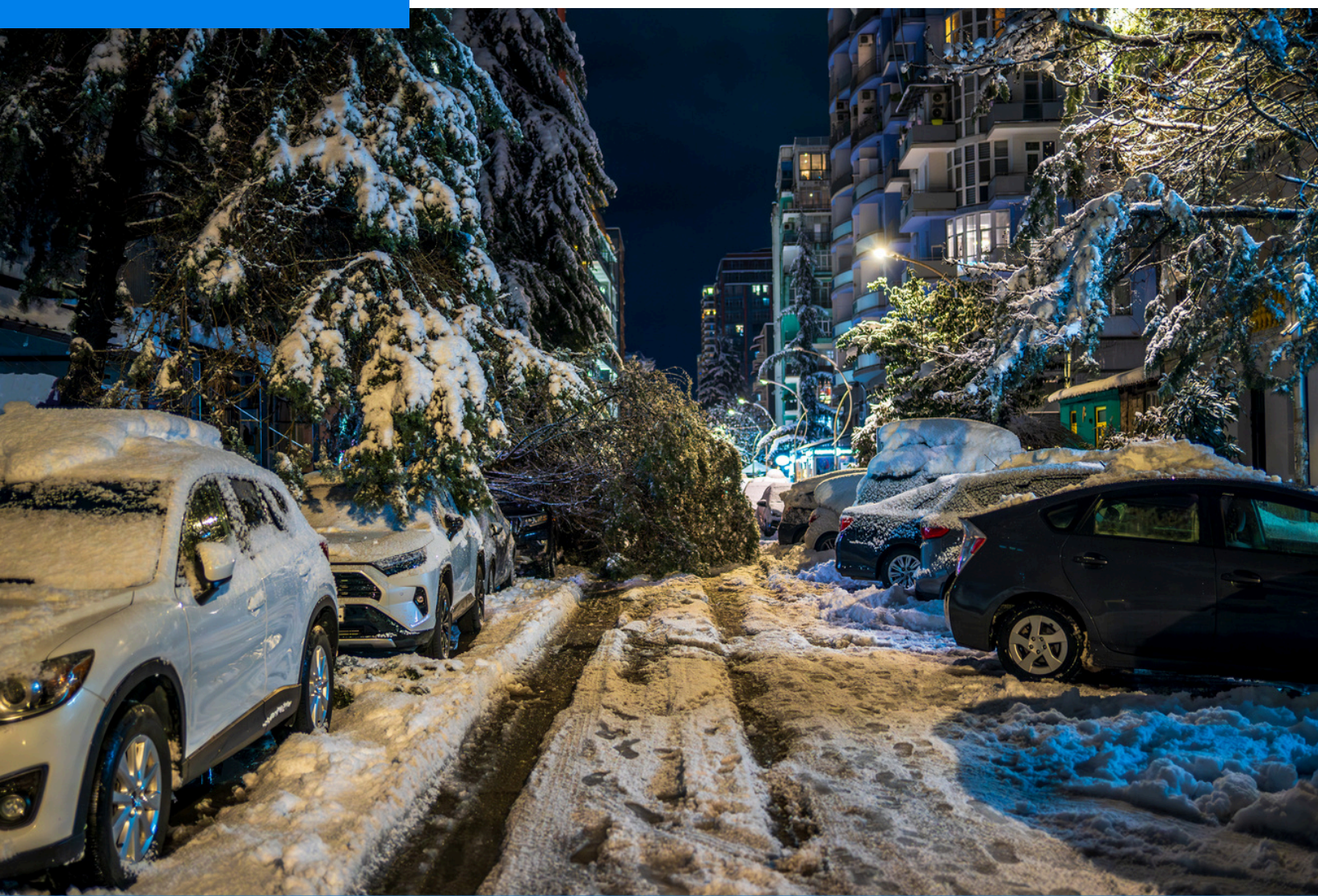


# WEATHERING WINTER: BUILDING STORM- RESILIENT URBAN FORESTS



How Proactive Tree Management Saves Cities Money,  
Protects Infrastructure, and Safeguards Communities

# WINTER STORMS AND URBAN FORESTS

Winter storms are among the most disruptive weather events for cities, causing damage to infrastructure, straining ecosystems, and threatening public safety. As climate change warms winter temperatures, the atmosphere also warms, increasing the air's capacity to hold moisture and resulting in more evaporation and heavier precipitation. This added heat and moisture energize storm systems, leading to more frequent and intense winter storms. The result? Heavier snowfalls, more frequent icing events, and sudden temperature swings now pose significant challenges for even the most prepared urban areas. Prolonged cold snaps are becoming less common. However, unpredictable winter weather that brings rapid shifts between freezing and thawing continues to increase risks to infrastructure and public safety.

