Preparing Minnesota for Climate Change: A Conference on Climate Adaptation – 11/7/2013
Science Museum of Minnesota
Saint Paul, Minnesota

Adapting to Urban Ecosystem Changes: Urban Forestry Issues

Climate changes have challenged urban forest health and condition in three primary ways: 1) more frequent and violent loading events such as wind storms, ice storms and snow storms; 2) warmer temperatures at night that don't allow plants to fully recover from heat/drought stress during the daylight hours, and 3) short or long-term drought events during the growing season. All of these conditions predispose urban trees and urban forests to more problems that normally would not be a problem for healthy trees and forests.

In the upper Midwest, the three most common loading events (in order) are wind, ice and snow. A loading event is a natural weather event that places an extraordinary amount of weight/pressure on a dynamic system, like a tree.

Most Common Loading Events

1. Wind
   - Thunderstorms (30 mph+)
   - Straight-lined Winds (65 mph+)
   - Tornados (65 mph+)

Beginning at about 30 mph, wind loading events can cause tree failure or some degree of damage. This is compounded when the wind loading event includes the weight of rain.

Most Common Loading Events

2. Ice

Worthington, 2013

Duluth, 2009

Ice loading events begin to cause damage when the thickness of the ice on the trees reaches 3/8 inch or more. More damage with less ice can occur if it includes a wind loading event. In Minnesota, the most common areas of ice loading events includes the Northshore and southwest Minnesota.

Snow loading events tend to be problematic when they occur early or late in the season, when the snow tends to be heavier than normal. Snow loading events are also exacerbated by winds.

Urban Trees Predisposed to Loading Events

- Poor Architecture
- Dysfunctional Root Systems
- Decay

Trees that are inferior in architecture and stability are more likely to fail during these loading events.

The most common architectural features that lead to higher frequencies of failures during loading events are multiple leaders (codominant) as shown on the left, or included bark branch attachments, shown on the right.

Dysfunctional root systems, either smaller than normal as in this narrow boulevard setting, or those that grow up and around tree trunks and eventually compress and girdle them, account for the majority of tree failures that are total failures…the entire tree goes down. Note that the trees in the photo to the left that aren't in boulevards seemed to have escaped damage.

Decay

Note in these scenes, most of the damage occurred to trees near infrastructure. The presence of decay is the most common, pre-existing condition that was associated with tree failure during loading events, regardless of species.

Hot temperatures during the day cause plants to transpire (lose moisture) more in an effort to keep the leaves cooler. Normally, the trees recover during the night when temperatures are cooler and the trees can actively take up and store water.

When trees can't take up enough water during the day to fulfill the demands of transpiration, they shut down photosynthesis…they take a siesta until it cools off at night.

When trees take a siesta, the stomata close and they wilt…and stop photosynthesizing until normal water is built back up in the tree's system.

During the cooler evening hours, the trees continue to take up water until finally they are able to fully hydrate, open up the stomata, the leaves become turgid and open again and photosynthesis resumes…right about daybreak.

Recovery Potential

Trees in hostile, unusually hot sites never are allowed to cool off normally at night and so begin their next photosynthetic day later than healthy, normal trees growing in a good environment.

Recovery Potential

Surrounded by pavement and existing in a wind tunnel, these trees will always find it more difficult to recover during the night in a timely manner. As photosynthesis continually is compromised, so is the overall health of the trees.

As the trees continue into a decline in energy reserves due to the restricted photosynthesis, they become more vulnerable to normal stresses and tend to die back or die sooner.

Drought events can be restricted (summer), seasonal (spring through autumn), or chronic/extended, happening every year or for multiple growing seasons.

The summer of 2012 offered up a stressful growing season in terms of water management.

Repeated years of seasonal drought in these western Minnesota landscapes have set these trees up for an early death, usually due to other factors such as insect damage or opportunistic diseases.

Chronic drought-like situations are those that cause a water stress every day of the year, primarily due to the way the soil or soil volume or care of the trees is compromised. Small root volumes (rhizosphere volumes) dry up faster and rarely hold a mature and large tree upright.

∑ Climate-Challenges Exacerbated by

- Poor Species Selection
- Inadequate Maintenance
- Inadequate Rhizosphere Volume

Without proactive management practices such as matching the best trees to a site, spending some time and dollars to make certain they develop into structurally sound trees, and allowing for a normal amount of root growing space below ground, climate challenges will continue to weed-out certain species.

Midwest Maple Moratorium Movement

For at least 10 years, no more planting of forest-loving tree species, such as sugar maple in harsh, urban environments with little soil volume.

Increase the maintenance of trees, especially up to 15 years of age. These are the formative years and the years that will determine how well the trees will grow and thrive.

Give the roots 2 cu ft of rhizosphere environment for each square foot of canopy spread. This is a minimum requirement for healthy root systems and healthy trees.

Gary Johnson
University of Minnesota
Department of Forest Resources

www.trees.umn.edu

Gary's Notes