A Methodology to Study Bicycle Activity at Signalized Intersections and its Link to Built Environment, Road and Transit Characteristics, Bicycle Facilities and Weather Conditions

Jillian Strauss – Master's Student

Luis F. Miranda-Moreno – Assistant Professor

McGill University

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Outline

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Introduction and Background

- Active transportation is an essential component of every city’s transportation system

- The use of the bicycle as a mode choice is currently on the rise all throughout Canada

- Cyclist safety is sensitive to bicycle flows with a non-linear relationship – the risk faced by each cyclist declines as the number of cyclists increases – “safety in numbers” effect

Introduction and Background

- Bicycle flows are necessary to provide complete measures of risk exposure
- Many agencies refrain from collecting such data since it is an expensive and time consuming task
- A model capable of predicting bicycle activity is vital since these flows are required for many studies

Literature Review

- In California, 3 studies developed models linking observed bicycle volumes to built environment factors, road characteristic as well as socio-demographic attributes
  - Santa Monica - afternoon bus frequency, land use mix, density of residents under the age of 18 and proximity to the bicycle network
  - San Diego - employment density and the length of nearby multi-use trails
  - Alameda County – commercial retail properties, proximity to a major university, bicycle facility on at least one leg of the intersection, non-hilly terrain and road network connectivity

Literature Review

- There are several gaps in the current literature:
  - Many studies have been interested in pedestrian activity modeling
  - Few studies have investigated the link between built environment and geometric design on bicycle activity
  - Most studies have been based on small samples of intersections and few hours of count data
  - Counts have generally not been expanded to obtain average annual daily values
  - Weather conditions at the time the counts were done have not been accounted for

Objectives

1) Apply a new methodology to account for the effects of weather conditions on bicycle flows

2) Establish and validate a bicycle ridership model to estimate bicycle flows through signalized intersections based on built environment, road and transit attributes, the individual characteristics of each intersection and weather conditions

Conceptual Framework

$$\ln(C_{i,t}) = \alpha + \beta LU_i + \gamma\, TN_i + \phi\, GD_i + \tau\, CF_i + \eta\, W_t + \rho\, \omega_j \bar{C}_j + \delta_t + \varepsilon_{i,t}$$

Where:

