Trees Among Us

The Role of Urban Forests in Iceland's Urbanised Landscape

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Introduction

Urban forests are essential to Iceland's green infrastructure, with 95% of the population living in urban areas making Iceland the eighth most urbanised country globally. This research presents the first comprehensive assessment of Iceland's urban forest canopy distribution and structure, revealing heterogeneous tree canopy cover across regions, significant ecosystem service values, and concerning vulnerability in species composition. Despite challenging growing conditions and historically limited forest cover, urban greening initiatives have created substantial tree canopy in many settlements. These urban forests provide vital services including carbon sequestration, air pollution removal, and stormwater mitigation critical factors for population health, environmental quality, and climate resilience. This nationwide assessment establishes foundational parameters for evidence-based urban forestry policy development.

Methodology

National Assessment: Tree canopy data were collected across 99 urban areas in Iceland (2023-2024) using i-Tree Canopy with random point sampling within defined urban polygons. High-resolution Google Maps satellite imagery was classified as "tree" or "non-tree" based on canopy intersection at each point. Following i-Tree Canopy guidelines, a minimum of 300 points were assessed per urban area (averaging 434 points), with sampling continuing until the standard error fell below 2% for statistical reliability[4].

Reykjavik Case Study: A plot-based urban forest assessment was conducted in Reykjavik. The municipality was stratified into neighborhoods, parks, cemeteries, and woodlands. 278 square plots (400m^2 each) were randomly selected and surveyed[3]. All trees within each plot were measured for multiple parameters during the leaf-on period (June-July 2023). The i-Tree Eco software was used to estimate carbon storage/sequestration, pollution removal, and replacement value.

National Urban Tree Canopy Distribution

Analysis of 99 urban areas revealed heterogeneous tree canopy cover (UTC) across Iceland, with significant regional variation. The national average UTC is **9.4%**, with the North-Western region showing the highest coverage at **15%** and the Southern Peninsula recording the lowest at just **1%**. The significant negative correlation between population density and per-capita tree canopy highlights potential environmental equity issues, with residents in densely populated areas having access to less tree canopy per person.

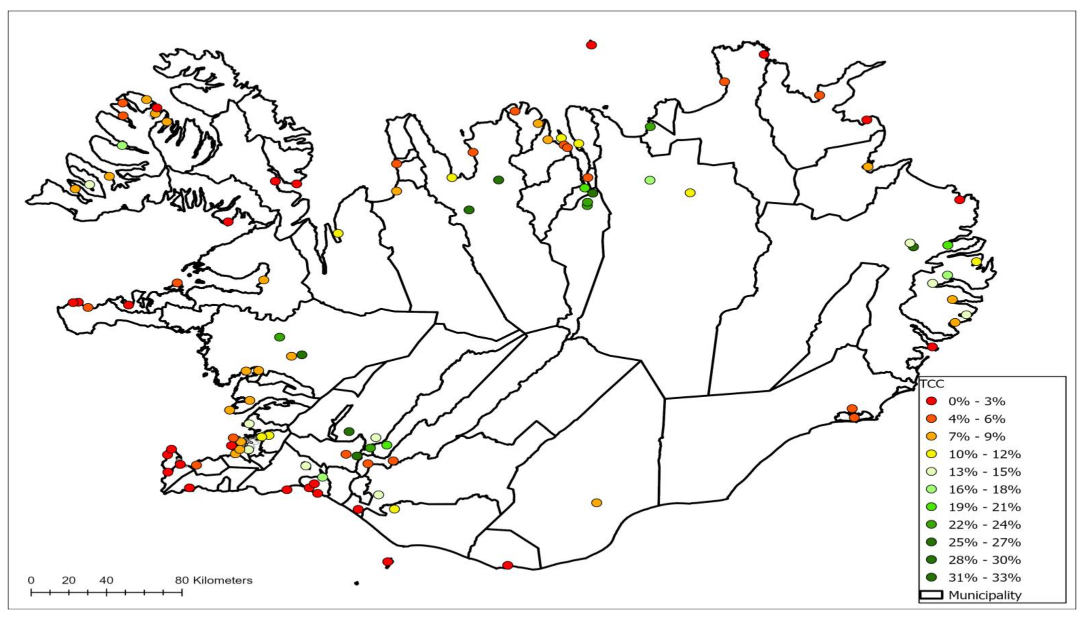

Figure 1: Urban tree canopy cover (UTC) percentages across Iceland

As shown in Figure 1, coastal settlements generally exhibit lower tree canopy coverage compared to inland areas, likely reflecting challenging growing conditions due to exposure to harsh maritime weather. The map reveals clustering of higher canopy percentages in sheltered fjords and inland valleys, particularly in the North-Western and Eastern regions.

