



# URBAN FORESTRY AND STORM RESILIENCE 101



A Guide to Strengthening Cities Against  
Hurricanes and Tropical Storms

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# A GUIDE TO STRENGTHENING CITIES AGAINST HURRICANES AND TROPICAL STORMS

Urban areas are on the front lines of an escalating battle against hurricanes and tropical storms. With each passing season, storms are becoming more powerful, more unpredictable, and increasingly destructive—pushing cities to their limits. The 2024 Atlantic hurricane season alone reshaped our understanding of risk, with record-breaking intensities, catastrophic financial losses, and a steep toll on both communities and ecosystems.

Urban Forestry and Storm Resilience 101 offers a clear pathway for cities seeking to adapt and thrive in this new era. The guide starts with a stark look at the storm threat: intensifying hurricanes fueled by warming oceans, surging property and environmental damage, and a disproportionate impact on vulnerable populations. But it also illuminates a proven, practical solution—urban forestry.

You'll discover how thoughtfully planned urban tree canopies not only intercept stormwater and curb flooding but also strengthen infrastructure, support biodiversity, and build equity. From selecting wind-resistant tree species and replanting after disasters, to integrating trees with innovative green infrastructure like bioswales and permeable pavements, this ebook unpacks step-by-step strategies and case studies that show resilient urban design in action.

With practical tools, species recommendations, and evidence-based best practices, this guide empowers city planners, urban foresters, and residents alike to transform their streetscapes. By growing smarter, more diverse, and storm-ready forests, our communities can weather the toughest storms—and emerge more resilient than ever.

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# Understanding the Threat



The 2024 Atlantic hurricane season made one thing clear: hurricanes are becoming stronger, faster, and more unpredictable. Based on research by [NOAA's Geophysical Fluid Dynamics Lab](#), warming oceans are increasing the intensity of tropical cyclones and the proportion of category 4 & 5 storms is expected to rise. The 2024 season saw [34 rapid intensification events](#), nearly double the 10-year average. These rapidly strengthening storms are harder to forecast, and their destructive power often outpaces cities' ability to prepare.

Urban areas face unique risks. With numerous impervious surfaces, aging infrastructure, and vulnerable populations, cities are more likely to experience flooding, power outages, and prolonged public health crises due to tropical storms.

In 2024 alone, [hurricane damages topped \\$500 billion](#), including \$250 billion from Hurricane Helene, making it the costliest single season on record. But the impact goes beyond property loss. Hurricanes increasingly cause long-term ecological degradation, [population displacement](#), and thousands of excess deaths over the following decade.







# The Rising Cost and Impact of Hurricanes

The past five years (2020–2024) averaged nearly [\\$150 billion per year in disaster losses](#), more than twice the historical average. Tropical cyclones are the costliest disaster type in the U.S., with each event averaging \$23 billion in damages. Coastal communities face the greatest risk, with over \$2.2 trillion in coastal property exposed to potential storm surge.



Environmental losses are equally steep. Intensifying storms drive coastal erosion, wetland loss, and habitat degradation. They also increase the spread of invasive species, disrupting fragile ecosystems already under stress from development.

For residents, the 2024 season alone caused over 230 hurricane-related deaths. Research suggests each major hurricane contributes to 7,000–11,000 excess deaths over the following 15 years. These impacts fall disproportionately on low-income households, seniors, and marginalized communities, who often lack the resources for preparation or recovery.





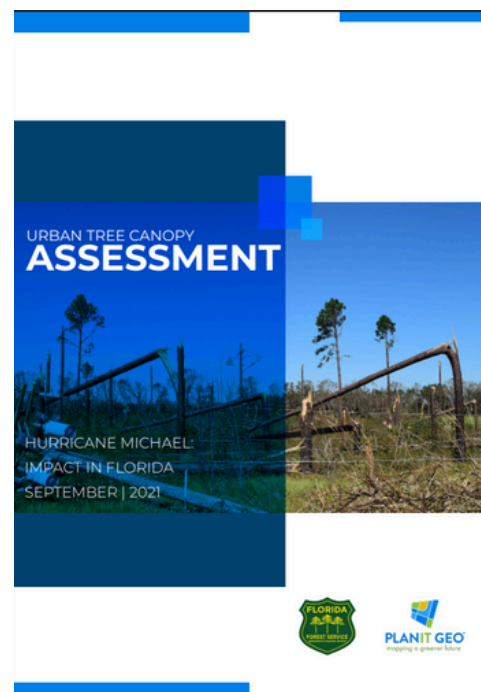


# The Role of Urban Forestry in Storm Resilience

[Urban trees can contribute to mitigating stormwater runoff from hurricanes and tropical storms.](#) Through rainfall interception, evapotranspiration, and soil infiltration, [trees help cities absorb more water where it falls and reduce runoff volumes.](#)

