Road environment and injured cyclists resulting from an accident with a motor vehicle: what risk factors in a low density setting?

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1. Background and literature review

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- The practice of cycling remains lower in Quebec than what is observed in Europe.

- Cyclists are very vulnerable when involved in a collision with a motor vehicle: around 100 cyclists are hospitalized in a 1000 and about 10 in 1000 accidents are fatal.

Source: Vélo Québec (2010)

1. Background and literature review

- The increased risk for all cyclists in a collision seems amplified in suburban and rural areas.

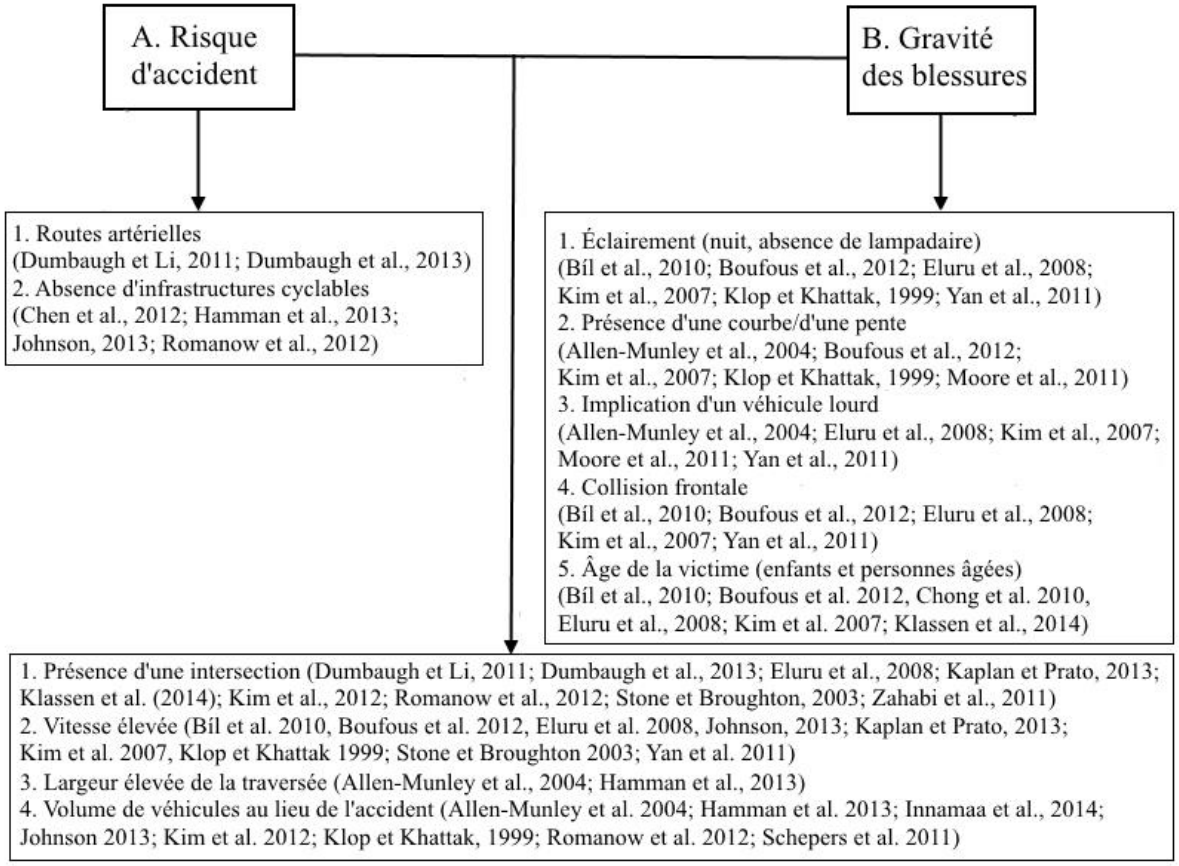
- The injuries sustained by cyclists in suburban and rural areas are more severe.

- Suburban and rural areas have little been studied in the literature on cyclist road safety.

Source: Vélo Québec (2010)

1. Background and literature review

Road safety and cyclists – Risk factors



Research objective

The general objective of this study is to document the risk factors related to the road environment for accidents between a cyclist and a motor vehicle in a less dense “regional environment” (small and medium sized communities), often including a city of greater importance and surrounding villages.

