Natural Resources Canada
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The cooling effect of urban trees

CANADIAN FOREST SERVICE SCIENCE-POLICY NOTE

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Summary

Climate change has increased temperatures globally, resulting in more extreme heat events that affect human health and well-being. Urban areas are more vulnerable to extreme heat due to the urban heat island effect, where infrastructure and a lack of green space cause cities to become warmer. Urban heat disproportionately affects low-income, racialized populations. Turning up "nature's air conditioning" by strategic planting, tree protection, and ensuring trees grow to maturity can mitigate urban heat and locally decrease air temperatures by 3 °C to 6 °C in summer.

Trees reduce heat in urban areas by providing shade and through evapotranspiration

What is an urban forest?

Urban forests are the trees, forests, and associated organisms that grow near buildings and in gardens, green spaces, parks, and golf courses located in villages, towns, and suburban and urban areas. Urban trees play an important role in cooling urban and outdoor environments and provide co-benefits to humans through improved stormwater management and water quality, reduced air pollution, and reduced building energy use.

What is the urban heat island effect?

Urban heat islands develop when natural landscapes are transformed into urban landscapes dominated by built materials (e.g., concrete, asphalt). These materials temporarily absorb and store heat from solar radiation, increasing the air temperature when released into the atmosphere, usually in the evening following a hot day. The structure of the urban environment (physical size, number, and positioning of buildings) can create a heat trap, preventing heat from escaping the city.

Why is tree equity important?

Many cities have an inequitable distribution of urban forests. Low-income and racialized neighbourhoods tend to have less tree cover and are hotter than high-income neighbourhoods. With a reduced ability to find cooling locations both indoors and outdoors, these neighbourhoods are more vulnerable to the effects of heat events.

How do trees cool cities?

With rising global temperatures, Canadians can expect to experience increased likelihood and intensity of being affected by urban heat. Urban trees play an important role in the natural cooling of cities. In urban neighbourhoods with healthy mature trees or with a high canopy cover, local temperatures can drop by 3 °C to 6 °C in summer. They locally cool the ground surface and the surrounding air by providing relief from the heat through shade and evapotranspiration.

Shade

Trees intercept solar energy through their leaves and woody components, blocking incoming thermal radiation, shading built surfaces, and preventing built surfaces from absorbing and reradiating heat. Tree shading contributes the most to local air temperature reduction. Deciduous trees with large leaf surfaces (e.g., maple, basswood) or large crown volume (e.g., elm, oak) provide more shade in the summer and passive heating in winter. Evergreen trees provide shade and protection from wind throughout the year.

Evapotranspiration

Trees transpire water at the leaf surface. The solar energy used to evaporate this water consumes heat energy that would otherwise raise the air temperature and instead cools the leaf surface. Individual trees can transpire hundreds of liters of water per day, and with deeper roots, can maintain their cooling function during heat events. However, under extreme heat conditions, trees need to retain moisture; they prevent their own water loss by reducing or shutting down the evapotranspiration processes. If this occurs, the trees still provide relief through their shade. Trees with a high transpiration rate provide a greater cooling effect in urban areas. For example, riparian tree species (which grow along the banks of bodies of water) such as poplars have a higher transpiration rate than conifers and drought-sensitive broadleaf species because they have physiological characteristics that evolved in areas with better access to water.

