurants, are billed primarily at Tier 3 usage rates, so every gallon of water conserved would produce savings of $21.85 per gallon of water. In Action 3.5.1, the City develops a restaurant water efficiency program to reduce water and water costs. Action 3.5.2 recommends the creation of a stormwater utility fee to fund green infrastructure improvements. Action 3.5.3 increases the use of soap improvements through bulk purchasing programs. And, in Action 3.5.4, the City develops a demonstration project on Ted Turner Drive to encourage innovation and greater use of resilient infrastructure across Metro Atlanta.

Action 3.5.2: Create a stormwater utility fee to develop and fund a comprehensive stormwater management program

Establish a stormwater utility fee to fund the City’s stormwater management program, which is designed to reduce surface water flooding, addressing infrastructure, and improve the quality of water in our streams. The initiative will include funding projects identified in the City’s Watershed Improvement Plans, leveraging partnerships through the Green Infrastructure Strategic Action Plan, and providing incentives for customers to install green infrastructure best management practices (BMPs) on private property to handle on-site stormwater runoff. The Department of Watershed Management has proposed a comprehensive Stormwater Management Program to be supported by a stormwater utility fee established through the standard practice of billing property owners based on the amount of Impermeable surface present on a property. The program will be modeled after a combination of national best practices and programs from neighboring jurisdictions. Atlanta’s stormwater utility fee will be designed to specifically address equity concerns by providing grant programs to ensure low-income residents are not adversely affected by the cost of the fee nor unable to participate in SMP implementation programs.

Resilience Value to Atlantans:

- Primary Driver: Provides Continuity of Critical Services
- Secondary Driver: Provides Environmental & Human Health

Lead Implementing Partners:

- City of Atlanta’s Watershed Management, Code Enforcement Office of Resilience, The Conservation Fund, American Rivers, West Atlanta Watershed Alliance

Potential Metrics/Measures of Success:

- Volume of pollutants captured by installed Green Infrastructure Best Management Practices (BMPs)
- # of SHP’s installed
- # of flooding incidents citywide and in U.S. Federal Emergency Management Agency recognized flood-prone areas
- $ collected through stormwater utility fee

Partner Spotlight

Green Infrastructure Taskforce

In 2012, the City of Atlanta convened relevant City agencies, as well as partner groups, to promote and support the incorporation of green infrastructure into all types of public environmental investments. This Green Infrastructure Task Force has developed a Strategic Action Plan to address the challenges associated with managing stormwater runoff that leads to flooding, degraded water quality, and property damage. The Plan, which the Atlanta City Council unanimously approved in 2015, suggests actions for removing institutional barriers to green infrastructure development.

Increasing cost-effectiveness of green infrastructure; and engaging multiple City departments, citizens, developers, and environmental groups in working towards the goal of reducing stormwater runoff by 25% million gallons annually. Numerous projects have been completed, including Southwest Atlanta Ponds, Doraville Park, Kynsi Creek Park, and Historic Fourth Ward Park. Upcoming initiatives include Proctor Creek Greenway, Bowers Park, and the Atlanta Urban EcoPark Center @ Proctor Creek, and Roddy Road, Sr. Park.

Source: Resilient Atlanta: Actions to Build an Equitable Future
EXAMPLES FROM 100 RC - NEW YORK CITY

At the stormwater greenstreet located on Nashville Boulevard between 116th Avenue and 209th Street in Queens (Nashville), 100% of stormwater runoff entered local catch basins and ultimately the combined sewer system prior to installation in 2011.

Over our 2012 monitoring season (April - November), we found that 21 out of 24 storm events were 100% retained within the site.

Furthermore, our data suggests that the Nashville site can retain 100% of the flow directed to it during all storms with less than 1.6 inches of rainfall.

In addition, Nashville was closely monitored during both Hurricane Irene and Superstorm Sandy, and it captured much more stormwater runoff than anticipated.

Source: Landscape Architecture Foundation News
NYC GREEN JOBS CORPS
New York City continues to be a leader in reducing greenhouse gas emissions that contribute to atmospheric climate change and is the largest city in the state to move forward on an 80 percent reduction in emissions by 2050. Achieving this goal requires significant investments across the city’s energy sectors, building modernization, and waste sectors. At the same time, we are committed to supporting New York City residents with greater economic opportunities and pathways to good-paying jobs.