Cities are seeking effective strategies to manage these escalating winter risks and protect critical infrastructure.

An urban forestry strategy built on proactive maintenance, smart species selection, and integration with green infrastructure stands out as one of the most cost-effective defenses against winter storm impacts. Trees act as natural windbreaks, reducing wind speed and protecting buildings from blowing snow. Their canopies intercept snow and ice, minimizing buildup on roads and sidewalks and lowering slip hazards. By slowing the wind and moderating temperatures, trees also help shield infrastructure from rapid freeze-thaw cycles that can cause pavement damage.

As snow and ice melt, tree roots and the surrounding soil structure improve the infiltration of meltwater into the ground. This process reduces surface runoff, helps filter out pollutants before they reach waterways, and lessens the burden on urban drainage systems. Trees also stabilize soils, minimizing erosion during snowmelt or winter rains.

Together, these benefits allow communities to recover more quickly and at lower cost when winter storms hit, while also supporting urban wildlife and maintaining ecological resilience.

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# The Escalating Impact of Winter Storms



## ECONOMIC IMPACTS

- **Energy Reliability:** Winter storms cause nearly [22% of all weather-related power outages in the U.S.](#) During major cold waves, electricity demand can spike by up to 20%, putting immense pressure on already strained grids.
- **Infrastructure Strain:** Damage from snow, ice, and high winds across the U.S. [costs an average of \\$4.3 billion per storm event.](#) These losses are concentrated in urban areas, where dense networks of roads, power lines, and water systems face frequent outages, transportation shutdowns, and costly repairs. Disrupted services, structural damage, and the need to quickly restore vital infrastructure make winter storms a major economic burden for cities each year.





## ENVIRONMENTAL IMPACTS

- **Forest Damage:** Ice accumulation can [fracture branches and uproot trees](#), leading to cascading ecological effects such as habitat loss and increased vulnerability to pest infestations. Storm-damaged trees are more prone to decay and more likely to attract insects and disease, which can further destabilize urban forests.
- **Water Quality Decline:** Melting snow and ice carry accumulated pollutants, including deicing chemicals, heavy metals, hydrocarbons, and nutrients, [into storm drains and local waterways](#). This runoff degrades surface water quality, threatens aquatic life, and harms urban trees and soils when contaminants are absorbed or persist in the landscape.



Researchers at the USDA Forest Service found that U.S. urban forests save \$7.8 billion annually in avoided residential heating and cooling costs and an additional \$3.9 billion in avoided emissions. (2017 USD)

*-5 Benefits of Urban Forests, College of Natural Resources, NC State University*



## SOCIAL IMPACTS

- **Community Displacement:** Severe winter storms can lead to [temporary or prolonged displacement](#). Damage to homes or infrastructure forces families, especially in lower-income areas, to seek shelter elsewhere, which disrupts social networks and limits access to employment and education. Large-scale disruptions can also cause transit closures and create barriers for emergency response, making recovery more difficult for vulnerable groups.
- **Extended Utility Outages:** [Vulnerable neighborhoods](#) are more likely to experience long-duration power outages and delayed recovery of essential services after major storms, compounding risks for health, safety, and access to care. In affected communities, residents may also lose heating, internet, and water services, increasing the strain on households with limited resources.



# The Role of Urban Forestry in Winter-Ready Cities

Trees form a living infrastructure that shields cities from storm damage and accelerates post-event recovery. Through proactive pruning, risk assessment and contingency planning, thoughtful species selection, integration with stormwater systems, robust soil and root zone design, coordinated emergency contracting, and ongoing monitoring, urban forests can dramatically lower cleanup costs, bolster grid reliability, and safeguard community well-being.

