SAFETY APPLICATIONS OF CYCLIST GPS TRIP DATA IN MONTREAL

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Jillian Strauss and Luis Miranda-Moreno
Department of Civil Engineering and Applied Mechanics, McGill University

INTRODUCTION

- Active modes of transportation are on the rise – unfortunately commonly referred to as vulnerable road users
- A high number of injuries occur each year in urban cities
- In Montreal, from 1999-2008 – over 9000 cyclists were injured - about 62% at intersections
- To identify risk factors and map risk in the network - three main sources of data are required: 1) geocoded injury data, 2) geometric design and built environment characteristics and 3) exposure measures

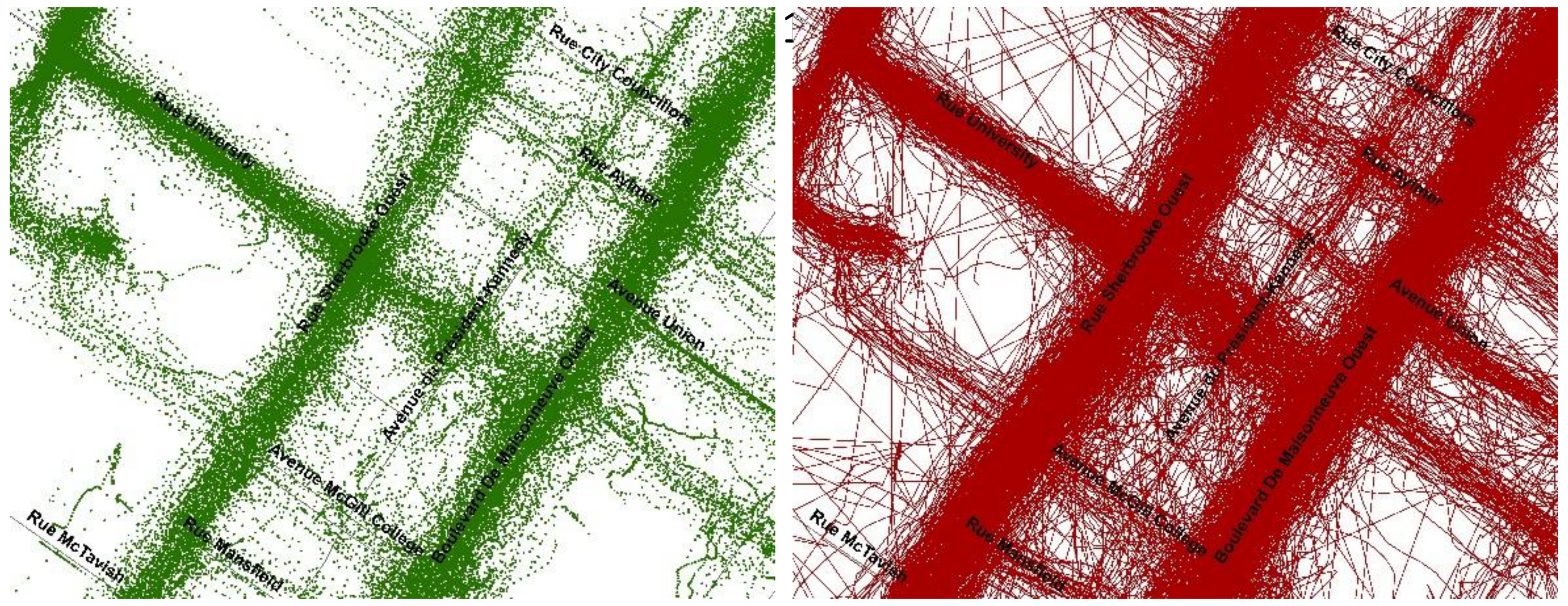
OBJECTIVES

1. Develop a methodology to estimate bicycle volumes followed by injury risk throughout the entire Montreal network of links and intersections
2. Map flows, injuries and risk throughout the entire network
3. Identify hotspots