2. Methodology

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Study area

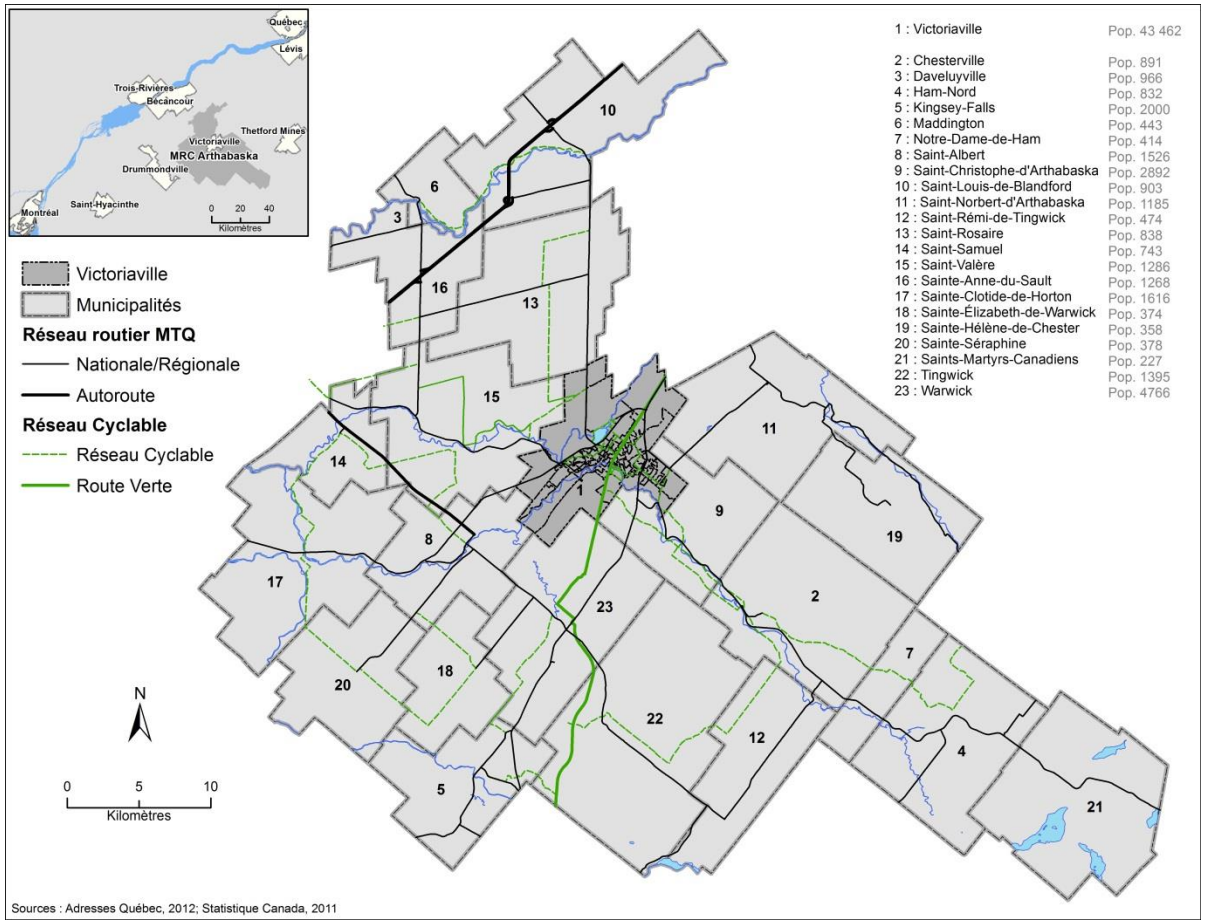
RCM of Arthabaska,

Centre-du-Québec

150 km from Montreal and Quebec City

23 municipalities

+/- 70 000 inhabitants



2. Methodology

Data

Original data	Source	Attributes used
Road network hierarchy	MTQ	*Road segments* : number of lanes, speed limit *Road network*: urban local, urban arterial, provincial network (highways, national roads and regional roads)
Accidents (2007-2011)	MTQ	*Accident characteristics*: severity, collision type, intersection (yes/no), x/y coordinates
		Vehicle characteristics : vehicle type, including pedestrians and cyclists
		Victim characteristics: age
Traffic	*Data collected on the field*	Estimated annual average daily traffic (AADT)
Road environment	*Data collected on the field*	*Segments* : slope, curve, lighting (day/night)
Zoning	RCM	*Zoning* : residential, business, commercial, rural
2006 Census of population	Statistics Canada	Total population (by municipality)
Other road infrastructures	RCM	Presence of cycling infrastructure on segment