## 1) ROUTINE PRUNING

Routine pruning of public trees within a city's jurisdiction is one of the most effective preventative strategies for winter storm resilience. Removing dead, diseased, or weak limbs and following industry standards like ANSI A300 reduces the risk of branch failure and minimizes property damage during storms. This [study](#) supported by the USDA Forest Service describes how regularly pruned trees are more resistant to snow and ice loads (which can increase branch weight by 10 to 100 times) before experiencing crown failure, due to reduced structural weaknesses and decreased ice accumulation surface area. Property owners also play a key role in making their community winter-ready by maintaining private trees and reporting hazards near public spaces. Cities can support residents through outreach, technical guidance, training, cost-share programs, and accessible arborist services. In addition to regular pruning, other essential maintenance includes inspections for disease and decay (see #2 below), mulching for root protection, and strategic removal or replacement of declining specimens.

Pruning practices for public trees should follow ANSI A300 standards, which focus on safety, structural correction, and canopy balance instead of aesthetics. [Maintenance cycles of every ~3-8 years](#) for established street and park trees\* lowers the risk of storm damage by eliminating hazardous branches and improving overall tree health. Consistent care helps reduce emergency response needs and operational costs while supporting healthier, longer-lived urban trees that contribute to citywide winter readiness.

\*Footnote: Effective maintenance cycles depend on the species composition, size and relative age classes, health and condition, and other variables. A study in Milwaukee, WI found that the optimal pruning cycle for street trees is five years, determined by comparing the marginal cost of lost tree value with marginal savings from reduced pruning frequency. Regular cycles maintain tree condition and value most efficiently; as cycles are extended beyond five years, tree condition declines more rapidly than maintenance savings increase (Miller, R. W., Hauer, R. J., & Werner, L. P. (2015). *Urban Forestry: Planning and Managing Urban Greenspaces*, Third Edition.)





## 2) TREE RISK ASSESSMENTS AND RAPID RESPONSE PLANNING

Tree risk assessments and rapid response planning are critical components of making cities “winter-ready” by proactively identifying and managing urban trees most likely to fail during storms. In the U.S., protocols like the ISA Tree Risk Assessment Qualification (TRAQ) standardize the systematic evaluation of tree defects, site conditions, and targets to prioritize mitigation efforts, document findings, and ensure consistency across management teams ([ISA TRAQ Program](#)).

Pre-storm risk assessments and associated management policies allow city departments to identify hazardous trees, schedule timely removals, and coordinate monitoring ahead of forecasted winter events ([USFS Urban Tree Risk Management - Community Guide](#)). Effective data management using up-to-date tree inventories and asset mapping software leads to faster debris cleanup, less staff overtime and emergency callouts, fewer power outages, improved road clearance, and more efficient mobilization of utility and public works crews ([Arbor Day Foundation "When a Storm Strikes"](#)).

Having detailed pre-storm risk data and proactive maintenance means trees are less likely to snap or uproot, reducing costly outages and service disruptions. Post-storm assessments detect delayed hazards, such as structurally compromised trees, pest infestations, or subtle cracks that can lead to future branch failures (for example, after ice accumulates, trees may appear stable but develop decay or structural splits that worsen in thaw cycles).

Other best practices include cross-training response teams, clear protocols for citizen reporting, and timely re-inspections to monitor high-value or high-risk trees after freezing rain or heavy wet snow events. Together, thorough risk assessment and rapid post-storm protocols make cities more resilient, safe, and efficient in their winter storm response ([USFS Urban Forest Strike Teams](#)).