DATA

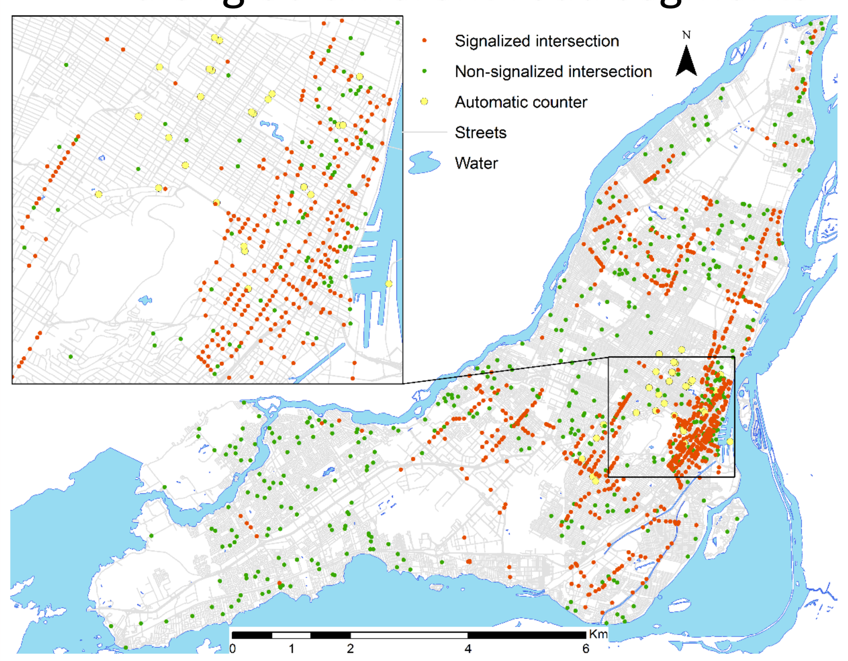
- Smartphone GPS trips and traces:
  - *Mon RésoVélo* Smartphone application for both Android and iOS
  - July 2nd 2013 to November 15, 2013

Android iOS

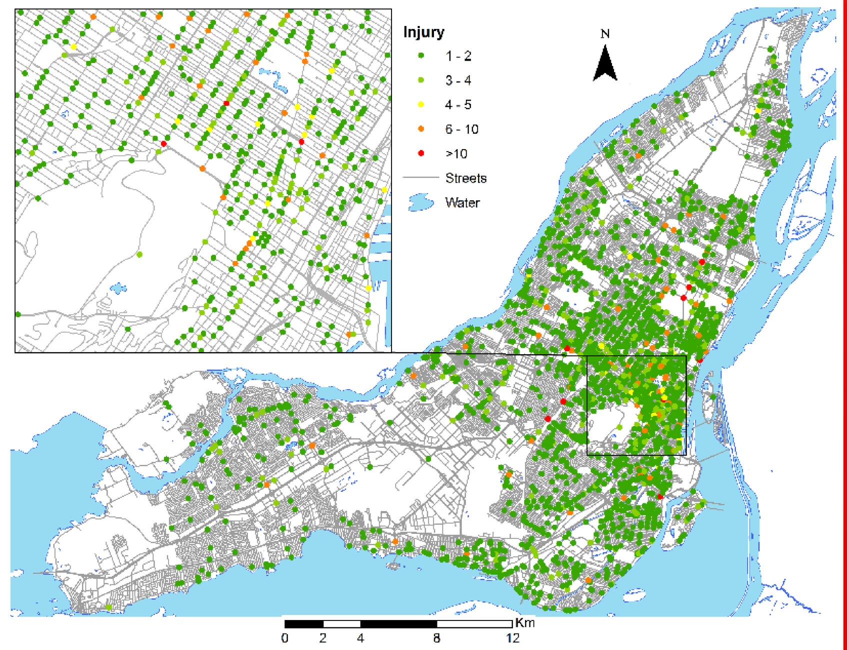


Raw GPS points and traces

- Short-term and long-term bicycle counts:
  - 8-hour manual counts at over 600 signalized intersections in 2009
  - 1-hour manual counts at over 400 non-signalized intersections in 2012
  - Long-term automatic counts from inductive loops and pneumatic tubes along 30 different road segments - installed since 2008



