



**WATERFRONT  
ALLIANCE**



# **CLIMATE RESILIENCE LITERACY HANDBOOK**



# INTRODUCTION



This handbook outlines a menu of climate solutions in order to increase awareness among neighborhood-level stakeholders and community members. The goal of this resource is to help create climate-informed communities that can weigh in on public planning processes and advocate for climate resilient infrastructure and projects.

Several categories are covered in the handbook including climate change basics, preparedness, climate solutions, environmental justice, urban adaptation, and coastal protection strategies. These categories contain terms and definitions alongside relevant examples in the NY-NJ area.



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# GUIDE to HANDBOOK

Term  
Category

standard pop out page

Preparedness

## RETROFITTING

Term

Term  
Definition

### Basic Definition

Involves modifications to existing commercial buildings that may improve energy efficiency, reduce potential damage from flood waters, or decrease energy demand.

- ADAPTATION
- MITIGATION

Tags

NYC  
example

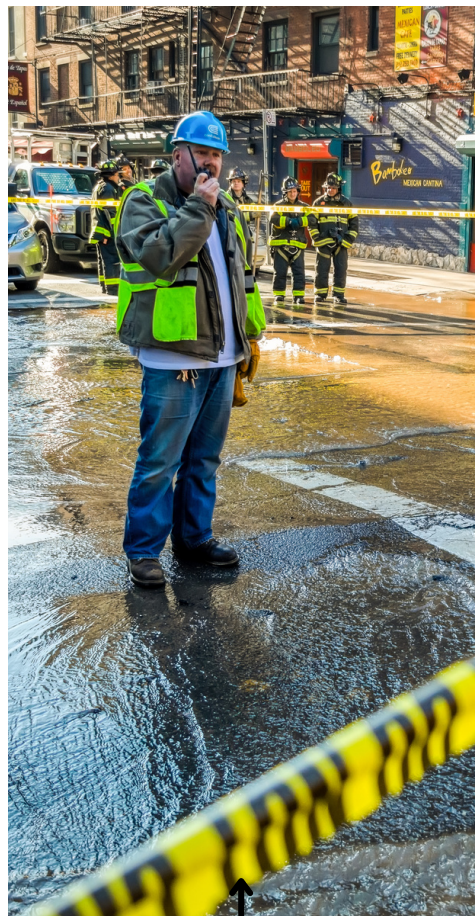
### Retrofitting in NYC

To reduce carbon emissions from buildings, the City of New York enacted Local Law 97 in 2019 as a part of the Climate Mobilization Act. This leading-edge law places carbon caps on most buildings larger than 25,000 square feet. In order maintain compliance, many buildings will require energy-efficiency retrofits, which will cut energy usage and reduce the operational costs, particularly in older buildings.

Term  
Color



Term Image



Relevant Image



# CLIMATE CHANGE BASICS



## Climate Change

Significant changes in temperature, precipitation, wind, or other global or regional climate patterns that occur over several decades or longer.

## Cloudburst

A sudden, heavy downpour where a lot of rain falls in a short amount of time. Cloudbursts can cause flooding, damage property, and disrupt critical infrastructure.

## Estuary

Bodies of brackish water where freshwater rivers meet the sea (such as a bay, mouth of a river, salt marsh, lagoon).

## Weather

Short-term state of, or changes to, the atmosphere, which can vary from time to time or location to location.

## Climate

Long-term weather patterns, such as averages of precipitation, temperature, humidity, and wind velocity that occur in a particular place.



## Greenhouse Gases

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The gases in Earth's atmosphere that trap heat and contribute to global warming. Examples include carbon dioxide (CO<sub>2</sub>), methane (CH<sub>4</sub>), nitrous oxide (N<sub>2</sub>O), and water vapor (H<sub>2</sub>O).

## Emissions

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The gases and particles which are put into the air or emitted by various sources such as cars, factories, power plants, etc.

## Global Warming

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An overall increase in world temperatures caused by additional heat being trapped by greenhouse gases.

## Maladaptation

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Actions that may lead to increased risk of adverse climate-related outcomes, including via increased greenhouse gas emissions, increased vulnerability to climate change, more inequitable outcomes, or diminished welfare, now or in the future. Most often, maladaptation is an unintended consequence.

## Storm Surge

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A rise in coastal water level associated with a hurricane or other strong coastal storm above the level associated with normal tides. The storm surge height is the difference between the observed storm tide and the normal tide.





## Adaptation

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Adjustment or preparation of natural or human systems to a new or changing environment that moderates harm or exploit beneficial opportunities.