## 3) SPECIES SELECTION AND DIVERSITY PLANNING

Cities can proactively shift vulnerable tree populations to resilient ones by selecting species with flexible branching and durable wood that perform well in urban winter conditions. For example, Amur maple (*Acer ginnala*) is recommended for the Upper Midwest and Northeast, northern red oak (*Quercus rubra*) is suitable across much of the Eastern and Central U.S., and ginkgo (*Ginkgo biloba*) thrives in diverse regions, including the Plains and Mid-Atlantic. In the Southeast and mid-Atlantic, hybrid elms (e.g., *Ulmus* 'Emerald Sunshine'), honeylocust (*Gleditsia triacanthos*), and zelkova (*Zelkova serrata*) are noted for storm resilience and good branching structure. In the Western U.S., California sycamore (*Platanus racemosa*), valley oak (*Quercus lobata*), and London planetree (*Platanus × acerifolia*) are examples of sturdy, storm-tolerant, and well-branched choices. Remember to follow best practices for tree species diversity and site selection in your city's planting plans. Continue reading for more information. (Species recommendations drawn from the USDA Forest Service, Penn State Extension, and UF/IFAS best practices guides)

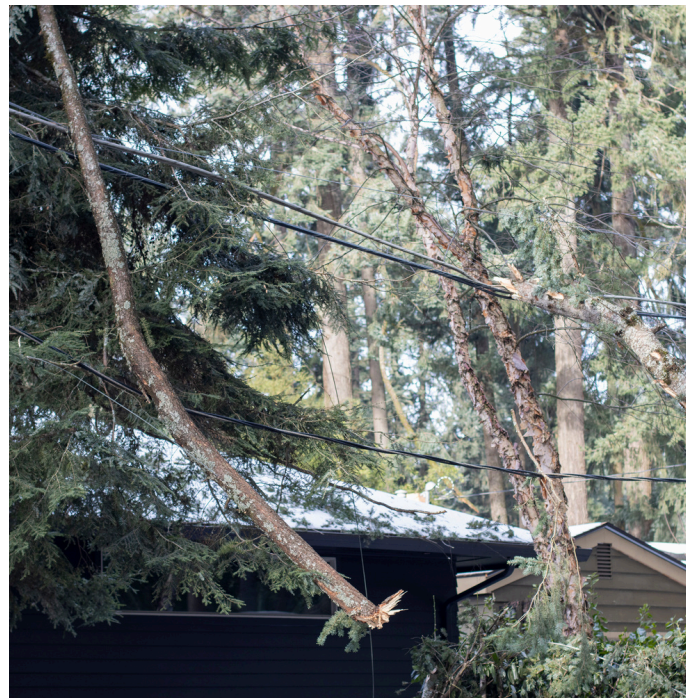




Resources such as the [Arbor Day Foundation's "Right Tree, Right Place" guide](#) advise selecting trees that match local hardiness zones and urban microclimates, incorporating climate-resilient cultivars and species.

Cities should aim for tree populations with [no more than 10% of any one species, 20% of any one genus, and 30% of any one family](#) to buffer against losses from storms, pests, or disease. This rule or principle is recognized as a best practice in several industry resources such as the [Sustaining America's Urban Forests report](#). Adhering to the rule is a critical strategy for maintaining canopy integrity and rapid recovery after winter events.

Diversifying both species and age classes, especially in high-risk settings like streetscapes and parks, gives city managers control over future canopy resilience and reduces the risk of widespread loss from a single event. Careful planning yields safer, healthier, and more adaptable urban forests for winter-ready cities.



#### 4) INTEGRATION WITH STORMWATER MANAGEMENT SYSTEMS

Urban forestry and stormwater systems are interdependent. According to the [EPA's "Stormwater to Street Trees" guide](#), the canopy of trees intercept rainfall and snow, regulate microclimates, and enhance infiltration, easing urban runoff pressure. The larger the canopy, the greater the service.

Integrating tree trenches, rain gardens, bioswales, permeable pavements, and bioretention cells enables urban areas to capture and hold snowmelt, mitigating flooding and improving groundwater recharge. These systems also boost soil aeration and root health, decreasing tree failure rates while helping filter pollutants from runoff.

Coordinated planning among civil engineers, arborists, and landscape architects delivers multifunctional city design that improves water management, public safety, and storm resilience.



## 5) STRUCTURAL SOIL AND ROOT ZONE MANAGEMENT

Healthy root environments anchor trees through high winds and saturated soil. Cities should adopt structural soil systems underneath sidewalks and parking areas—an approach supported by the [USDA Urban Forest Systems and Green Stormwater Infrastructure guide](#).

