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Ottawa Tree Density Analysis – Methodology

OTTAWA TREE DENSITY ANALYSIS - METHODOLOGY
Project 1: City-Managed Tree Distribution Equity Analysis
Analyst: Prosper Ocheme
Date: November-December 2025

1. Project overview

Research question:
I wanted to identify which areas in Ottawa have the lowest tree coverage and could support urban tree expansion. Specifically, where should the City prioritize new tree planting initiatives?

Policy Context
This project addresses some environmental and climate resilience concerns in Ottawa. Climate resilience through urban forests has become important, and a fair tree distribution ensures all residents benefit from environmental services like cooling, air quality improvement, and stormwater management.

Analytical Approach
For tools, I used QGIS and Excel. I used QGIS for spatial analysis and Microsoft Excel for statistical analysis. Both tools were used to show visualization as well. My analysis compared tree density (trees per square kilometer) across all 24 wards to identify areas with significantly fewer city-managed trees than comparable wards.

Key Findings:
I found that rural wards like Osgoode, Rideau-Jock, and West Carleton-March have very low tree density compared to urban and suburban wards. These represent potential priority areas for new tree planting initiatives. Urban core downtown areas and suburban areas like Somerset, Kitchissippi, and Barrhaven East can serve as potential models as they demonstrate achievable targets that could be adapted to improve coverage in underserved rural areas.

A significantly surprising moment for me was the dramatic imbalance Osgoode has only 6 trees per km² while Barrhaven East has 633, a 100-fold difference. I expected rural areas to have fewer street trees, but not this extreme a gap.

2. DATA SOURCES

All datasets used in this analysis came from the city of Ottawa open data portal

Tree Inventory Dataset:
This is the city's tree inventory containing 300,000 records of city-managed trees. This CSV file includes each tree's location coordinates and assigned ward number. The data was in 2018 and was last updated in 2025. The trees in the dataset are on public land maintained by the city of Ottawa. The dataset includes individual tree information like tree diameter, species, address, lot location etc.

Ottawa Ward Boundaries Dataset:
I downloaded the ward boundaries dataset in GeoJSON format. The dataset contains the City of Ottawa's 24 ward polygons that were recently approved by city council on October 13, 2021. Each ward has its own name, number and classification as either urban, suburban, or rural areas

Data Download:
I downloaded both datasets directly from the city of Ottawa Open Data Portal in November 2025. The datasets did not require any significant cleaning before use for analysis.

3. ANALYSIS METHODOLOGY

Software and Tools
I did my analysis using QGIS for all spatial work and Microsoft Excel for statistics and charting. I used EPSG:3857 (Web Mercator) as the coordinate reference system for visualization because it's the standard for web-based maps.

My Analysis Process: Here's how I approached my analysis, step by step.
Step 1: Loading and Preparing Data
I started by loading both datasets into QGIS - the tree inventory file and the ward boundaries. I checked that the coordinate systems were good and verified there were no missing values in the critical fields (WARD numbers, coordinates). Everything looked clean, so I proceeded without needing to clean the data.

Step 2: Counting Trees by Ward
I tried to count trees by spatially intersecting tree points with ward polygons, but this didn't work as the results looked extremely off. So, I used SQL through QGIS's DB Manager to aggregate the tree data. Here's the query I ran:

```
SELECT
        WARD, COUNT (*) as tree_count
FROM Tree_inventory
GROUP BY WARD
ORDER BY tree_count DESC
```

This gave me 24 records showing total tree counts for each ward. I exported the SQL data as tree_counts_by_ward.gpkg so I could join it to the ward boundaries. This SQL method gave me a clearer and more accurate picture

Step 3: Joining Tree Counts to Ward Boundaries
I joined the tree counts data to the ward boundary polygons by using a spatial join on the ward field, and this linked each ward's tree count to its geographic polygon. This contributed to a more accurate analysis and gave a more realistic picture.

Step 4: Calculating Tree Density
I calculated the density of each ward area in square kilometers (converted from square meters). This allowed me to calculate the overall tree density in each Ward.

Tree density: trees per square kilometer (tree count ÷ ward area). This density metric allowed me to fairly compare wards of different sizes

Step 5: Statistical Analysis
This is where I started my statistical analysis to get more insight. I calculated descriptive statistics for tree density across all 24 wards, including mean, median, range, and standard deviation. This revealed the overall distribution patterns and identified outliers.

Step 6: Comparative and Priority Analysis
I used comparative analysis next to get deeper insights on wards specifically. This helped me inform my final decisions, recommendations, and potential prioritization for the city of Ottawa. I compared tree density across ward types (Urban, Suburban, Rural) and ranked all wards by density to identify priority areas. This comparative analysis informed my final recommendations for where the City should prioritize new tree planting.

4. KEY ANALYTICAL DECISIONS & JUSTIFICATIONS

Throughout this analysis, I made several important methodological decisions. Here's why I made each choice.

4.1 Using Density Instead of Raw Tree Counts

Decision: I calculated trees per square kilometer rather than using raw tree counts.