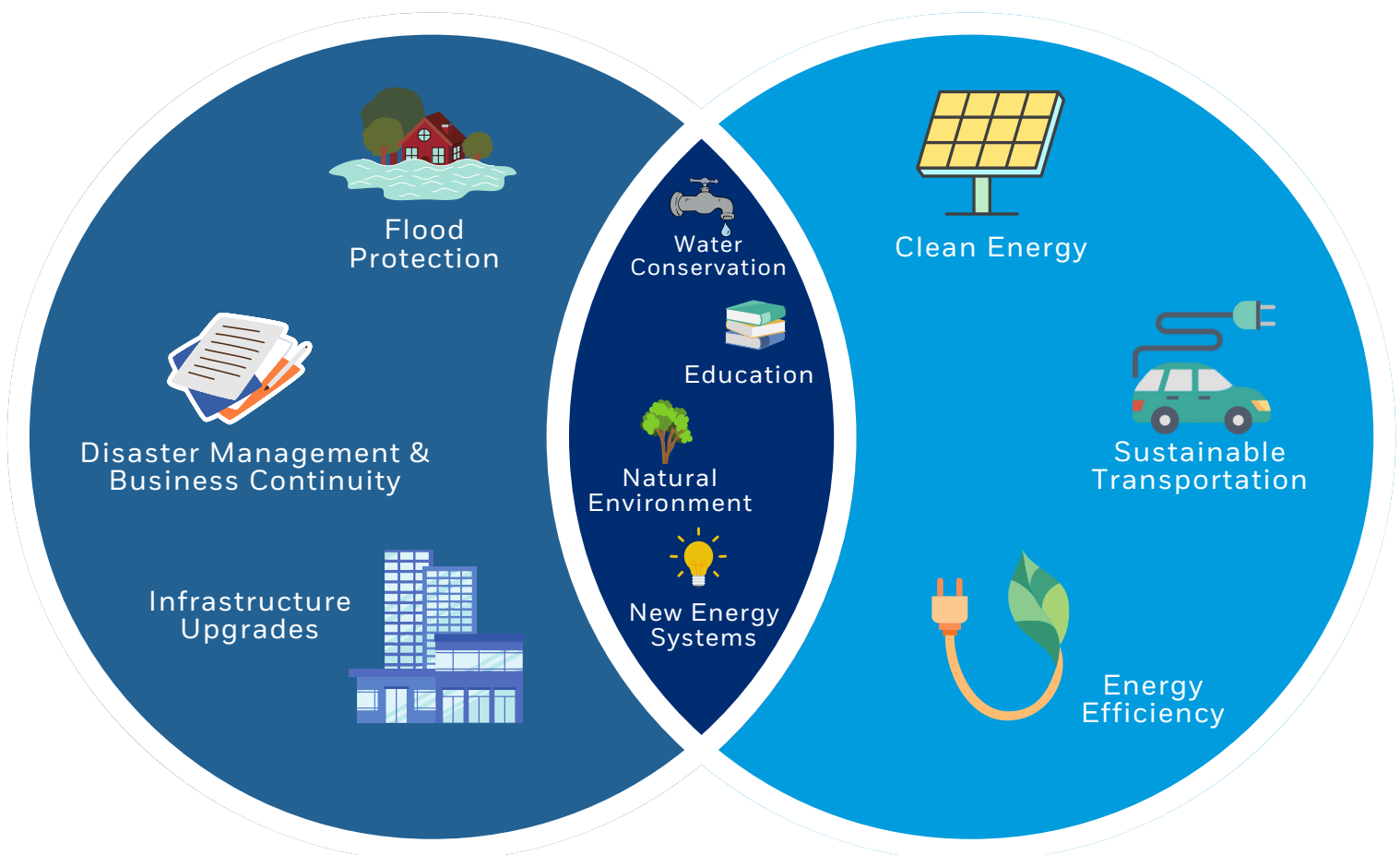
## Mitigation

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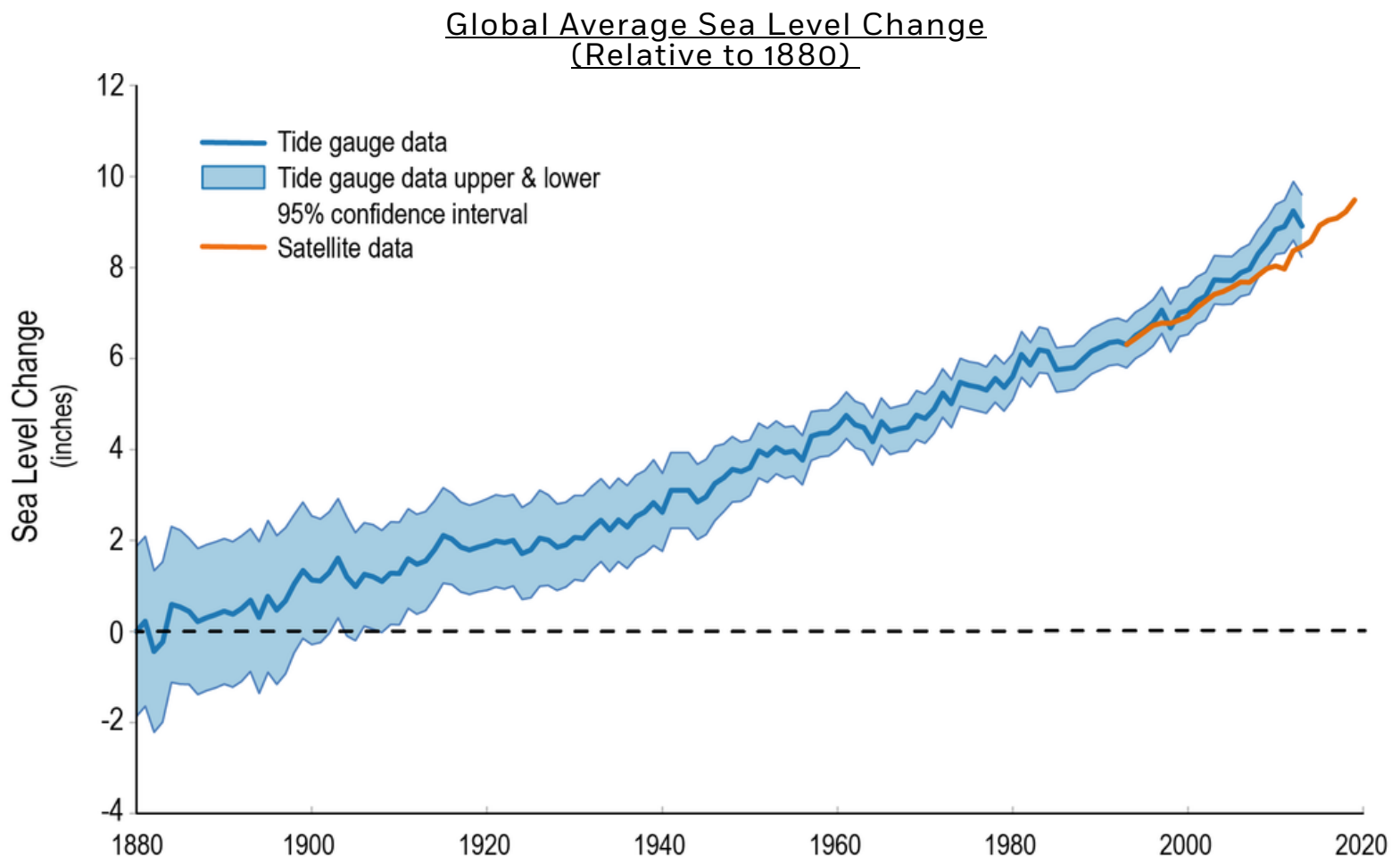
Efforts to minimize damages and reduce effects caused by climate change.