Amending soils with organic compost and ensuring proper drainage reduces frost heaving and waterlogging, two major contributors to winter tree failure. Municipal specifications for new planting should therefore include subgrade depth allowances, uncompacted soil volumes, and root-directed pavement systems like [Silva Cells](#).

## 6) EMERGENCY COORDINATION AND CONTRACTOR PRACTICES

Resilient urban forestry also depends on [rapid mobilization following a storm event](#). The [Alexandria, Louisiana disaster preparedness model](#) highlights the benefit of predefined contractor agreements, internal protocols for debris removal, and clear responsibilities for tree stabilization and hazard response.

Including private arborists via on-call contracts ensures hazardous removals receive immediate attention, reduces risks of secondary accidents, and supports FEMA reimbursement eligibility.

Collaboration and communication between city staff, contractors, and utility crews is essential for swift, safe response. Integrating urban forestry disaster planning with broader municipal emergency plans, investing in cross-training and drills, and establishing prioritization protocols (such as clearing roads first) all contribute to more efficient cleanup, better service restoration, and stronger citywide resilience.



## 7) CONTINUOUS IMPROVEMENT AND MONITORING

Long-term resilience doesn't stop at cleanup. Tree performance data captured through citywide inventories and [GIS-based canopy assessments](#) guides future species selection and resource allocation. Tools such as TreePlotter™ and the precursor to this eBook, [Urban Forestry and Storm Resilience 101](#), provide frameworks for adaptive management and measurable ROI in maintenance budgets.

A robust monitoring system transforms urban forestry from reactive recovery to predictive resilience, ensuring that each storm leaves communities stronger, not weaker.





# Groundwork for Resilience: Soil Health and Structure

## [A Healthy Soil Profile is the Essential Foundation](#)

Urban trees often struggle with clay-heavy, compacted, or poorly drained soils, which restrict root growth and thereby increase the risk of windthrow, uprooting, and ice-related failures. Best management practices recommend a combination of soil aeration, organic mulching, and engineered drainage systems to fortify root zones, improve storm resistance, and support the long-term health and stability of urban trees during severe weather. Proactively investing in soil rehabilitation and [structural soils](#) allows urban trees to develop broader, deeper root networks, resulting in up to [63% greater infiltration and much higher survival rates after storms](#).

By improving soil health, cities can reduce costly replanting and emergency removals caused by storm-related damage while enhancing green infrastructure for more effective stormwater capture and pollutant filtration. Healthy soils support stronger, longer-lived trees and increase resilience to extreme weather events.

## [Living Snow Fences: Nature's Infrastructure](#)

Living snow fences, composed of intentionally designed rows of trees and shrubs along roadways, are some of the most cost-effective and multifunctional storm resilience tools available. According to the [Arbor Day Foundation](#), these plantings intercept and capture as much as 10–12 times more snow than traditional barriers, which translates to lower plowing costs, reduced use of road salt, and enhanced visibility and safety for drivers.

The benefits go beyond storm management: living snow fences also improve local biodiversity, stabilize soils, and increase aesthetic and recreational value. This approach demonstrates the economic and environmental advantages of leveraging [nature-based solutions](#) in urban storm planning where every planted row becomes part of a resilient, cost-saving infrastructure.

For further technical guidance and research on soil management and living snow fence design for storm resilience, explore resources from the [USDA Forest Service Urban Soils Guide](#) and the Arbor Day Foundation's [stormwater tree resources](#).

# Planning for the Winter Storm Before It Starts

Preparation before winter storms is proven to be significantly more cost-effective than post-disaster recovery. Cities that prioritize proactive practices not only accelerate response times, but also realize substantial savings in emergency management and enhance community resilience.



## 1) COMPREHENSIVE TREE INVENTORY

A critical first step is to conduct a [comprehensive tree inventory](#), which provides baseline data on tree locations, size, composition, health, risk zones, and tree ownership / maintenance responsibility. For cities with the resources, on-the-ground field inventories using platforms like [TreePlotter INVENTORY](#) provide the most comprehensive and actionable data— capturing detailed management information about individual public trees. For a broader, more affordable top-down approach, [TreePlotter CANOPY](#) displays overall canopy cover across both public and private land, helping cities to quickly identify high concentrations of canopy cover to provide risk managers and urban foresters with data for winter storm planning. Emerging technologies like [mobile LiDAR](#) now enable public works and planning departments to rapidly map and assess streetscapes, including the size, structure, and health of both trees and built infrastructure.