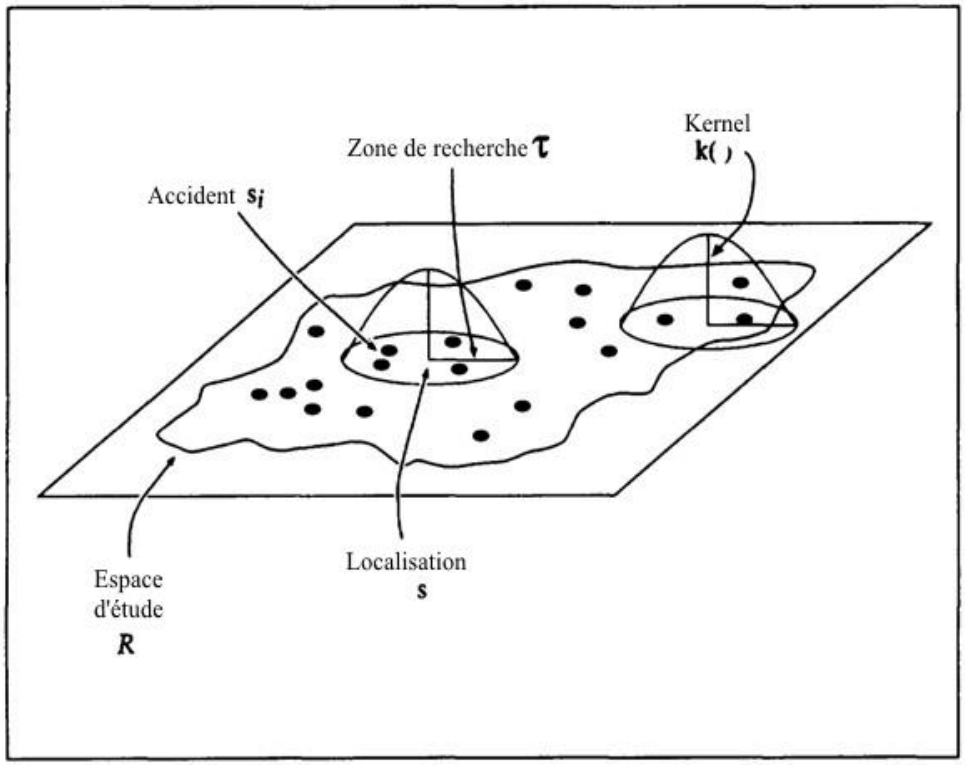
2. Methodology

1. “Hot spot” detection

a. Kernel Density Estimation (KDE)

Grid cell: 2,5 m

Bandwidth / radius: 250 m



Source: Adapted from Gatrell, A. C. & al. (1996)