### ADAPTATION

### MITIGATION



# SEA LEVEL RISE



## Basic Definition

An increase in the level of the world's oceans due to the effects of climate change. It is caused primarily by two factors related to global warming: the added water from melting ice sheets and glaciers as well as the expansion of seawater as it warms.

The above chart illustrates global sea level change since the Industrial Revolution. While there are small fluctuations year to year, the overall trend is that the average global sea level is rising.

## Climate Change Basics

# RESILIENCE

### Basic Definition

A capability to anticipate, prepare for, respond to, and recover from significant multi-hazard threats with minimum damage to social well-being, the economy, and the environment.



# HURRICANE

### Basic Definition

A tropical cyclone in the Atlantic, Caribbean Sea, Gulf of Mexico, or eastern Pacific, which the maximum 1-minute sustained surface wind is 64 knots (74 mph) or greater.



# 100-YEAR FLOOD



## Basic Definition

A flood or storm that has a 1% probability of occurring in any given year. The 100-year flood zone is the extent of the area of a flood that has a 1% chance of occurring or being exceeded in a given year.



## 500-Year Flood

In contrast to 100-year floods, a 500-year flood has a 0.2% chance (or 1 in 500 chance) of occurring in a given year. Due to climate change, flooding from hurricanes will intensify with sea level rise, and what used to be a once-in-500-years flood may occur once every 5 years by 2030, scientists report.

# CLIMATE SOLUTIONS



## Decarbonization

Shifting away from energy systems that produce and emit carbon dioxide into the atmosphere.

## Electrification

The process of replacing technologies that use fossil fuels (such as coal, oil, and natural gas) with technologies that run on electricity.



# GREEN INFRASTRUCTURE



## Basic Definition

Natural systems including forests, floodplains, wetlands, and soils that provide additional benefits for human well-being, such as flood protection and climate regulation.

## Nature-based Solutions

Actions to protect, sustainably manage, and restore natural ecosystems in ways that address societal challenges effectively and adaptively to provide both human well-being and biodiversity benefits.

## Green Infrastructure in NYC

The NYC Green Infrastructure Program aims to reduce polluted stormwater runoff through Nature-based Solutions. These solutions include retrofitting NYC's streets & sidewalks, incentivizing green infrastructure on private property, and advancing daylighting opportunities in the Bronx. In addition to stormwater management, these projects provide co-benefits to communities and the environment, such as urban heat island reduction and expanded habitats for birds and pollinators around the city.



# GRAY INFRASTRUCTURE

## Basic Definition

Generally, traditional gray infrastructure collects and conveys stormwater from impervious surfaces, such as roadways, parking lots and rooftops, into a series of piping that ultimately discharges untreated stormwater into a local water body.



# GREEN-GRAY INFRASTRUCTURE

## Basic Definition

Infrastructure that mixes the conservation and restoration of nature (including natural coastal buffers such as mangroves and seagrasses) with conventional approaches (such as concrete dams and seawalls).

# MANAGED RETREAT



## Basic Definition

The voluntary movement and transition of people and ecosystems away from vulnerable coastal areas. This typically leads to the return of the land back to its natural state to protect communities up- and down-stream.

## Managed Retreat in NYC

NYC's first urban managed retreat project was piloted in Oakwood Beach, Staten Island, in 2013 after Hurricane Sandy. Residents formed the Oakwood Beach Buyout Committee to petition the state government to buy out the entire neighborhood as they were acutely aware of the increasing flood risks due to climate change. The goal of the state buyout program was to return bought-out properties to their natural state and prohibit future development. This process serves as a successful example of community leadership, as only 3 years later, 99% of residents participated in the program.

# PREPARDNESS



## Exposure

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The presence of people, livelihoods, species, or ecosystems in places and settings that could be adversely affected.

## Hazard

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The potential occurrence of a natural or human-induced physical event or trend that may cause loss of life, injury, or other health impacts, as well as damage to infrastructure, livelihoods, service provision, ecosystems and environmental resources.

## Risk

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The potential for adverse consequences for human or ecological systems, recognising the diversity of values and objectives associated with such systems

## Evacuation Route

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Routes designed for the movement of persons to safety in the event of a emergency and or natural disaster.

## Flood Insurance

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A type of property insurance that covers a residence for losses sustained by water damage specifically due to flooding.

## Backwater Value

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A protection device that prevents outbound water or sewage from back flowing or re-entering residence.

## Elevation

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Height above a given level, especially sea level.



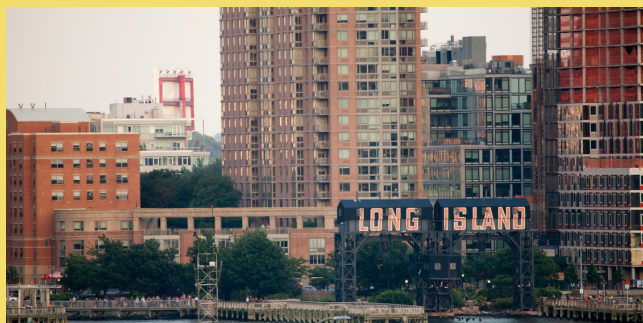
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- ADAPTATION
- MITIGATION



# ENVIRONMENTAL & CLIMATE JUSTICE

## Civic Engagement

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The ways in which citizens participate in the life of a community in order to improve conditions for others or to help shape the community's future.

## Governance

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The structures, processes and actions through which private and public actors interact to address societal goals. This includes formal and informal institutions and the associated rules and procedures for deciding policies at any geographic or political scale, from global to local.

## Land Use Change

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A process by which human activities transform the natural landscape.

## Vulnerability

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The susceptibility of a given population, system, or place to experience harm from exposure to climate-related shocks and stresses.