Access to accurate and up-to-date inventory data allows cities to make proactive plans and respond in real time during winter storms. Knowing a tree's precise location, species, and responsible party (city, utility, or adjacent property owner) is essential for targeted risk reduction before severe weather and for efficiently dispatching crews after a storm. Inventories must be kept current and can serve as a one-stop hub by allowing uploads of photos, contracts, and standard operating procedures for reference during emergencies. Work orders, service requests, and reporting are easily integrated into these software platforms or with in-house GIS, providing a streamlined and coordinated response for winter-ready urban forestry.



## 2) HIGH-RISK TREE MANAGEMENT PLANS

Tree Risk Management Plans that address high-risk trees are essential for identifying management strategies for trees near power lines, hospitals, transit corridors, and emergency routes. Using GIS mapping and risk index models, these plans allow teams to prioritize urgent mitigation actions where damage would most disrupt emergency services and public safety. Collaboration with local emergency management departments should occur yearly to ensure that tree care and failure prevention are integrated into the broader disaster response strategy in these priority areas.

### 3) PRE-STORM DEBRIS MANAGEMENT CONTRACTS

Pre-storm debris management contracts and organized vendor networks are another best practice. These arrangements allow municipal crews and private arborists to rapidly mobilize for hazardous removals and debris clearance, cutting delays and reducing procurement expenses.

#### 4) CLEAR PUBLIC COMMUNICATION AND COMMUNITY ENGAGEMENT

Finally, clear public communication and active community engagement such as sharing planned inventory work, ecosystem benefit reports, and educating residents about tree risk and local [tree risk management policies help foster trust and unlock valuable citizen support](#) for urban forestry investments. Two-way engagement, where residents can report issues, request services, or offer feedback, builds a shared sense of stewardship and better prepares communities for both proactive planning and post-storm response.



# Post-Storm Recovery and Replanting

Effective post-storm recovery begins with safety assessments and staged cleanup, prioritizing the rapid clearance of roads, transit corridors, and utility areas to restore essential services and minimize hazard exposure. Urban forestry teams often deploy trained arborists for [Level 1 Rapid Assessments](#) which are quick windshield surveys that identify high-risk trees and guide initial interventions. This step should be documented and coordinated with local emergency response plans and protocols.

**Digital tree management platforms** and updated [tree inventory mapping](#) ensure that every dollar invested in post-storm recovery yields measurable improvements. These solutions help track storm mitigation practices (e.g., restoration pruning), new plantings, maintenance needs, and monitor the overall recovery trajectory so that data-driven strategies continually strengthen community resilience.

Additionally, communities should **leverage GIS-based canopy change tools**, such as [TreePlotter CANOPY](#) or the [Arbor Day Foundation's national canopy assessment tool](#), to precisely document tree and canopy loss using imagery before and after an event, and to prioritize replanting initiatives in the most underserved or storm-damaged neighborhoods. High-resolution imagery and annual reassessment allow cities to accurately measure recovery progress and address equity gaps in canopy coverage.



Urban tree programs deliver benefits that consistently outweigh their costs. In five western U.S. cities, for every dollar invested in management, benefits returned annually ranged from \$1.37 to \$3.09, with savings from energy, air quality, water, and property values surpassing all expenses for maintenance and planting.

*[The Cost-Benefit Approach to Urban Forests: A Western Analysis](#)*

**Diverse replanting strategies** using native, climate-adapted, and structurally resilient species are essential for long-term storm resistance and faster ecological recovery. Many best practice programs also incorporate phased restoration such as “reforestation hubs” reusing downed wood for park assets or community projects, maximizing both environmental and economic gains.



