Evaluating the Spatial Accessibility of Bike Services in Toronto, ON

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Background

In 2019, the Toronto City Council adopted a net-zero by 2040 climate strategy - TransformTO - which outlines multiple plans to "reduce local greenhouse gas emissions and improve our health, grow our economy, and improve social equity" (City of Toronto, 2021). As of 2020, transportation accounts for 33% of the City's greenhouse gas emissions (City of Toronto 2021). This presents a substantial opportunity for the City to reduce their carbon footprint and reach their goal. Many of the City's strategies and plans (ActiveTO, Vision Zero, etc.) are inherently linked to sustainable transportation methods such as biking, which is widely considered to be one of the most sustainable, healthy, and efficient modes of transportation (Handy et al. 2014; Karanikola 2018; UNEP n.d.). However, marginalized communities have been and are subject to many social injustices, such as lower access to urban amenities (Rigolon and Németh 2021). Consequently, their voices should be amplified, and needs prioritized in the discussion for a sustainable future.

Research Questions

This research project aims to answer the following, with the aims of helping the City to identify underserved communities, given the historical and current socio-environmental context:

1. How are current bike services spatially distributed throughout the City of Toronto and is there a spatial pattern within sociodemographic variables (income, race, etc.)?
2. Does the 10-year bike network plan improve access across Toronto's diverse communities?

Methodology

Using data obtained from the City of Toronto and Statistics Canada's 2021 Census, I calculated the following variables for each census tract in Toronto:

- bike service variables (4):
  - current proportion of centerlines with bike lanes
  - planned proportion of centerlines with bike lanes
  - areal density of bike shops
  - areal density of bike parking
- sociodemographic variables (6):
  - median after-tax income
  - proportion of persons walking or biking as a commute mode
  - proportion of visible minorities
  - proportion of indigenous
  - proportion of immigrants and non-permanent residents
  - proportion of non-citizens

I ran local Moran's I analyses (Queen Contiguity) on the following variables:

- Univariate (4)
  - current bike lanes
  - planned bike lanes
  - bike shops
  - bike parking
- Bivariate (12)
  - current bike lanes **X** all sociodemographic variables
  - planned bike lanes **X** all sociodemographic variables