# COALITIONS



## Basic Definition

An alliance of individuals, groups, or states that come together and join forces for a specific purpose or common goal. At the community level, coalition-building is the means by which a wide range of community representatives come together to identify, define, and address community needs.



## • ADAPTATION

### Coalitions in NYC

Rise to Resilience is a coalition with more than 100 organizations spearheaded by the Waterfront Alliance. The coalition calls for federal, state, and local governments to make building climate resilience an urgent priority. Some other examples of coalitions include:

- Climate Works for All
- NYC Climate Action Alliance
- NY Renews
- Play Fair Coalition
- DivestNY



# ENVIRONMENTAL JUSTICE

• ADAPTATION



## Basic Definition

The fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies.

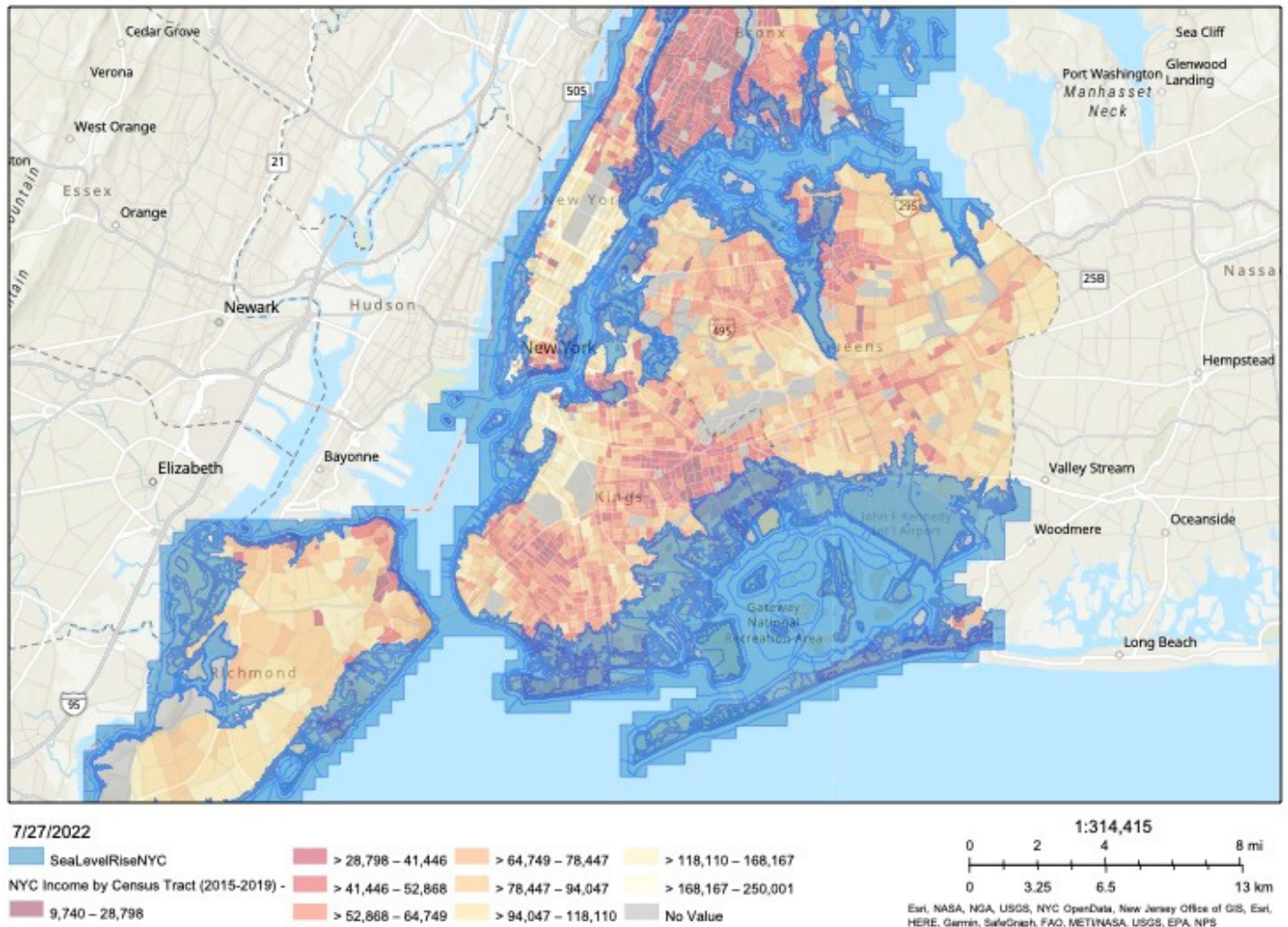


## Environmental Justice in NYC

WE ACT is an environmental justice (EJ) organization committed to empowering and organizing low income, people of color to build healthy communities for all.