Intersections with manual counts and automatic count locations

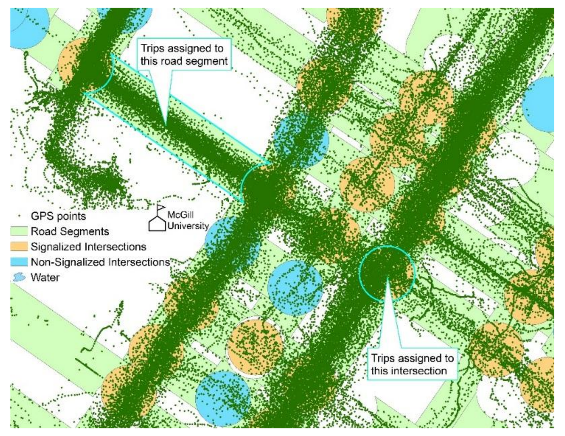


Cyclist injuries at intersections

- Cyclist injury data:
  - From ambulance interventions
  - From 2003-2008 – over 5,000 cyclists were injured at intersections and over 3,500 were injured along segments

METHODOLOGY

The methodology has several steps:



1. Assign the GPS traces to the network elements
   - Map all raw GPS observations (x,y)
   - Use buffer approach to assign to links and intersections – 35 metres – to capture majority of trips
2. Obtain AADB volumes from short-term and long-term counts and develop an extrapolation function for the GPS data
   - Compute AADB at manual count sites from permanent counter data
   - Develop function to associate AADB with GPS flows:

$$AADB_i \propto \beta \cdot T_i + \alpha$$

where β = parameter weighing the number of GPS traces denoted as T_i, α = correction factor associated with geometric design or built environment characteristics

3. Validate the predicted AADB from GPS data through the development of Safety Performance Functions (SPF)
   - Develop SPF models with both sources of bicycle flows
   - Compare parameter coefficients and variable significance

SPF_{count} vs SPF_{GPS}

4. Apply the predicted AADB for links and intersections for safety applications
   - Map flows, injuries and risk throughout entire network
   - Identify hotspots

RESULTS

Results of AADB model

Signalized Intersections			Non-Signalized Intersections		
Variable	Coef.	P>z	Variable	Coef.	P>z
GPS count - No facilities	11.5	0	GPS count - No facilities	1.28	0
GPS count - Bicycle path	6.71	0	GPS count - Bicycle path	1.15	0
GPS count - Cycle track	17.43	0	GPS count - Cycle track	4.14	0
Distance to downtown*	-15.34	0	Distance to downtown*	-24.1	0
Constant	238.4	0	Constant	378.4	0
R-squared	0.696		R-squared	0.58	

Variable	Segments					
	Cycle Track		Bicycle Path		No Facility	
	Coef.	P>z	Coef.	P>z	Coef.	P>z
GPS flow	20.1	0	9.4	0	46.6	0.001
Constant	1557.1		1387.1		1579.8	
R-Squared	0.52		0.76		0.27	