At the 2017 State of the City address, Mayor de Blasio announced the NYC Green Jobs Corps, a partnership with industry and labor to train 3,000 New Yorkers with the skills needed to 2040 jobs in the emerging clean energy economy over the next 3 years. This new program builds on the success of earlier initiatives, such as the Mayor’s Supportive Opportunities for Young New Yorkers: two-opportunity training programs leading to occupational training programs, creating a pathway for young adults to enter the construction industry, and other related training programs.

NYC COOLROOFS
NYC CoolRoofs is a partnership with the Department of Small Business Services (DBS), the Mayor’s Office of Recovery and Resilience, and Sustainable South Bronx connects New Yorkers with training and work experience installing energy-saving reflective roofs. By developing professional skills and reducing industry-related costs, participants complete the program prepared for entry-level jobs in the construction industry. Seventy New Yorkers will participate this summer.

Since its launch in 2019, the program has coated over 7 million square feet of rooftops across the city reducing emission and energy consumption and increasing city's solar energy potential. The City aims to coat one million square feet of rooftops virtually to support the City’s 100% goal.

DEP GREEN INFRASTRUCTURE MAINTENANCE TRAINING
Thomson Arkocharis joined DEP as part of the agency’s green infrastructure maintenance unit. Thomson is currently studying environmental science in Queens Community College and is an active volunteer for the nature restoration team. Thomson is also actively involved in community and is a member of the Friends of the Highbridge Park in Queens.

“Previously, I’ve worked in landscaping and for the Parks Department and I hope this job at DEP will lead to a career in forestry in New York City’s public sector.”

DEP’s green jobs will help to maintain the City’s investment in green infrastructure and provide workers with basic skills in horticulture and green infrastructure maintenance. DEP will also provide opportunities for seasonal employees to become permanent staff, allowing for further professional advancement within the agency. DEP’s continued expansion and development is a green job as it constructs new green infrastructure across the city.

Initiative 3: Expand green infrastructure and smart design for stormwater management in neighborhoods across the city

(Sources: One NYC 2017 Update)

Initiative / Supporting Initiative Lead Agencies Initiative / Funding Status Progress Since April 2018 Milestones to complete by December 31, 2020 2020 Milestone Status Milestones to complete by December 31, 2021
3.5A Alleviate flooding in Southeast Queens DEP In Progress / Funded The City, through DEP, completed an engineering study of the 50 hardest-hit flooding grids and identified site-specific solutions. The City also began the design of 2020 rain gardens in southeast Queens and expects construction to begin in the summer of 2019. In addition, DEP launched design for green infrastructure retrofits for these areas, while construction is underway for green infrastructure at two schools. The Bluebyrd Pond Bluebelt planning and design for green infrastructure on the NYCNA property in the area is expected to begin summer 2017. Complete design of green infrastructure on public land Completed
Complete an engineering study to assess the 50 hardest-hit flooding grids and identify site-specific solutions for each grid Completed
Initiate construction of right-of-way green infrastructure Completed
Begin construction on Bluebyrd Pond Bluebelt Completed
Source: One NYC 2017 Update
MAJOR MOTIVATIONS FOR GSI - LEGAL

Decentralized systems for resilience

Sewage and stormwater management

Source: St. Louis, MO – Clean Rivers Healthy Communities Program Illustration
MAJOR MOTIVATIONS FOR GSI - ECONOMY

Source: Resilient Greater Miami and the Beaches

Source: Climate Ready Boston, 2014
MAJOR MOTIVATIONS FOR GSI – THE “RESILIENCE DIVIDEND”

1. Greenhouse gas emissions △
2. Temperature (urban heat island effect) △T
3. Flooding △V, △$
4. Real estate △$
5. GW recharge - △H
6. Economy (jobs created/added) - △J
7. Water use/reuse - △V, △$
8. Building energy costs - △□□
9. Wildlife habitat - △□🐾
10. Recreation - △🏊🌧
11. Soil erosion/subsidence △serir
12. Water quality △💧 △$

Source: Department of Homeland Security
MEASURING METRICS

• Citizen participation (similar to lay monitoring programs)
• Public private partnerships
• Partnering with universities
• Real time sensor based data collection and analysis to develop trends
CONCLUSIONS

• GSI practices are true examples of a “resilience dividend” – one feature, multiple benefits

• Designing for resilience rather than risk allows not only robustness and redundancy – but also increases flexibility

• GSI practices allow progress toward Sustainable Development Goals – offering more metrics
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The more I see, the less I know for sure.

John Lennon