Lu_i = Land use characteristics

Tn_i = Urban form and road and transit network attributes

GD_i = Geometric design at the intersection

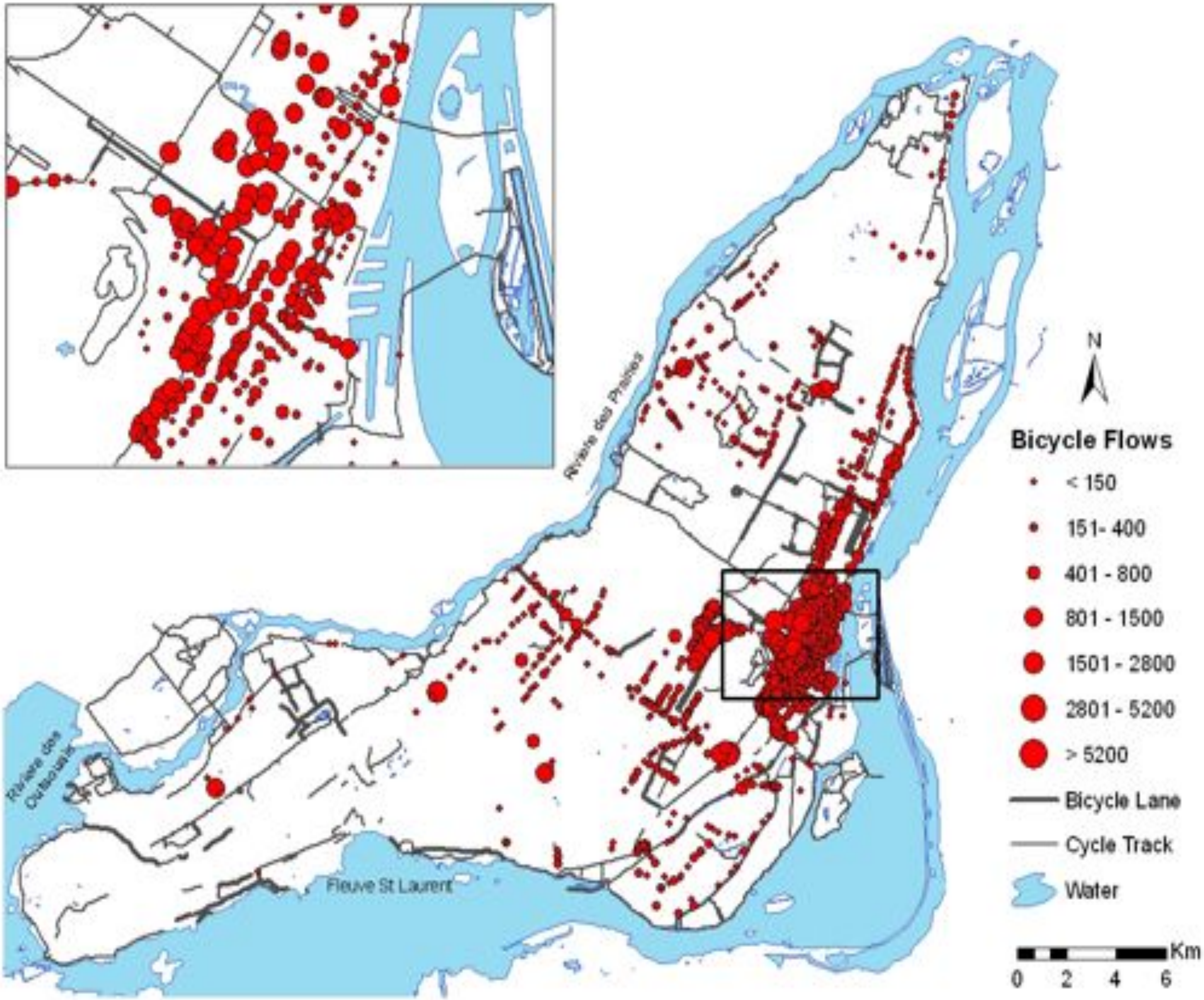
CF_i = Bicycle infrastructure

W_t = Hourly weather conditions

Data

- The Island of Montreal, Quebec
- Focus on 755 of over 2000 signalized intersections
- Intersection data
  - Manual 8-hour counts, number of approaches, presence of a median, one-way streets, speed limits, street typology, bicycle facilities, motor-vehicle flows
- Land use and urban form
  - Four buffer dimensions tested: 50m, 150m, 400m and 800m
  - Within each buffer obtain land use, demographics as well as road and transit characteristics
- Weather data
  - Temperature, humidity and precipitation

Data



Rivière des Prairies
Rivière des Outaouais
Fleuve St Laurent
N
Bicycle Flows
< 150
151- 400
401 - 800
801 - 1500
1501 - 2800
2801 - 5200
> 5200
Bicycle Lane
Cycle Track
Water
Km
0
2
4
6

Approach 1

- Development and application of a weather impact model to correct flows for weather

$$\Delta R = 0.67 + 0.19\Delta Temp - 0.65\Delta Humidity - 16.2 Precipitation$$

- Adjust 8-hour flows using weather model
- Apply hourly, daily and monthly expansion factors to obtain annual seasonal daily bicycle volumes
- Use these expanded flows in the analysis

Approach 2

- Directly introduce weather conditions into the bicycle activity model
- Without accounting for weather in the flows, apply the hourly, daily and monthly expansion factors
- Introduce the weather conditions as explanatory variables in the bicycle activity model

Results

Variables	Adjusted for Weather			Weather as Variables		
	Coef.	P>t	Elasticity	Coef.	P>t	Elasticity
400m Employment ('000)	0.460	0.000	65.8%	0.413	0.000	59.1%
400m Presence of Schools	0.336	0.002	28.6%	0.256	0.009	22.6%
800m Metro Stations	0.225	0.000	31.1%	0.264	0.000	36.5%
150m Bus Stops	0.064	0.005	21.6%	0.046	0.025	15.4%
50m Parks	-	-	-	0.104	0.030	3.2%
800m Land Mix	7.009	0.000	148.9%	6.064	0.000	128.9%
50m Mean Income ('000 $)	5.721	0.025	24.3%	10.763	0.000	45.8%
Presence of One-Way Approach	-	-	-	0.240	0.022	21.4%
Presence of an Arterial	0.526	0.000	40.9%	-	-	-
Presence of Bicycle Lane	-	-	-	0.836	0.000	56.7%
Presence of Cycle Track	0.889	0.000	58.9%	0.834	0.000	56.6%
800m Length of Bicycle Facilities (Km)	0.120	0.000	28.4%	0.080	0.007	18.8%
Temperature	-	-	-	0.034	0.000	47.5%
Humidity	-	-	-	-0.009	0.001	-58.2%
Presence of Precipitation	-	-	-	-0.306	0.009	-35.7%
Constant	0.787	0.016		1.641	0.000	
R - Squared	0.3892			0.4221		

* Elasticities are expressed in terms of a 100% change in the independent variable or a 0 to 1 change in the case of a dummy variable

Conclusion

1) The model results are indeed sensitive to the approach used to account for weather
2) Land mix and metro stations in the 800m buffer, employment and schools in the 400m buffer, bus stops in the 150m buffer and mean income and parks in the 50m buffer all increase bicycle activity through intersections
3) The presence of a bicycle lane or a cycle track near an intersection has the effect of increasing cyclist flows by 56%
4) Adverse weather conditions such as high humidity and precipitation exert a negative effect on bicycle activity

Future Work

- Improved intersection data and a larger sample of intersections
- Account for spatial autocorrelation between bicycle activity through nearby intersections
- Consider larger buffer sizes to account for greater travel distances achieved by bicycle trips compared to pedestrian trips
- Improve the weather model

Thank you!