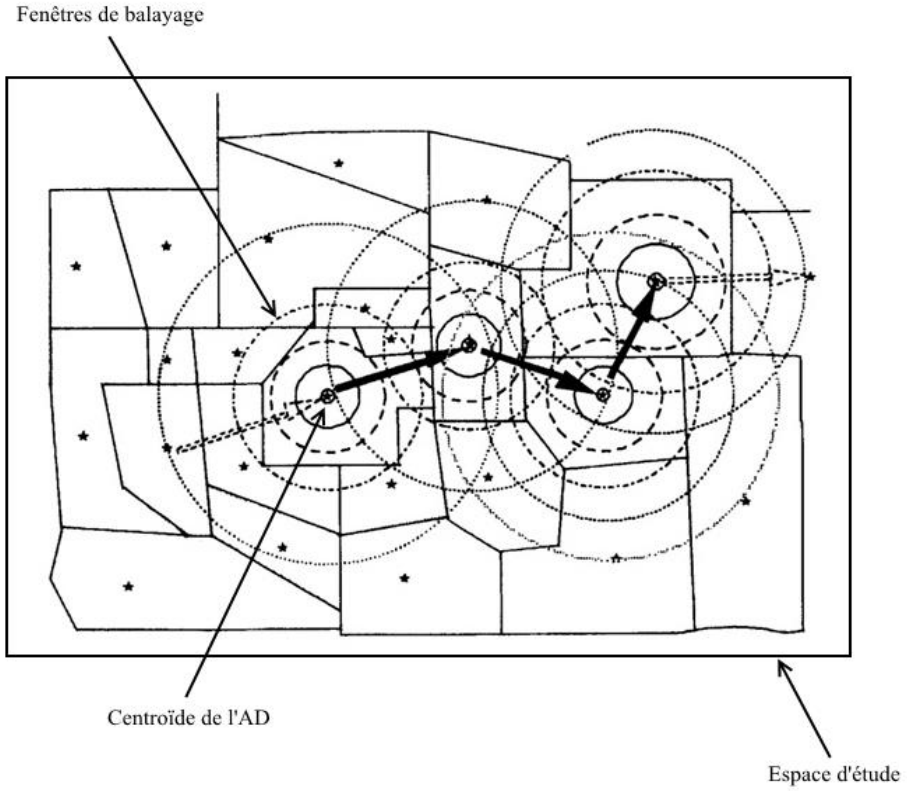
2. Methodology

1. “Hot spot” detection

b. Kulldorff Spatial Scan Statistics

Population at risk: motor vehicle AADT

Spatial scan radius: up to 2% of the population at risk



Source : Adapted from Hjalmars & al. (1996)

2. Methodology

2. Predictive models of accidents and severity

a. Predictive model for accidents

Zero-inflated Poisson regression

Dependent variable (Y):

- Accident frequency per segment (number of accidents per segment / segment length (km))

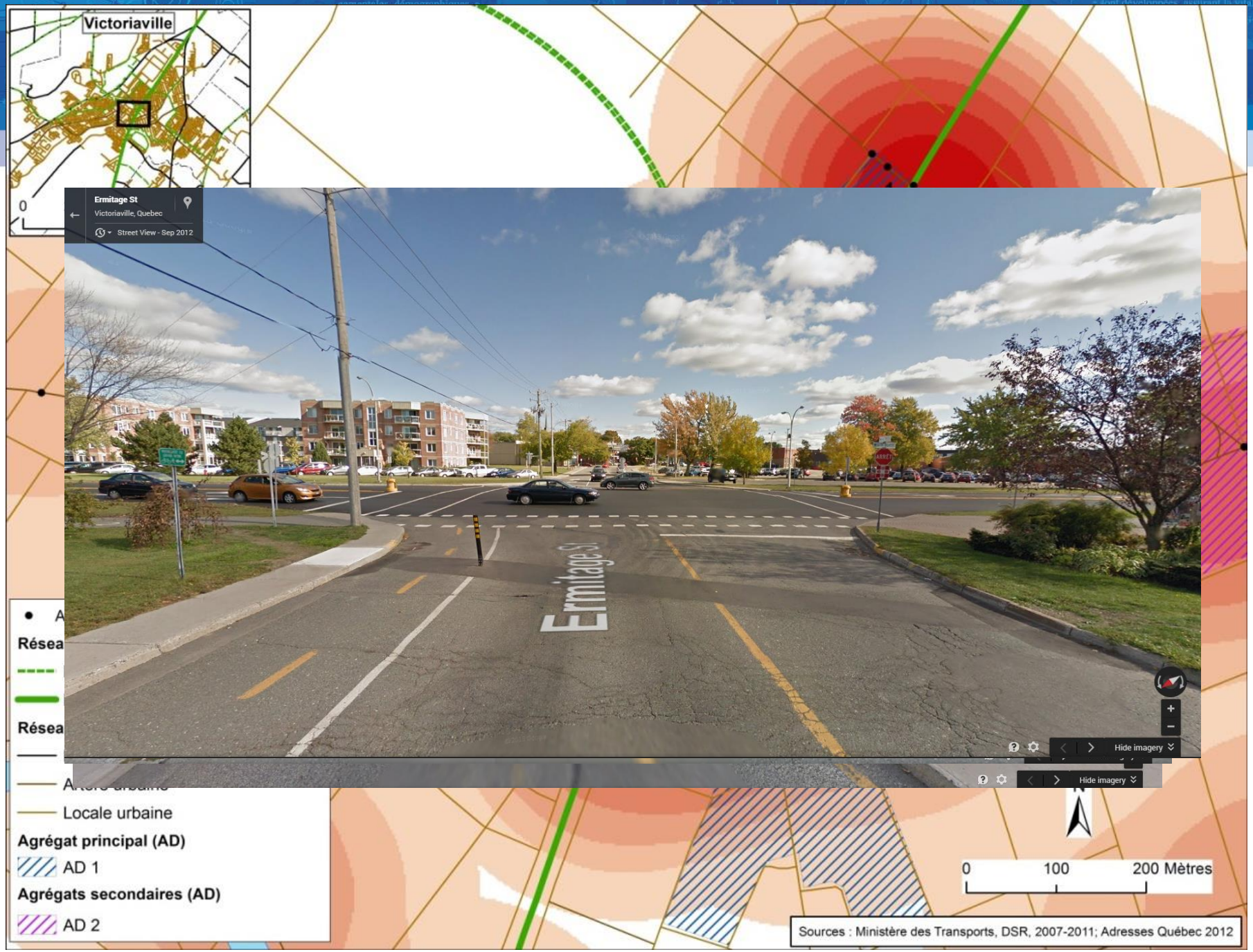
b. Predictive model for accidents with injuries