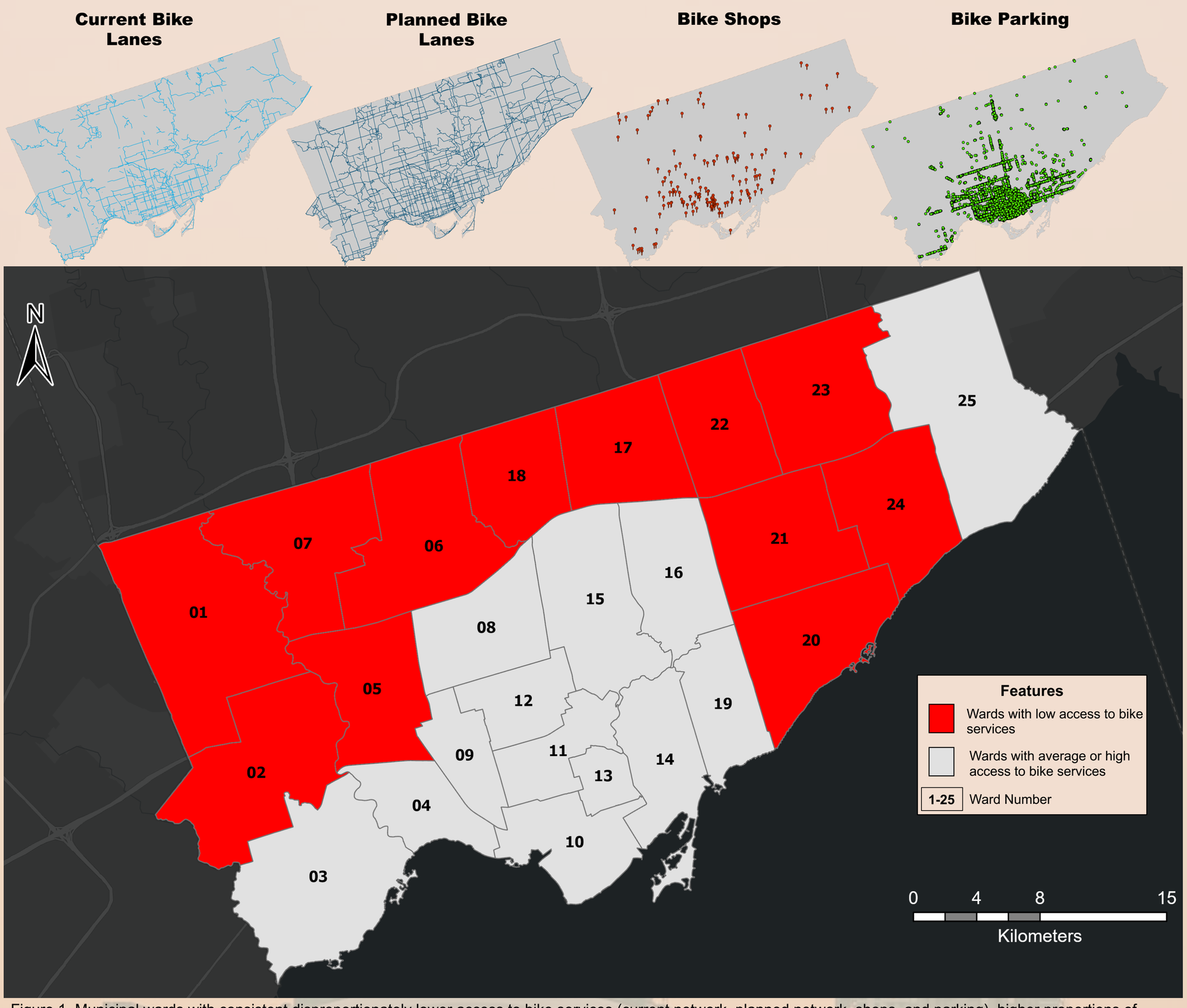

Figure 1. Municipal wards with consistent disproportionately lower access to bike services (current network, planned network, shops, and parking), higher proportions of marginalized communities (visible minorities, low income, immigrants/non-permanent residents), and lower proportions of persons who walk or bike as commute type. Analyses were performed using census tracts but represented in ArcGIS Pro using wards to increase familiarity. Basemap from ESRI, ward boundaries from the City of Toronto (2022).

Main Findings

1. Northwestern and northeastern areas of Toronto have disproportionately lower access to bike services, though the spatial pattern varies depending on the service in question.
2. Areas with disproportionately lower access to bike services correlate with:
   a) Visible minorities
   b) Low income
   c) Immigrants and Non-Permanent Residents
   d) Lower proportions of walk/bike commuters
3. Bike services are mostly clustered in the downtown area of Toronto (wards 10, 11, 13, and 14).
4. The 10-year cycling network plan seems to increase overall relative access to bike lanes for these communities, however local clusters show relatively little change in most categories.

Conclusions and Limitations

This analysis did not look at the quality of bike lanes throughout the study area. The quality of a bike lane has been proven to have a high impact on psycho-physiological responses of cyclists (Guo et al. 2023), with high-quality lanes being associated to lower stress, higher gaze focus, reduced cycling speeds, and higher overall perceived safety. Considering this, it is likely that, whether consciously or subconsciously, a person is less likely to utilize lower-quality bike lanes. Thus, subsequent analyses should incorporate this into the study design.

This study utilized queen contiguity as the spatial weights matrix. However, it may be more informative to increase the number of neighbors utilized, as the goal is to visualize certain clusters based on the mean of a bigger portion (or the entire) of the study area. For example, despite the clear lack of bike shops in northwestern and northeastern parts of the study area, low-low clusters were not prominent, likely due to the weights used.

Recommendations

1. First, invest in a future plan to develop high-quality, accessible, and connected bike services with an increased focus in the highlighted wards. This plan should conclude before 2040 to provide a window for citizens to adapt to the new services and make lifestyle changes if they so choose. The plan should incorporate features to stay on track in order to meet TransformTO net-zero by 2040 goal.
2. Develop programs and incentives to increase bike ownership, rental, and business opportunities to support low-income communities. This will increase equity within Toronto's communities and build towards ActiveTO initiative goals.
3. Additionally, consider converting streets to walkways and bikeways only. Permanent or seasonal street closures improve walkability, local business revenue, and sense of community (Correia et al. 2021). These areas are often hotspots for street festivals, where local artists or businesses can gain exposure. It will also decrease vehicular traffic and help Vision Zero's plan to increase safety in the streets (City of Toronto n.d.).
4. Consider repeating this analysis with the 2026 Census and/or census products (i.e., Canadian Index of Multiple Deprivation) and reconsidering the spatial weights used.

References

Background Image: Wyatt Heiberg/Tandem X Visuals
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