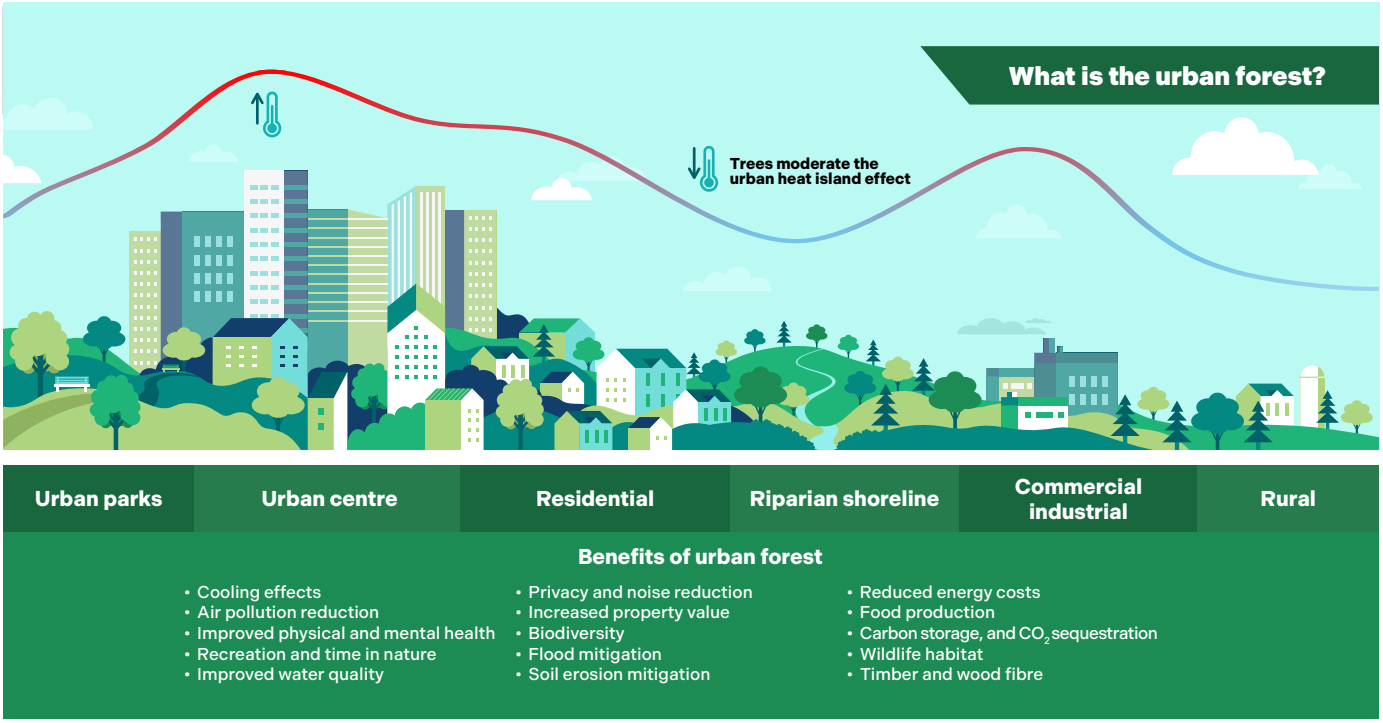

Diagram showing land use types in urban or near-urban areas where trees and forests can grow. Trees in all these land use types encompass an area's 'urban forest'. The quantity of trees influences ambient temperature.

What do communities need to consider when planting trees for cooling?

Trees in urban areas are exposed to various stressors (e.g., compacted or nutrient-poor soils, road salinity, water shortages, space availability, underground utilities). Urban trees that are well-watered will contribute more to cooling due to increased evapotranspiration. Planting the right tree species in the right place and conducting maintenance are key to optimizing tree growth, mitigating the urban heat island effects, and adapting to climate change. Protecting and maintaining mature trees is also essential to maintaining canopy cover.

Care should be taken to avoid planting trees in locations that block ventilation – such as tall trees that block openings between tall buildings – as this can prevent the benefits of cooling summer winds, trap heat from the ground and increase temperatures at night.

Cooling abilities can be optimized by carefully selecting trees based on structure (e.g., leaf and branching structure, rooting system) and traits (e.g., drought, salt, or pollution tolerance), since these influence the tree's ability to mitigate urban heat. Native species are preferable, as they support urban biodiversity. More information on tree planting and maintenance can be found at Tree Canada's Compendium of Best Urban Forest Management Practices.

Canadian Forest Service research supporting a healthy urban canopy

The Canadian Forest Service (CFS) is working to support a healthy urban forest canopy by funding science and research that address the many stressors on trees in both urban and forest environments. This includes assessing tree vulnerability to pest outbreaks, developing pest mitigation strategies, identifying wildfire risk and mitigation strategies in near-urban areas, decision and management tools for canopy recovery, and improving tree stock and forest seed genetics. The results of this research can be found on the CFS Publications Database.

Conclusion

In Canada, the duration, frequency, and intensity of extreme heat events are expected to increase over time. Reforestation, species selection, tree preservation, and maintenance strategies, along with sound urban forest management, can increase a community's resilience to climate change and address the negative consequences of increased urban heat, especially those related to health and energy use. Trees are an important tool in lowering temperature in urban areas by increasing shade and through evapotranspiration.

Trees can be strategically planted to protect from summer heat and winter winds, reducing seasonal energy use.

References

1. Bardekjian, A. Compendium of best urban forest management practices. 2nd ed. Tree Canada; 2018. Chapter 9, Maintenance: watering, mulching, fertilizing, cabling, bracing, recognition/removal of hazard trees. https://treecanada.ca/resources/canadian-urban-forest-compendium/9-maintenance-watering-mulching-fertilizing-cabling-bracing-recognition-removal-of-hazard-trees/

2. Meili, N et al. Tree effects on urban microclimate: diurnal, seasonal, and climatic temperature differences explained by separating radiation, evapotranspiration, and roughness effects. Urban Forestry & Urban Greening. 2021;58: 126970. https://doi.org/10.1016/j.ufug.2020.126970

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