Logistic regression

Dependent variable (Y):

- 0: Accident without injury
- 1: Accident with injury (minor, serious, fatal)

3. Results


Victoriaville
0
Ermitage St
Victoriaville, Quebec
Street View - Sep 2012
Ermitage St
Hide imagery
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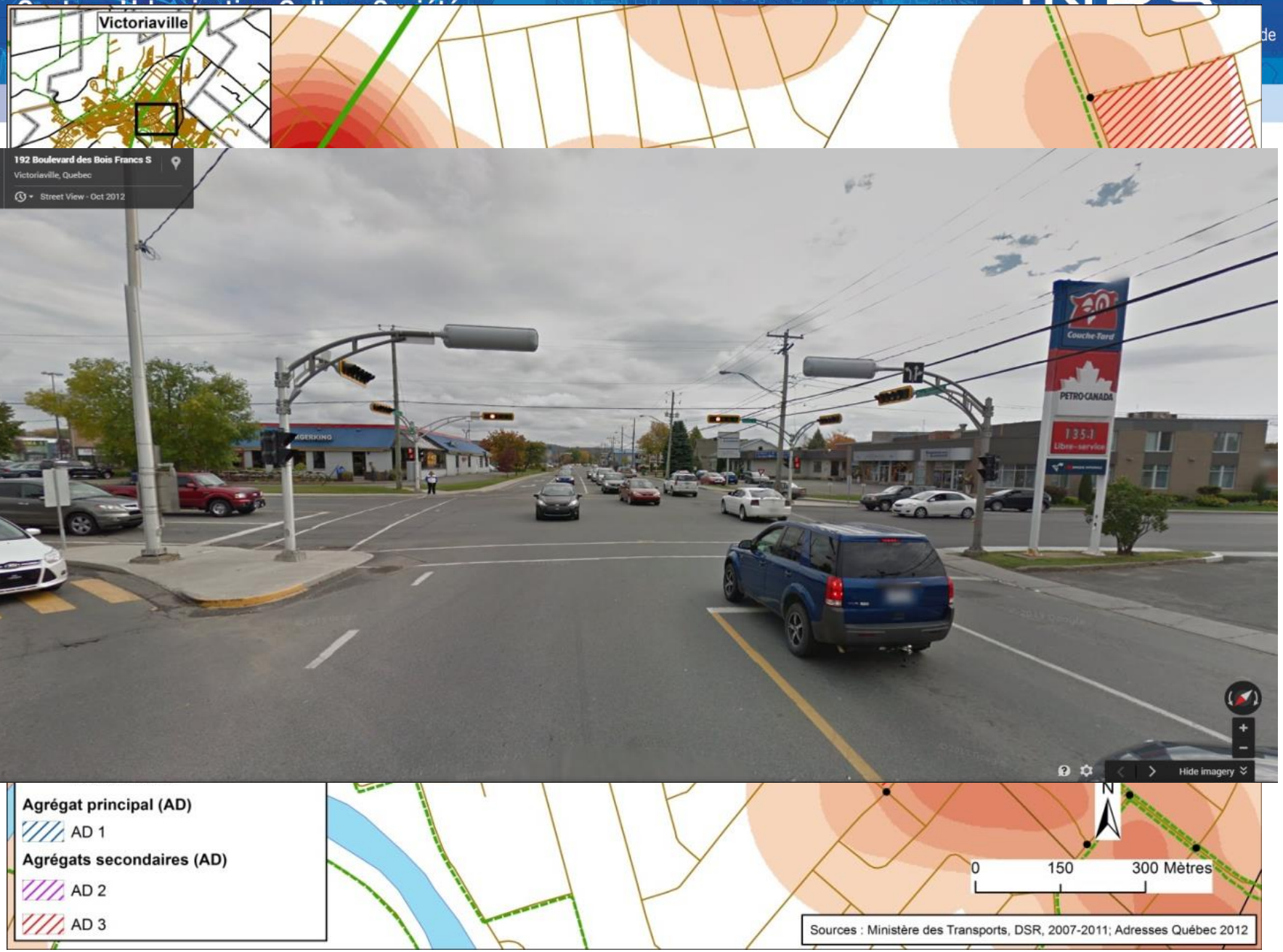
Locale urbaine
Agrégat principal (AD)
AD 1
Agrégats secondaires (AD)
AD 2
0
100
200 Mètres
Sources : Ministère des Transports, DSR, 2007-2011; Adresses Québec 2012