Why I made this choice:
I needed a metric that would reveal actual coverage gaps across wards. When I first looked at raw tree counts, something seemed off - the numbers suggested there were no city-managed trees in Ottawa's urban core downtown, which I knew was false. The problem was that wards vary dramatically in size, from about 13 km² to over 1,500 km². A small urban ward with 5,000 trees could actually have better coverage than a massive rural ward with 10,000 trees.

Calculating density (trees per km²) normalized for area differences, which allowed me to make fair comparisons between wards regardless of their size. For example, Somerset is tiny compared to Osgoode, but density revealed that Somerset actually has much better tree coverage per unit of area.

4.2 Differentiated Targets by Ward Type

Decision: I proposed a target of 50 trees/km² for rural wards versus 266 trees/km² for urban and suburban wards.

Why I made this choice:
Rural wards have fundamentally different land use patterns - primarily agriculture and forest lands - compared to urban areas with dense street networks and residential development. If I applied the urban target of 266 trees/km² to rural Osgoode, it would require planting over 300,000 trees, which is obviously unrealistic and inappropriate for agricultural land use.

Instead, 50 trees/km² represents a 5-fold improvement over the current rural average of 10 trees/km². This provides a meaningful and fair target that addresses equity without wasteful spending on inappropriate planting locations. Rural residents deserve better tree access in village centers and along roadways, but they don't need urban-level density across farmland.

4.3 Using Ward Numbers from Tree Data Rather Than Spatial Intersection

Decision: I used the WARD field already assigned in the tree inventory data rather than performing spatial intersection to determine which ward each tree is located in.

Why I made this choice:
I initially tried to count trees by spatially intersecting tree points with ward boundary polygons, but the results looked extremely off - showing zero trees in several urban wards that I knew had tree coverage. I realized this was because Ottawa redistricted its wards in 2022, while the tree data was collected between 2011-2025 with ward assignments based on older boundaries.

Using the WARD numbers already in the tree dataset proved more reliable. These numbers (1-24) match the current ward system, even though some trees near boundaries might have been assigned under the old system.

Limitation acknowledged:
This approach means a small number of trees near old boundary lines may be counted in different wards than where they're physically located today. However, this doesn't significantly impact the analysis since I'm examining ward-level patterns and relative comparisons, not precise boundary-level tree counts. The pattern of high-density versus low-density wards remains clear and valid for policy recommendations.

5. LIMITATIONS & CAVEATS

Like any analysis, this project has limitations that are important to acknowledge. Here are the key considerations when interpreting my findings.

5.1 Data Temporal Mismatch

The tree inventory data was collected over many years (2011-2025), but the ward boundaries are from the 2022 redistricting. This means some trees near old boundary lines may have shifted between wards during the city's boundary changes. However, this doesn't significantly impact my analysis since I'm examining ward-level patterns rather than precise boundary-level counts. The overall distribution patterns remain valid for identifying priority areas.

5.2 City-Managed Trees Only

My analysis includes only city-managed trees on public land maintained by the City of Ottawa. It doesn't account for trees on private property like residential backyards or private institutional lands. This means my analysis doesn't cover total tree canopy - only the trees the City is directly responsible for planting and maintaining. This is actually appropriate for my research question, since I'm examining equity in City tree planting services, not total environmental coverage.

5.3 Tree Age and Size Not Considered

I didn't consider tree information like age or size in my analysis - I counted young saplings the same as mature 50-year-old trees. This means my analysis may underestimate actual canopy coverage in areas with older, larger trees that provide more shade and environmental benefits. Wards with recently planted trees might show high counts but limited actual canopy coverage currently. A future analysis could incorporate tree diameter data to better estimate canopy coverage.

5.4 Population Density Not Analyzed

I used trees per square kilometer rather than trees per capita (per person). This means high-population wards may serve more residents despite having similar density to lower-population wards. For example, a dense urban ward might need more trees per resident than a rural ward with the same trees per km² but fewer people. Future work could incorporate population data to calculate trees per 1,000 residents for a different equity perspective.

5.5 Data Quality Assumptions

I'm assuming the City's tree inventory data is complete and accurate. I didn't conduct any field verification personally to confirm tree locations or check for missing data. I'm relying on the City of Ottawa's data collection standards and quality control processes. For the purposes of this portfolio project and policy-level analysis, this assumption is reasonable, though on-the-ground verification would strengthen confidence in specific ward-level counts.

7. REPRODUCIBILITY

Replication Steps:

Anyone with QGIS and the source datasets can replicate my analysis by:

1. Loading both datasets into QGIS
2. Running the SQL query documented in Section 3
3. Performing the attribute join on the WARD field
4. Calculating area_sqkm and trees_per_sqkm fields using Field Calculator
5. Running "Basic Statistics for Fields" and "Statistics by Categories" tools
6. Creating graduated symbology for visualization.

All analysis steps are documented in Section 3, and the SQL query is provided.

8. ETHICAL CONSIDERATIONS

This analysis was conducted with the following ethical considerations:

- All data used is publicly available from the City of Ottawa Open Data Portal
- No personally identifiable information is involved in this analysis
- Findings may inform municipal budget allocation and policy decisions

- Recommendations prioritize environmental justice and equitable service delivery across all ward types
- I have no financial or personal interest in the outcomes of this analysis
- This work was completed as an independent portfolio project to demonstrate my GIS and analytical capabilities