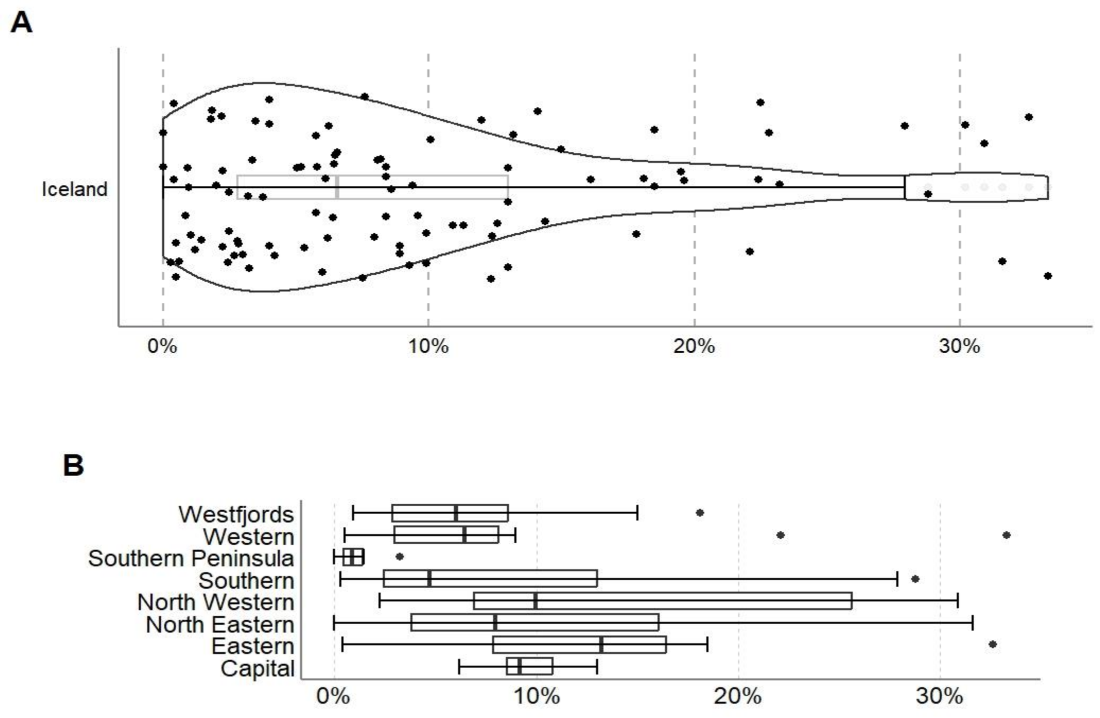

Figure 2: A) Violin plot showing national UTC distribution, B) Box plot showing UTC distribution by region.

Figure 2 illustrates the statistical distribution of urban tree canopy cover nationally and regionally. The violin plot (A) demonstrates that while most urban areas have UTC percentages below 10%, there is a wide distribution with several outliers reaching 20-30%. Regional analysis (B) reveals the Capital region has moderate but consistent coverage, while Northern regions show both higher medians and greater variability.

Ecosystem Services Valuation: Based on our nationwide analysis, Iceland's urban forests provide substantial ecosystem services:

- **268,000 tons (5.3 billion ISK)** Total Carbon Storage
- **15,000 tons/year (294 million ISK/year)** Annual Carbon Sequestration
- **136 tons/year (646 million ISK/year)** Annual Pollution Removal
- **982 million liters/year (226 million ISK/year)** Annual Avoided Runoff

These values demonstrate significant ecological and economic benefits from urban forests, even in Iceland's challenging northern climate, justifying increased investment in urban forestry initiatives.