# The Economic Power of Preparation

Every dollar invested in a proactive urban forestry program yields an estimated \$3–5 in savings on reactive costs after a storm (“[The Cost of Not Maintaining the Urban Forest](#)”, Hauer et al.). Some recent benefit-cost analyses show every dollar invested in preparedness and climate resilience can save communities \$13 in economic impact, damages, and cleanup costs ([U.S. Chamber of Commerce, “The Preparedness Payoff: The Economic Benefits of Investing in Climate Resilience”, 2024](#)). These savings come from fewer property losses, lower infrastructure damage, reduced emergency debris clearing and overtime costs, and the overall stabilization of city services. Cities that maintain robust tree care programs, plan ahead for risk, and prioritize regular maintenance not only protect budgets, they preserve public health and retain jobs.

## DIRECT ACTION STEPS FOR MAXIMIZING ECONOMIC IMPACT

1

**Implement routine, data-driven tree maintenance:** Schedule cyclical pruning, health monitoring, and risk assessments for all municipal trees. Use platforms such as [TreePlotter™ INVENTORY to streamline inspections](#) and optimize maintenance cycles.

2

**Leverage partnerships and community groups:** Engage nonprofits, advocacy organizations, and local agencies for shared resources, technical expertise, and cost-sharing, amplifying the impact of each dollar invested ([Urban Forestry Program Planning](#), [Federal Urban Forestry Funding](#)).

3

**Prioritize updates to urban forest management plans:** Keep inventories, protocols, and policies (e.g., risk tree policies, emergency response, debris management) current to account for recent planting, removals, or emergency events. Reference step-by-step guides for adaptive management such as [PlanIT Geo’s Urban Forestry Program Planning](#).

4

**Secure pre-storm debris management contracts and vendor agreements:** These enable rapid mobilization, streamlined FEMA reimbursement, and lower emergency procurement costs, as documented in [federal best practices](#).

By following these steps, cities not only reduce storm-related expenditures but also unlock national and state funding, minimize risk and reduce property losses, expand job opportunities, and support climate adaptation goals. The financial case for urban forestry is clear: proactive investment builds lasting economic, community, and environmental resilience.

# The Path Forward



Planting a diverse urban forest that includes trees resistant to ice storms and performing regular tree maintenance to avoid or remove structural weaknesses will reduce damage caused by severe ice storms. While we cannot stop ice storms from occurring, we can take steps to reduce the impact of this major forest disturbance on urban forests and the interface between forests, buildings, and infrastructure.

*-The Development of Ice Storm-Resistant Urban Tree Populations, USDA Forest Service*

Winter storms are growing fiercer, longer, and less predictable, a fact that urban leaders can no longer afford to ignore. The losses in dollars, infrastructure, and human well-being from inaction are staggering and mounting each year ([FEMA disaster resilience cost-benefit analysis](#)). A reactive approach to winter storms places even greater strain on city departments that are already contending with budget cuts, staffing shortages, outdated equipment, and responsibilities that extend well beyond their original job descriptions. This constant cycle of crisis response can stretch already limited resources to the breaking point and limit progress on proactive, long-term management goals. But while the storms themselves are inevitable, the scale of their destruction is not. Your choices today directly determine how your city weathers tomorrow's disasters.

This inflection point demands immediate, coordinated action. Delaying risk assessments, neglecting tree maintenance, or under-investing in soil and plant health will amplify future crises that will turn short-term savings into catastrophic long-term costs. Conversely, every investment in proactive pruning, high-quality urban tree inventories, and multi-agency response planning directly averts financial and community losses before the next storm event takes shape.

Urban foresters, risk managers, planners, city officials, and their partners must treat winter storm preparation as urgent climate infrastructure on par with roads, power, and emergency response. By embracing best practices, science, resilient species selection, robust public engagement, and smarter funding mechanisms, cities transform their forests into frontline defenders for public health and economic security.





Now is the moment to act. With every public tree mapped and assessed, every tree planted strategically, and every decision driven by data and collaboration, communities take a concrete step toward breaking the cycle of loss and beginning a legacy of resilience. The stakes are high, but so are the rewards of a future where preparation today ensures lives, livelihoods, and green spaces will persist for generations to come.

**WINTER STORMS ARE UNAVOIDABLE.  
THEIR DAMAGE IS NOT.**

Download the full ebook here



## About PlanIT Geo<sup>TM</sup>

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 arborists and consultants are ready to help your program become more proactive. 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.