# SEA LEVEL RISE PROJECTION MAPS

Projected Sea Level Rise by 2050 and Income Level by Census Tract

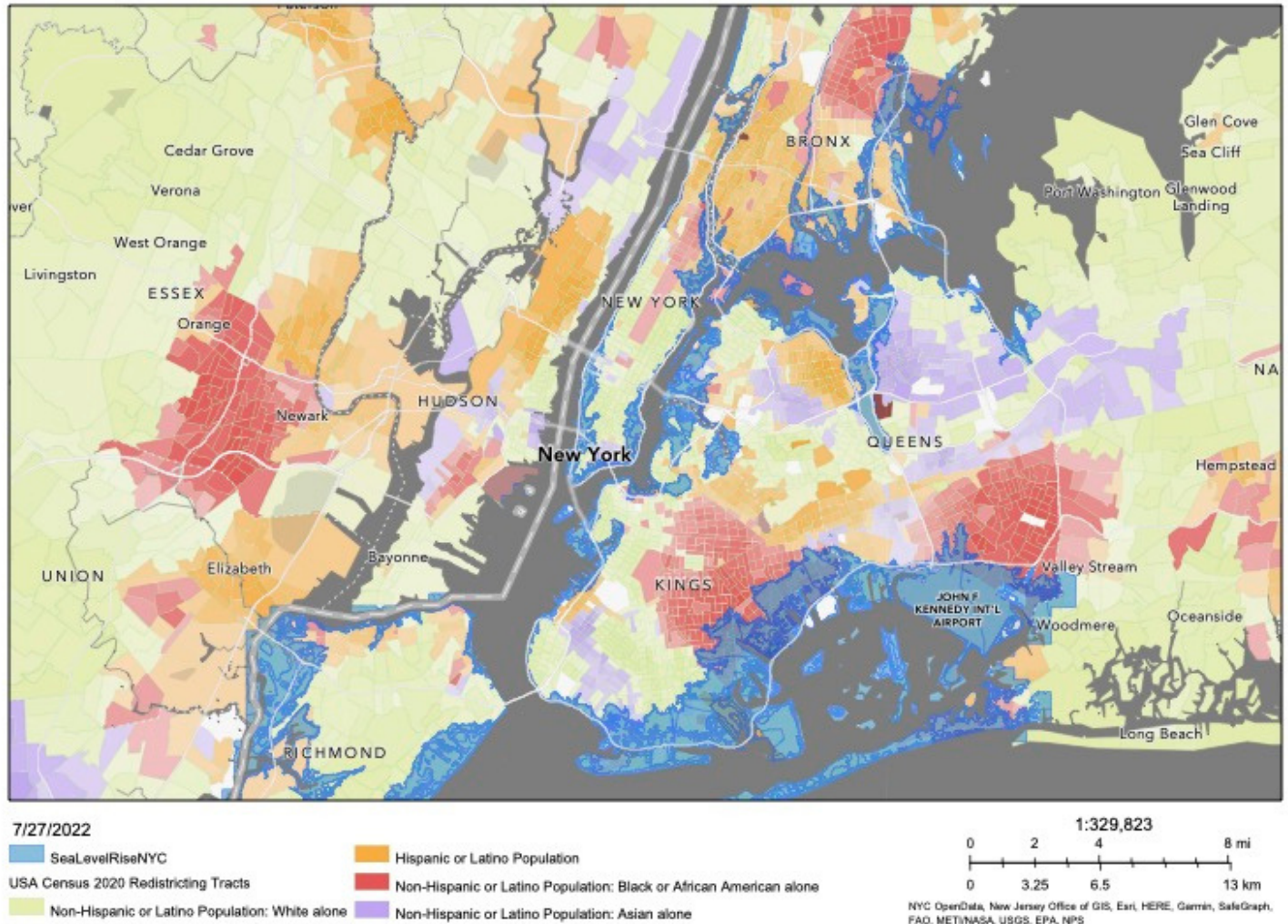


The Sea Level Projection Maps indicate communities that will be most impacted by sea level rise in 2050.

This map shows nine categories of income level by census tract overlaid with sea level rise projections. It contains the most current data released from the American Community Survey (ACS) about median household income using 5-year estimates shown by tract, county, and state boundaries.



## Projected Sea Level Rise by 2050 and Race and Ethnicity by Census Tract



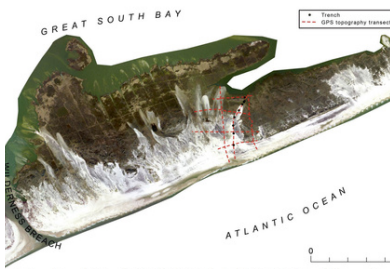
Data source: U.S. Census Bureau's 2020 PL 94-171 data for tract, block group, and block.

This map depicts each of the eight race/ethnicity categories, as represented by color, that have the highest total count living in that area.

Both maps provide visual representations of the anticipated impacts of a changing climate. The need for community-based justice coalitions is apparent as well as equitable mitigation and adaption policies. As shown by these maps, medium to low-income minority communities, who are statistically the least responsible for climate change, often are the most vulnerable.



# COASTAL PROTECTION STRATEGIES



## Barrier Islands

A long narrow, constantly changing deposit of sand lying parallel and close to the mainland, protecting the mainland from erosion and storms.



## Beach Renourishment

The process of placing additional sand on a beach or on the nearshore with the goal of increasing the beach width as well as the volume of sand.



## Berm

An elevated landscape feature or ridge of compacted soil located in such a manner as to channel water to the desired location.



## Bulkheads

A structure or partition made of stone, steel, or concrete that is built to retain or prevent sliding of the land into the water.



## Coral Reefs

An underwater ecosystem characterized by reef-building corals.



## Dikes

A barrier used to regulate or hold back water from a river, lake, or even the ocean.



## Dunes

A mound or ridge of sand or other loose sediment formed by the wind, especially on the sea coast or in a desert.



## Groins

Fingerlike-shaped barriers built perpendicular or at an angle to the shoreline that reduces currents. These lower currents help prevent erosion and encourage sediment deposition.



## Jetty

A long, narrow structure that protects a coastline from the currents and tides - typically made of wood, earth, stone, or concrete.



## Levees

A natural or artificial wall that blocks the overflow of water from one side, aimed to help prevent high risk of floods.



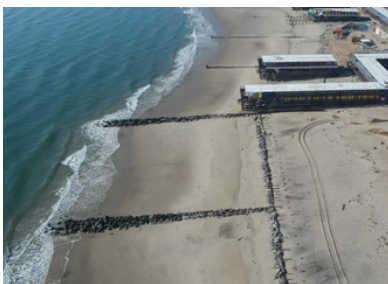
## Nearshore Breakwaters

Shoreline stabilization structures that control both alongshore and offshore movement of sediment. They can be designed either singly or as a system of segmented breakwaters.



## Revetments

A mound or ridge of sand or other loose sediment formed by the wind, especially on the sea coast or in a desert.



## Groins

Bank protection by armor, that is, by facing a bank or embankment with erosion resistant material.



## Riprap

Layer of large stones used to protect soil from erosion in areas of heavy runoff and are often located on steep, unstable slopes.