Reykjavik Case Study

Our detailed assessment of Reykjavik (64°08'N), the world's northernmost capital city, provides valuable insights into urban forestry in challenging northern climates. The city features **8.7%** tree canopy cover with approximately **350,000** trees at a density of **71** trees/hectare.

Urban Forest Structure:

The urban forest exhibits significant disparity, with tree density varying dramatically by land use: woodlands (380 trees/ha), cemeteries (163), parks (89), and residential neighborhoods (49). Reykjavik's forest shows a predominantly young demographic profile, with 74% of trees <30cm DBH (median: 19cm). Canopy cover ranges from 77% in the historic Hólavallagarður cemetery to just 1.4% in the peripheral Kjalarnes neighborhood.

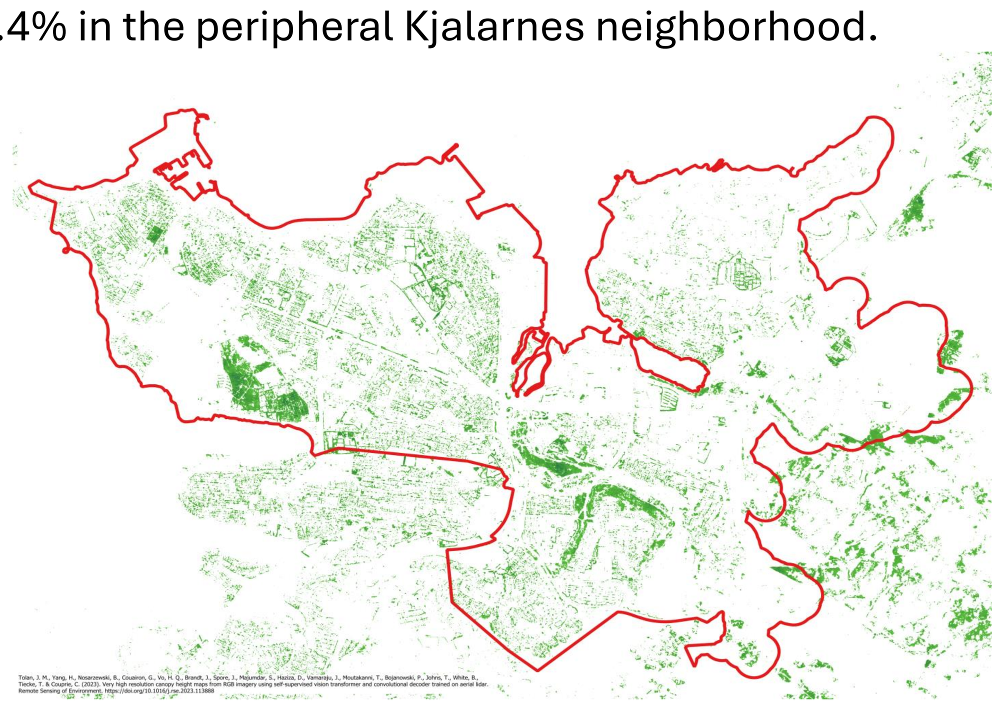

Figure 3: Urban tree canopy cover across Reykjavik

Ecosystem Services: Reykjavik's urban forest provides substantial ecological and economic benefits, including 39,800 tonnes of carbon storage (793 million ISK), annual carbon sequestration of 2,100 tonnes/year (42 million ISK), and air pollution removal of 19.7 tonnes/year (95.4 million ISK). The urban forest's value is further reflected in its 32 billion ISK replacement value (CTLA method), 576 billion ISK amenity value (CAVAT method), and 1.2 billion ISK visual amenity value of woodlands (Helliwell method).