Victoriaville
192 Boulevard des Bois Francs S
Victoriaville, Quebec
Street View - Oct 2012
Couche-Tard
PETRO-CANADA
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Agrégat principal (AD)
AD 1
Agrégats secondaires (AD)
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AD 3
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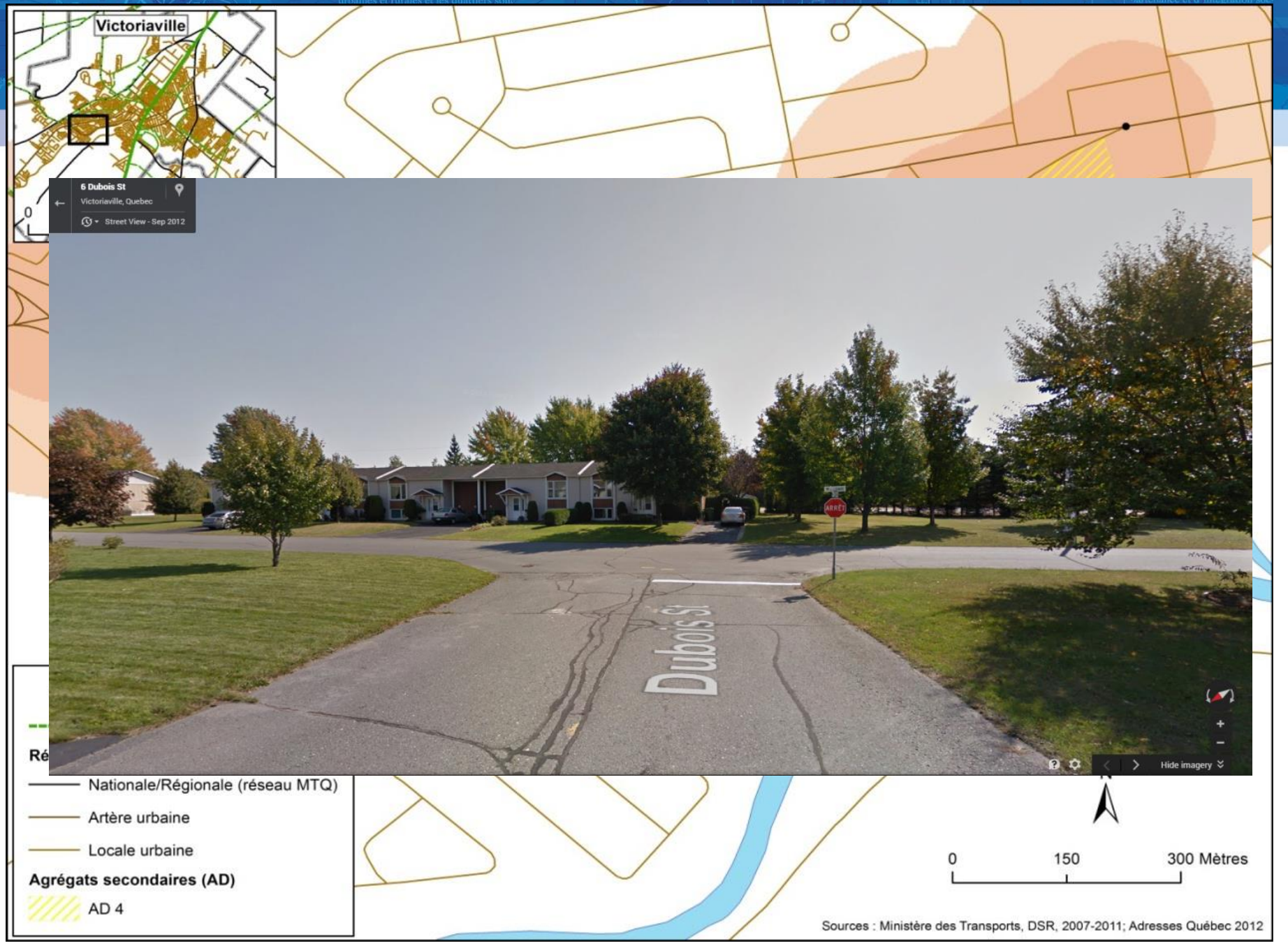
Sources : Ministère des Transports, DSR, 2007-2011; Adresses Québec 2012