## Wetlands

A type of environment that is seasonally or annually flooded by water, and is characterized by saturated soil. Wetlands are known for their high levels of biodiversity, similar to coral reefs.



## Salt Marsh

Coastal wetlands that form transition zones between land and sea. They provide valuable habitat for wildlife, serve as nurseries for fish and shellfish, store floodwaters, and protect our shorelines against damage from storm surges.



## Watershed

A land area that channels rainfall and snowmelt to creeks, streams, and rivers, and eventually to outflow points such as reservoirs, bays, and the ocean.

# LIVING BREAKWATERS

## Basic Definition

Offshore structures designed to limit wave energy by creating a barrier, most often underwater, between open water and the shoreline. While traditional breakwaters may be made from stone, concrete, or other building materials, a living breakwater is intentionally designed to incorporate natural habitat components while still providing protection to the coastline.



## Living Breakwaters in NYC

In response to Hurricane Sandy, the Staten Island Living Breakwaters Project proposed approximately 2,400 linear feet of near-shore "breakwaters," designed to reduce risk and provide habitat for local marine life.



## Living Shorelines in NYC

Randall's Island Park uses native plants along the shoreline for environmental remediation. While the built tide pools create habitats and encourage biodiversity, the poplar trees can be used to help extract heavy metals from the soil.

# LIVING SHORELINES

## Basic Definition

A technique using native vegetation alone (or in combination with low structures that run parallel to the coast) to stabilize the shoreline. Living shorelines provide a natural alternative to 'hard' shoreline stabilization methods like rip rap or bulkheads. They also provide numerous benefits, including nutrient pollution remediation, essential fish habitat structure, and buffering of shorelines from waves and storms.



# OYSTER REEF



## Basic Definition

Large clusters of oysters that form habitats in coastal waters. Oysters are amazing filters; a single oyster can filter as much as 50 gallons of water daily. Thus, playing an important role in maintaining water quality and providing habitat for juvenile fish and other marine organisms.

## Oyster Reefs in NYC

Billion Oyster Project has 13 active reef sites across the five boroughs, from Coney Island Creek in Brooklyn to SUNY Maritime College in the Bronx. They have installed over 30,000,000 oysters in NYC waterways since 2014.



- ADAPTATION
- GREEN INFRASTRUCTURE



# SEA WALL



- ADAPTATION
- GREY INFRASTRUCTURE

## Basic Definition

Solid, vertical structures used to protect backshore areas (sandy, beach areas) from heavy wave action, and in lower wave energy environments, to separate land from water. They can be constructed using a range of materials; the most common being poured concrete, steel sheet pile, concrete blocks, gabions, and timber cribs.

## Sea Walls in NYC

In Staten Island, which bore the brunt of damages from Hurricane Sandy, a defense project proposal received \$615 million in funding in 2019. This project includes a 5-mile-long sea wall that will be built to withstand a 300-year flood event and reach 20 feet above sea level.

# URBAN ADAPTATION



## **Basic Definition**

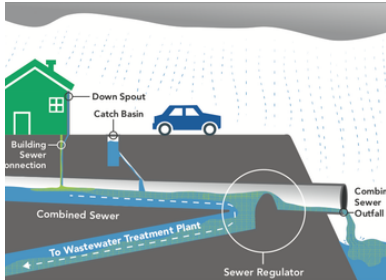
The process of changing cities and urban areas to adapt and mitigate climate change. These changes can be either preventative, to avoid anticipated damage or protective, to strengthen current infrastructure to brace for projected climate impacts.





## Catch Basin

A structure designed to collect and convey stormwater runoff to a storm sewer, a combined sewer, or an approved outlet.



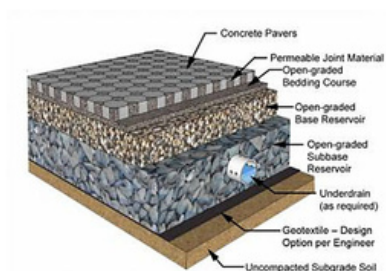
## Combined Sewer

In a combined sewer system, there is a single pipe that carries both stormwater runoff and sewage from buildings. This mix of stormwater and sewage is usually sent to a wastewater treatment plant.



## Combined Sewage Overflow

An event that occurs as a result of heavy rainstorms, where combined sewers receive higher than normal flows. Treatment plants cannot handle flows, leading to a mix of stormwater and untreated sewage directly discharging into the waterways.



## Permeable Pavement

An alternative to traditional pavement that helps reduce runoff by infiltrating rain water and melting snow. The alternative materials include pervious asphalt, pervious concrete, interlocking pavers, and plastic grid pavers, allow rain and snowmelt to seep through the surface down to underlying layers of soil and gravel.