According to research from the USDA Forest Service, urban tree canopy can reduce annual runoff by 2–7%. In a single growing season, one mature tree can prevent over [6,000 liters of stormwater](#) from entering drainage systems, translating directly into infrastructure savings and reduced flood risk.

These strategies became essential in the aftermath of Hurricane Michael, a 2018 Florida Category 5 storm. In Bay County, over 80% of the tree canopy was lost. [A canopy change analysis](#) conducted by PlanIT Geo compared pre-storm (2017) and post-storm (2019) imagery to quantify the loss and guide recovery efforts. This data-driven approach helped the region understand its losses and prioritize replanting efforts, directing resources to neighborhoods with both the most significant losses and the highest social vulnerability.



[Urban Tree Canopy Assessment, Hurricane Michael: Impact in Florida](#) from PlanIT Geo

## A Few Proven Storm Resistant Trees



*The Sand Live Oak*



*Kentucky Coffee Tree*



*American Sweetgum*



# Planting Smarter with Storm-Resistant Species

Choosing the right tree species can significantly increase the resilience of urban forests during high-wind events. Researchers at the University of Florida IFAS Extension have [identified tree species with high wind resistance based on extensive post-hurricane studies](#). To name a few, Live Oak and Sand Live Oak top the list due to their strong structure and salt tolerance. Sabal Palm showed a 90% survival rate during Hurricane Andrew, thanks to its flexible trunk and self-pruning crown. Bald Cypress and Southern Magnolia also rate highly due to their shape and dense wood.

*At Right: This large oak along Highway 90 in Mississippi with stood Katrina in 2005 and still stands along the gulf coast.*



**To guide planting, communities can use the [ETCHR tool](#), which provides storm resilience scores for over 400 tree species.**

Communities can use ETCHR to:

- Assess their current tree inventory: By inputting their local species list, communities can estimate what proportion of their urban forest consists of species rated as Lowest, Medium Low, Medium High, or Highest for wind resistance.
- Set planting goals: The tool helps set targets for increasing the proportion of wind-resistant species in the community, guiding future planting to enhance storm resilience.
- Select species for new plantings: ETCHR provides storm resilience (wind resistance) scores for hundreds of species, enabling planners to recommend or prioritize trees most likely to withstand hurricanes and tropical storms.
- Prioritize risk management: The tool can identify species at greater risk of storm damage, allowing communities to focus pruning, maintenance, or replacement efforts where they are most needed





# Integrating Urban Forestry with Green Infrastructure

Integrating urban forestry with green infrastructure creates a powerful synergy for resilient, sustainable cities. Tree canopy alone provides substantial benefits—such as shade, air purification, and habitat—but its impact is amplified when combined with engineered solutions like bioswales, rain gardens, and permeable pavements.

## Case Study: Lancaster, Pennsylvania

[A leading example of this integration is Lancaster, Pennsylvania.](#) The city's innovative green infrastructure plan strategically combines trees, bioswales, permeable pavement, and other nature-based solutions to manage stormwater. As a result, Lancaster captures and treats approximately 1 billion gallons of runoff each year, significantly reducing the burden on traditional “gray” infrastructure, such as pipes and treatment plants.

- **Permeable Pavement:** EPA studies show that permeable pavement systems can reduce stormwater runoff rates from 90% (traditional pavement) to just 30%. This allows more water to infiltrate the ground, replenishing aquifers and reducing urban flooding.
- **Bioswales and Bioretention Cells:** These landscaped features channel and filter stormwater, lowering peak flows by 60–70% and removing harmful pollutants such as oils, heavy metals, and nutrients before they reach local waterways.
- **Economic Impact:** Lancaster's green infrastructure approach is projected to save the city \$120 million in avoided gray infrastructure costs and generate \$5 million annually in public benefits, including improved air quality, increased property values, and enhanced urban aesthetics.