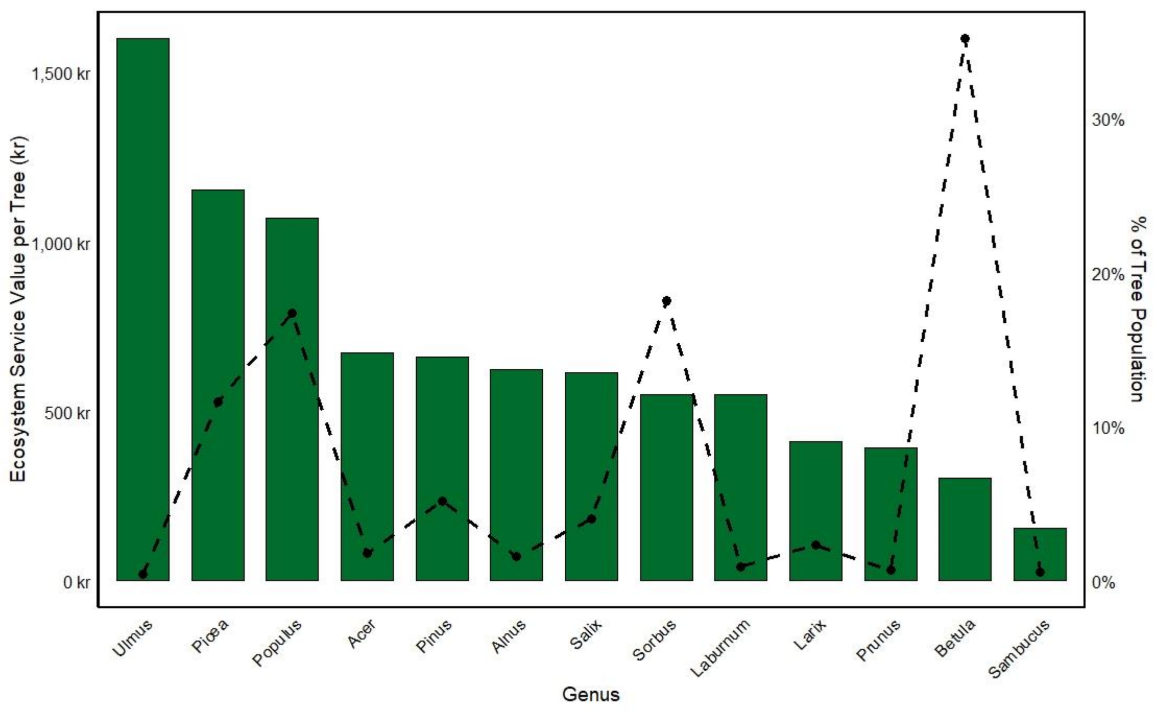

Figure 4: Ecosystem service value and share of population of main tree genus

Species Vulnerability & Adaptation: Species composition analysis across Iceland reveals concerning vulnerability, with just four taxa constituting 78% of Reykjavik's tree population: Betula pubescens (35%), Populus trichocarpa (19%), Picea sitchensis (13%), Sorbus aucuparia (11%) & Other (22%).

Adaptive Potential: While plots captured only 19 species, our field survey noted an additional 50 tree species outside sample plots, predominantly in residential gardens and arboretum. These serve as de facto common garden experiments and assisted migration trials. These existing trials provide urban forest managers with valuable tools to reduce vulnerability to climate change, improve biosecurity, and guide species selection beyond biogeographic origin toward functional traits conferring resilience in warming conditions.

Conclusions & Recommendations

This research establishes foundational parameters for evidence-based urban forestry policy in Iceland and proposes strategic targets for enhancing both canopy extent and functional diversity. We recommend establishing a national urban tree canopy goal of 30% by 2050, requiring approximately 35,000 new trees annually across Iceland's urban areas. Implementing the 3-30-300 rule for all urban neighborhoods (3 trees visible from every home, 30% canopy cover, 300m maximum distance to green space)[2] to enhance environmental equity and ecosystem service distribution.

To address species vulnerability, urban forestry programs should formalize common garden experiments as climate adaptation trials, evaluate promising species from residential gardens and arboreta for municipal use, and diversify species composition following the 10-20-30 rule (no species >10%, no genus >20%, no family >30%)[5]. Future species selection should prioritize functional traits over biogeographic origin to enhance climate resilience.

The substantial ecosystem services documented justify increased investment in urban forestry, even in challenging northern climates. Development of tree protection policies for urban planning and construction is essential to sustain these benefits, particularly as cities like Reykjavik pursue densification strategies to meet climate goals.

Reference

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