Victoriaville
6 Dubois St
Victoriaville, Quebec
Street View - Sep 2012
Dubois St
ARRÊT
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Nationale/Régionale (réseau MTQ)
Artère urbaine
Locale urbaine
Agrégats secondaires (AD)
AD 4
0
150
300 Mètres
Sources : Ministère des Transports, DSR, 2007-2011; Adresses Québec 2012

3. Results

2. Predictive model for accidents

Variables	Coef.	Erreur-type	Wald	P	IC 95%	
Location of the accident at an intersection	**0,611**	**0,081**	**57,46**	**<,0001**	**0,4533**	**0,7695**
Presence of cycling infrastructure	**0,421**	**0,067**	**39,26**	**<,0001**	**0,2894**	**0,5529**
Accident in urban setting (Victoriaville)	**0,711**	**0,243**	**8,58**	**0,003**	**0,2352**	**1,1866**
Road type (urban arterial) – Ref. Urban local	**0,920**	**0,325**	**8,02**	**0,005**	**0,2833**	**1,5565**
AADT (Annual Average Daily Traffic)	**0,0001**	**0,0000**	**1**	**0,029**	**-0,0002**	**-0,0000**

3. Predictive model for accidents with injuries

Variables	Coef.	Erreur-type	Wald	P	RC	IC 95%
Presence of cycling infrastructure	**-0,782**	**0,437**	**3,209**	**0,073**	**0,457**	**0,194-1,076**
Cyclist age (≤15) - Ref. 35-64	**1,689**	**0,947**	**3,1778**	**0,075**	**5,413**	**0,845-34,655**

4. Discussion / Conclusion

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Risk factors similar to urban areas: cycling infrastructure and age of victims

- The presence of cycling infrastructure reduces the risk of accident and injury, although the majority of spatial clusters are located near existing infrastructures.
- Young cyclists (15 and under) are more likely to be injured than adults (35-64).

4. Discussion / Conclusion

Risk factors proper to regions with low population density: intersection, rural area and urban local streets / urban arterial

- Intersections do not represent a major risk factor.
- The risk of accident is higher in rural areas than in urban areas, at least in the predictive models, since the spatial clusters are all found in urban areas.
- The risk of accident is higher on urban local streets and urban arteries compared to the provincial network (national / regional).

Thank you for your attention!