*Bioswales are a form of green infrastructure that effectively manage stormwater runoff during storms.*

For the 25-year green infrastructure scenario, the avoided capital cost of implementing gray infrastructure is \$120 million, and the avoided operational cost is \$661,000 per year.

*-The Economic Benefits of Green Infrastructure, A Case Study of Lancaster, PA*

## Why Integration Matters

- Amplified Benefits: Trees intercept rainfall, slow runoff, and improve soil infiltration. When paired with bioswales or permeable surfaces, they further reduce the risk of flooding and water pollution.
- Resilience: Integrated systems are more adaptable to extreme weather, helping cities cope with heavier storms and changing climate patterns.
- Community Value: Green spaces provide recreation, improve mental health, and boost neighborhood appeal—all while working “behind the scenes” to manage water sustainably.

**2-7%**

Tree canopies can reduce annual runoff by 2-7% - Arbor Day Foundation

**100 gal.**

A single tree can store over 100 gallons of water during a storm event - Arbor Day Foundation

**\$58 Mil**

saved by Portland by integrating trees and green infrastructure into stormwater management - University of Florida

**\$250**

Just three well-placed trees can save a household \$100-250 in annual energy costs - Arizona.EDU

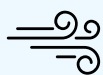






# Key Recommendations

## for Hurricane and Tropical Storm-Resistant Urban Forests



### Select Wind-Resistant Tree Species

- Plant wind-resistant, locally adapted tree species.
- Use wind ratings to guide species selection and planning.



### Plant Trees in Groups

- Plant trees in clusters with shared root space to boost hurricane survival and wind protection.



### Ensure Adequate Root Space and Health

- Ensure enough soil space for strong, stable root growth.
- Prevent root damage during construction to reduce storm failure risk.



### Implement Preventive Pruning Programs

- Regularly prune young and mature trees to remove weak branches, co-dominant stems, and dead wood, reducing wind resistance and breakage risk
- Preventive pruning should be a multi-year objective in urban forest management plans.



### Maintain Species and Age Diversity

- Plant diverse trees (species, ages, layers) to lower storm and pest risks.
- Boost diversity to strengthen forest resilience and ecosystem health.



### Strategic Urban Design and Placement

- Match trees to site conditions and avoid risky planting locations.
- Include trees in urban planning and disaster risk strategies.



### Post-Storm Recovery and Restoration

- Set clear goals for post-storm tree restoration, including pruning and hazard removal.
- Identify safe zones for debris and temporary housing to protect surviving trees.



### Community Engagement and Planning

- Engage the community in creating and supporting urban forest plans.
- Form diverse working groups for ongoing forest planning and review.



# The Path Forward: Embracing Urban Resilience

In an era of intensifying hurricanes and accelerating climate uncertainty, the lessons from recent storm seasons are undeniable: resilience is essential. As detailed in this guide, urban forestry stands as a frontline strategy for transforming cities from vulnerable targets into adaptable, thriving ecosystems. By understanding local risks, investing in wind-resistant species, keeping tree canopies healthy, and integrating nature-based solutions like bioswales and permeable pavement, cities can reduce flooding, limit environmental damages, and foster equitable recovery—while also enriching daily urban life.



Building a resilient city is a long-term commitment that begins with community engagement and data-driven planning. The path forward relies on collaboration among residents, local governments, planners, and tree care professionals to implement the proven strategies outlined in these pages. As the frequency and severity of storms rise, so too must our commitment to growing robust, diverse, and climate-adapted urban forests. With every tree planted, every group of volunteers mobilized, and every new layer of green infrastructure, we are not just preparing for the next hurricane—we are investing in safer, healthier, and more vibrant communities for generations to come.

## About PlanIT Geo

Since 2012, PlanIT Geo™ has provided cutting-edge technology and planning services globally for urban forestry, parks management, and arboriculture. Our TreePlotter™ Software Suite and expert team of **GIS specialists** and **consultants** are ready to help your community acquire canopy data and turn those insights into customized policy recommendations. If you would like to know more about our urban forestry software or services, please explore **our website** and feel free to **send us your questions**.