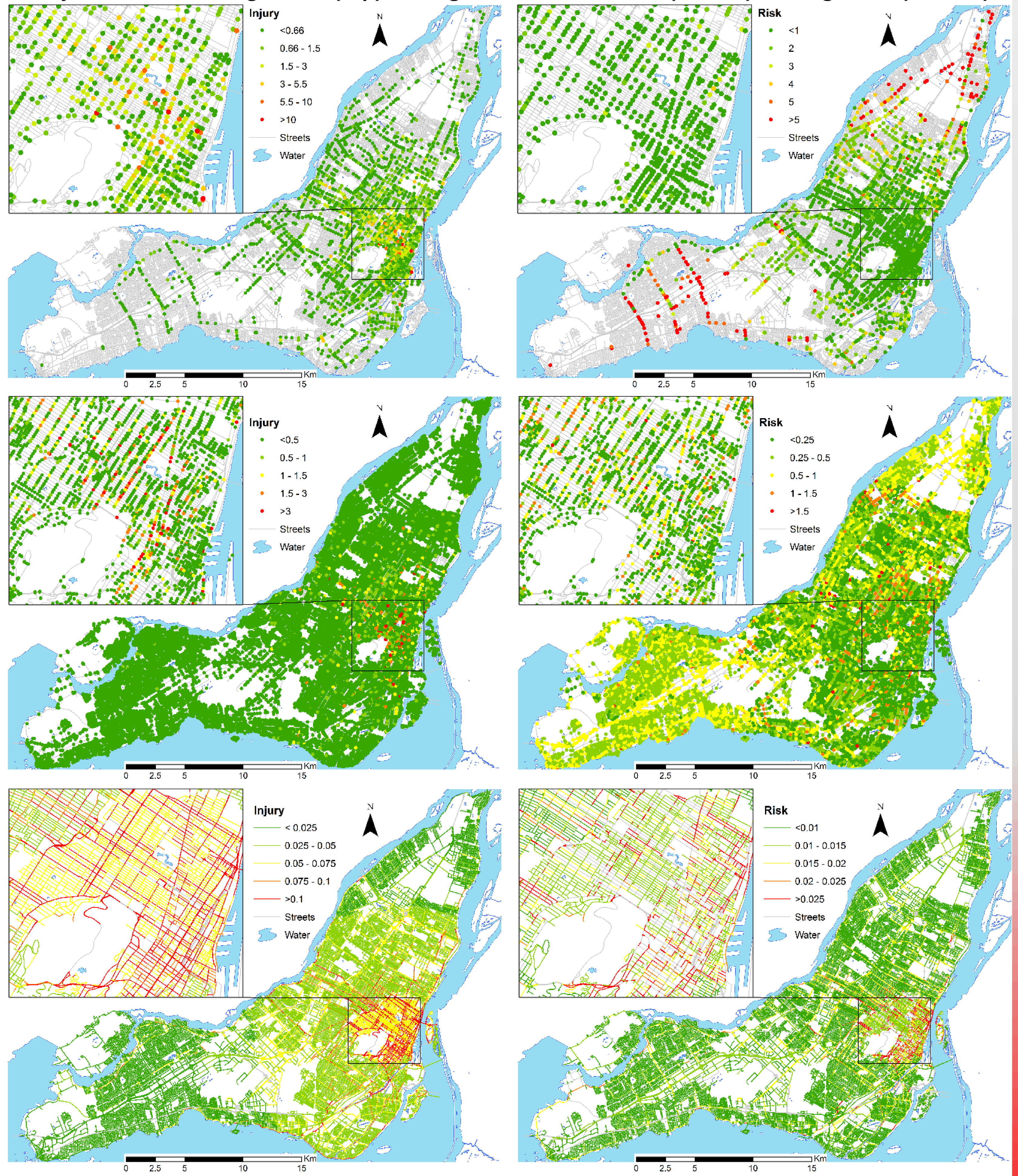
Validation for signalized intersections

*Ln = Natural logarithm

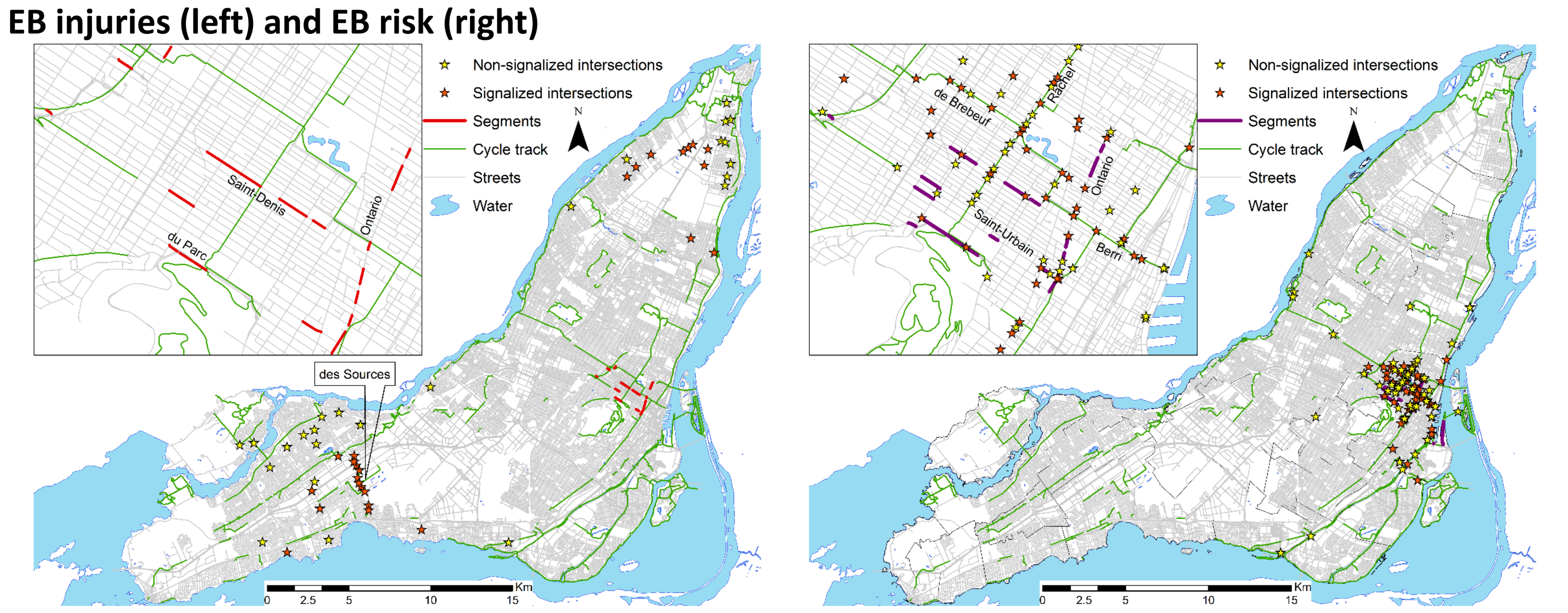
AADB from manual counts			AADB from GPS trips		
Variable	Coef.	P>z	Variable	Coef.	P>z
Ln* bicycle flow	0.510	0	Ln* bicycle flow	0.531	0
Ln* right turn motor-vehicle flow	0.174	0.008	Ln* right turn motor-vehicle flow	0.156	0.012
Ln* left turn motor-vehicle flow	0.138	0.012	Ln* left turn motor-vehicle flow	0.131	0.013
Crosswalk width	0.010	0.002	Crosswalk width	0.010	0.002
Bus stop	0.468	0.002	Bus stop	0.595	0
Raised median	-0.478	0.002	Raised median	-0.475	0.002
Constant	-6.53		Constant	-6.57	
Log-likelihood	-621.07		Log-likelihood	-628.26	
AIC	1258.14		AIC	1272.52	
Dispersion parameter	0.553		Dispersion parameter	0.634	

RESULTS

EB injuries and risk at signalized (top) non-signalized intersections (middle) and segments (bottom)



Top 25 most dangerous signalized intersections, non-signalized intersections and segments based on EB injuries (left) and EB risk (right)



CONCLUSION

- Richness of the GPS data - able to map flows, injuries and risk for cyclists throughout the entire network - used for many planning purposes
- Cyclist risk at intersections - greater outside the central neighbourhoods of the island where bicycle infrastructure is lacking - injuries are higher in the central neighbourhoods
- For segments both injuries and risk are highest in the central neighbourhoods overall, risk is much lower at segments than at intersections