# DAYLIGHTING

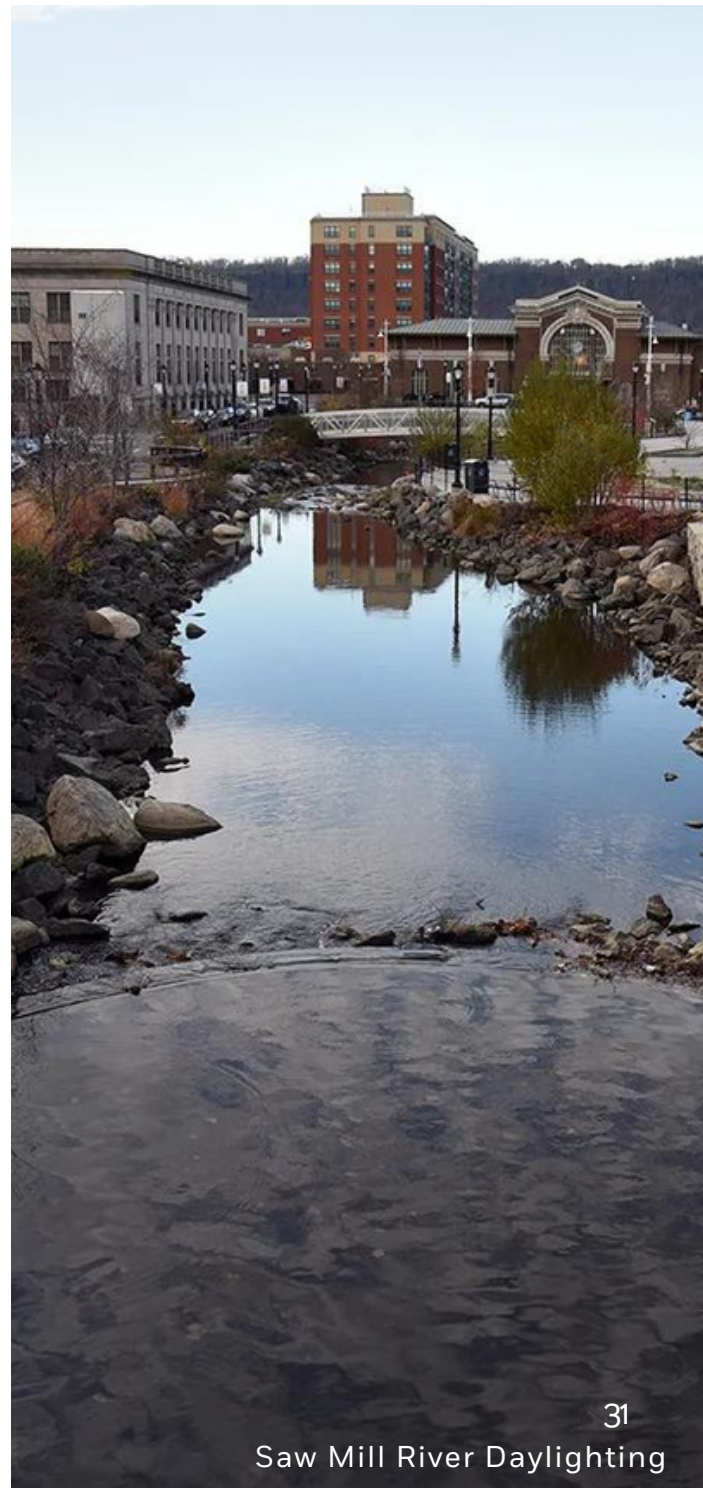
- GREEN INFRASTRUCTURE
- MITIGATION

## Basic Definition

The process of removing obstructions (such as concrete or pavement) that are covering a river, creek, or drainage way and restoring them to their previous condition.

## Daylighting in New York State

In Yonkers, the Saw Mill River has been daylighted, meaning the river that was previously covered by human development has been uncovered and returned to a natural waterway. Future daylighting projects of New York City's underground rivers has the potential to help reduce the massive amounts of rain and freshwater that currently flow into the sewage system.





# WHITE ROOFS

## Basic Definition

A roofing system that uses white paint to reflect the sun's radiation back into space. This can help lower temperatures and reduce energy costs, particularly in urban areas.

## White Roofs in NYC

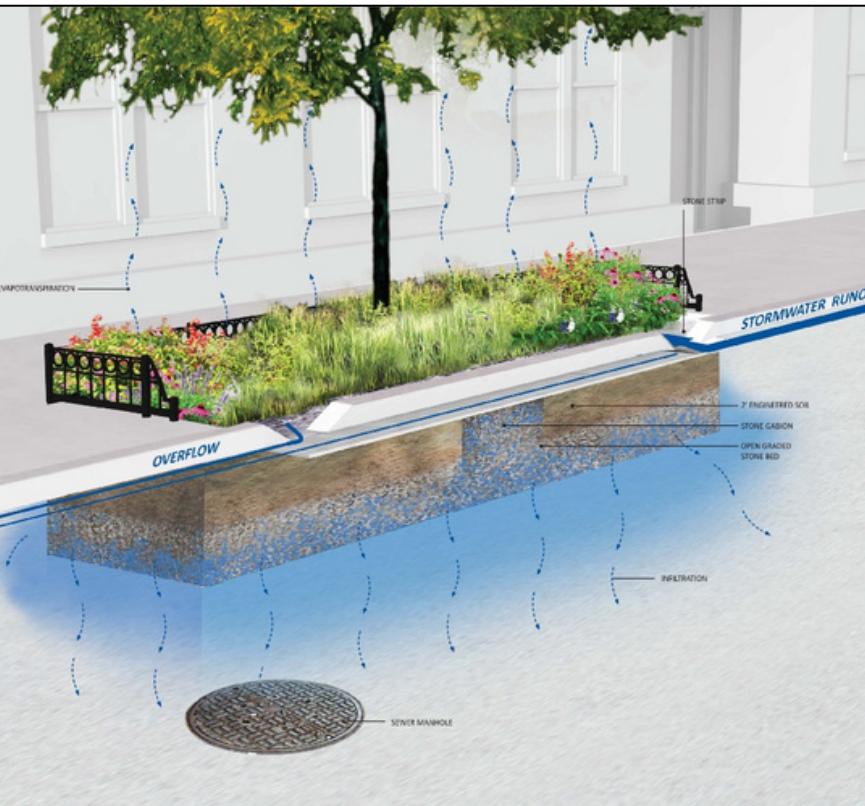
NYC CoolRoofs is a white roofs program that provides New Yorkers with paid training and work experience installing energy-saving reflective rooftops. The program supports the City's goal to reach carbon neutrality by 2050.



- GREY INFRASTRUCTURE
- MITIGATION

# RAIN GARDEN

A garden of native shrubs, perennials, and flowers planted in a small depression, generally formed on a natural slope. It is designed to temporarily hold and soak rainwater from a roof, driveway, or street, allowing it to soak into the ground instead of the sewer system. Rain gardens can improve the street by reducing ponding, providing summer shade, and greening the area.



- ADAPTATION
- GREEN INFRASTRUCTURE

# GREEN ROOF

- ADAPTATION
- GREEN INFRASTRUCTURE

## Basic Definition

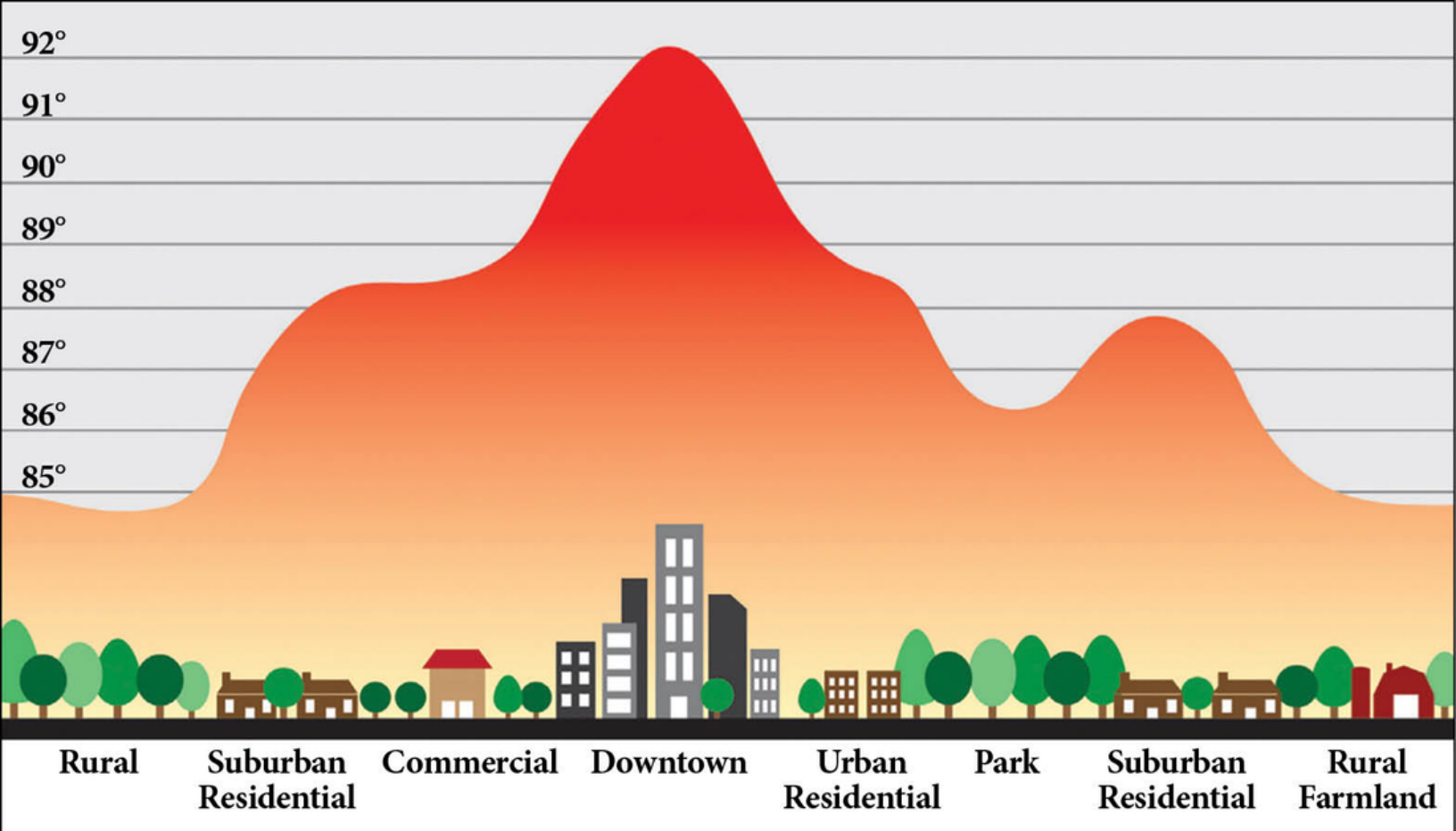
A vegetative layer grown on rooftops. Green roofs provide shade, reduce the roof surface and surrounding air temperatures, and absorb rainwater. They are particularly cost-effective in dense urban areas where land values are high and on large industrial or office buildings where stormwater management costs are likely to be high.

## Green roofs in NYC

New York City is home to about 730 buildings with green roofs. While it's a great start, there is progress to be made as less than 0.1% of the 1 million NYC buildings have them.







## Urban Adaptation

# URBAN HEAT ISLAND EFFECT

Heat islands are urbanized areas that experience higher temperatures than outlying areas. Structures such as buildings, roads, and other infrastructure absorb and re-emit the sun's heat more than natural landscapes such as forests and water bodies. Areas of New York City with green space and tree-lined streets, like areas located near Central Park, often experiences lower temperatures than areas with less green space and densely packed buildings. Summer temperatures can vary throughout the New York Metro area up to roughly 7F, and the highest temperatures are primarily felt by marginalized communities.

# Urban Adaptation URBAN TREE CANOPY

## Basic Definition

The layer of leaves, branches, and stems of trees that cover the ground when viewed from above. In urban areas, the UTC provides an important stormwater management function as well as reducing the urban heat island effect, air pollution, increasing property values, providing wildlife habitat, and community benefits such as improved quality of life.

The urban tree canopy in New York City is composed of more than 7 million trees, as well as the associated physical and social infrastructure that supports it.





# APPENDIX

This guidebook was made using knowledge spanning local organizations like Waterfront Alliance, federal departments such as the National Oceanic and Atmospheric Administration (NOAA), to the International Panel on Climate Change (IPCC), a group of scientists spanning the globe working to converge their local knowledge for the greater good. If you'd like to learn more, or have questions about content within the guidebook, scan the QR code to the right for a complete list of sources and imagery used throughout the guidebook.



# ACKNOWLEDGEMENT

Special thanks to Gabbie Batzko, Shangtong Li, Carly Lovas, Carley Petrone, Anushka Srivastava, and Zachary Weiss from The Columbia Climate School for work on the guidebook and collaboration with Waterfront Alliance.

Additional thanks goes to those that filled out the survey, which helped influence content, language, and the audience of the guidebook. We hope to continue working together to make the NYC/NJ metro a more climate-ready community.



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