Downscaling Emissions From Residential Wood Burning using Real Estate data and Thermal Imagery

Jad Zalzal[1] and Marianne Hatzopoulou[1]

[1]Department of Civil and Mineral Engineering, University of Toronto, Toronto, Ontario, Canada

Civil Engineering
UNIVERSITY OF TORONTO

University of Toronto
Transportation and Air Quality Research Group (TRAQ)

Environnement et Lutte contre les changements climatiques
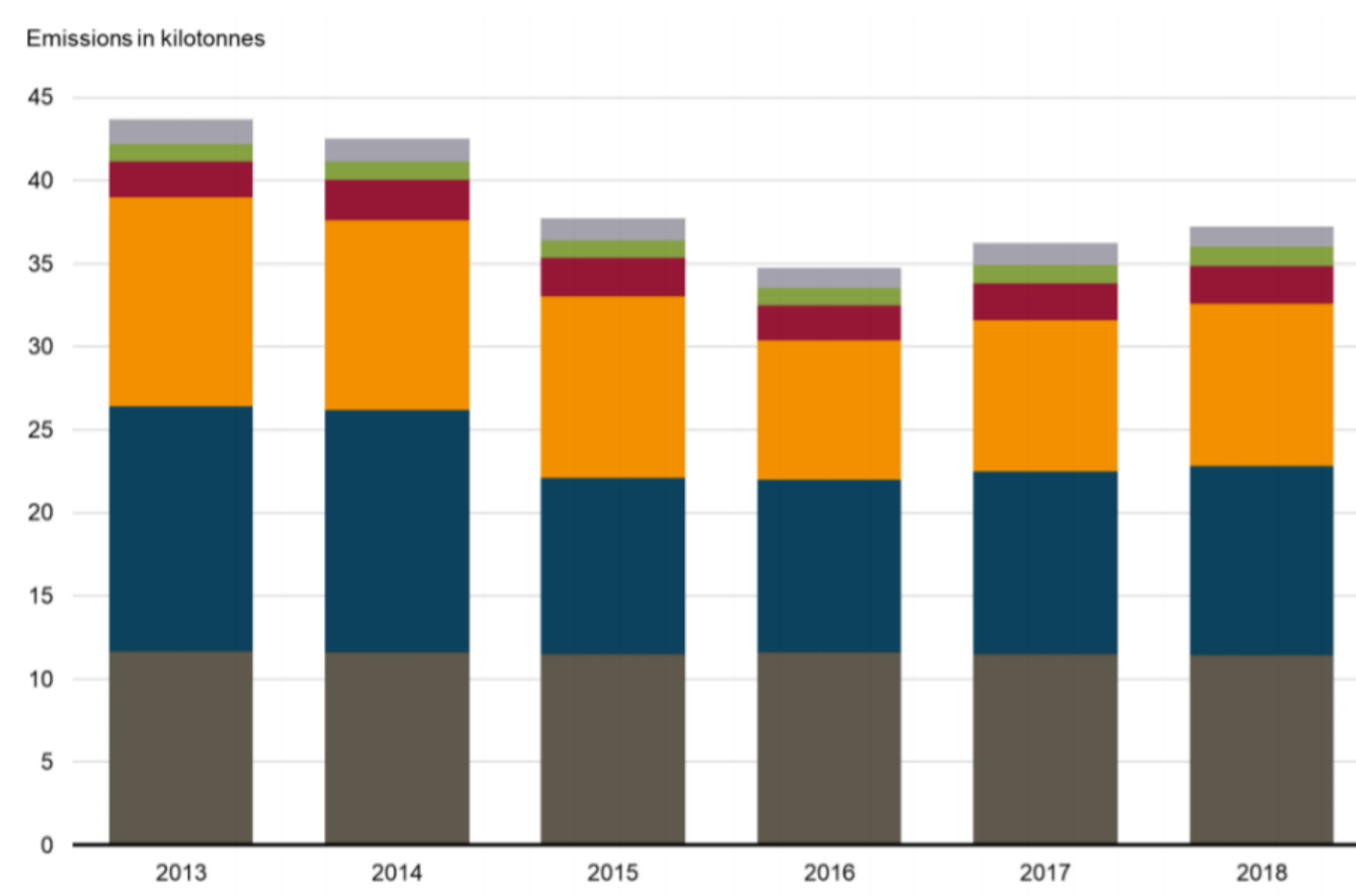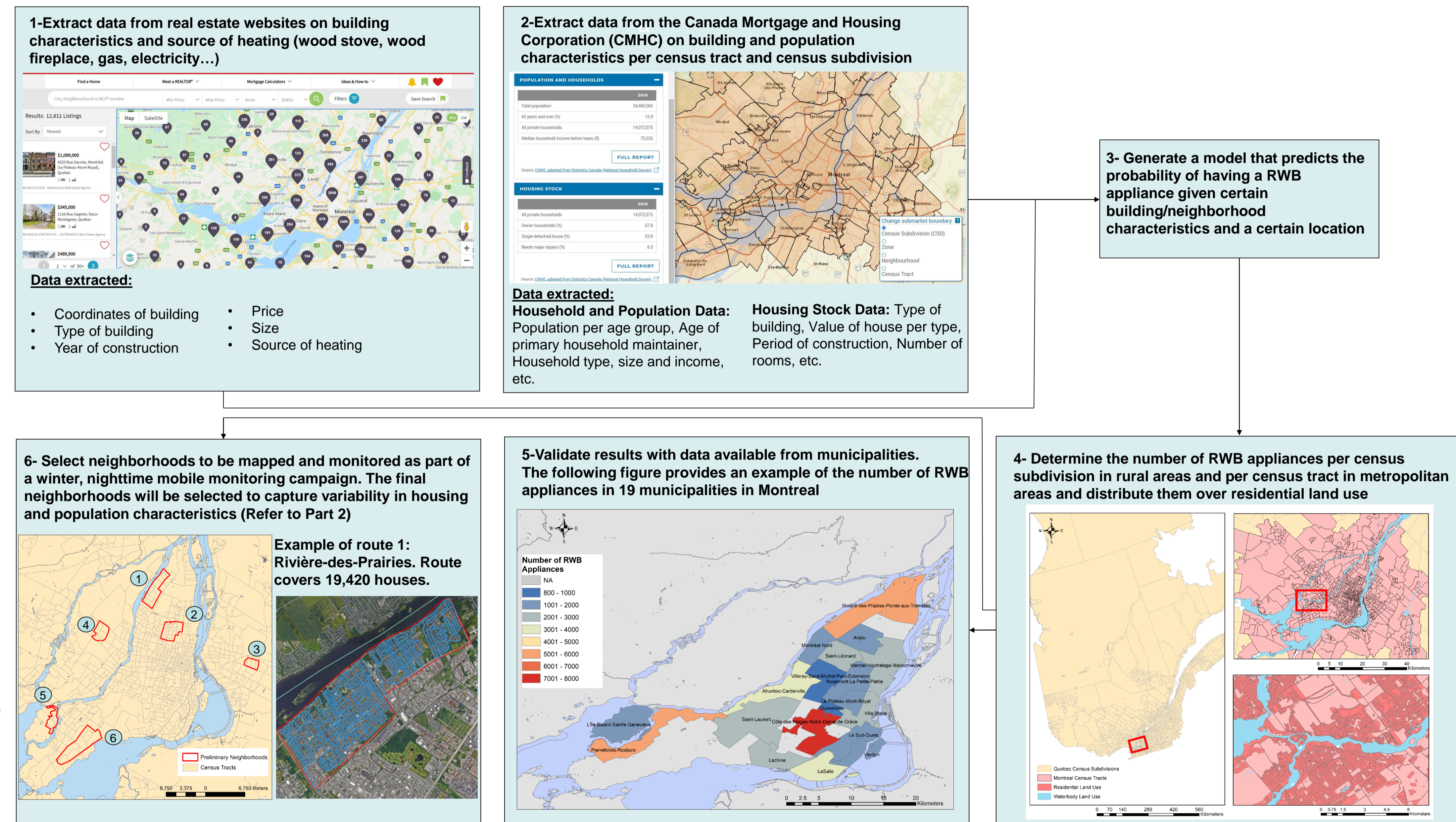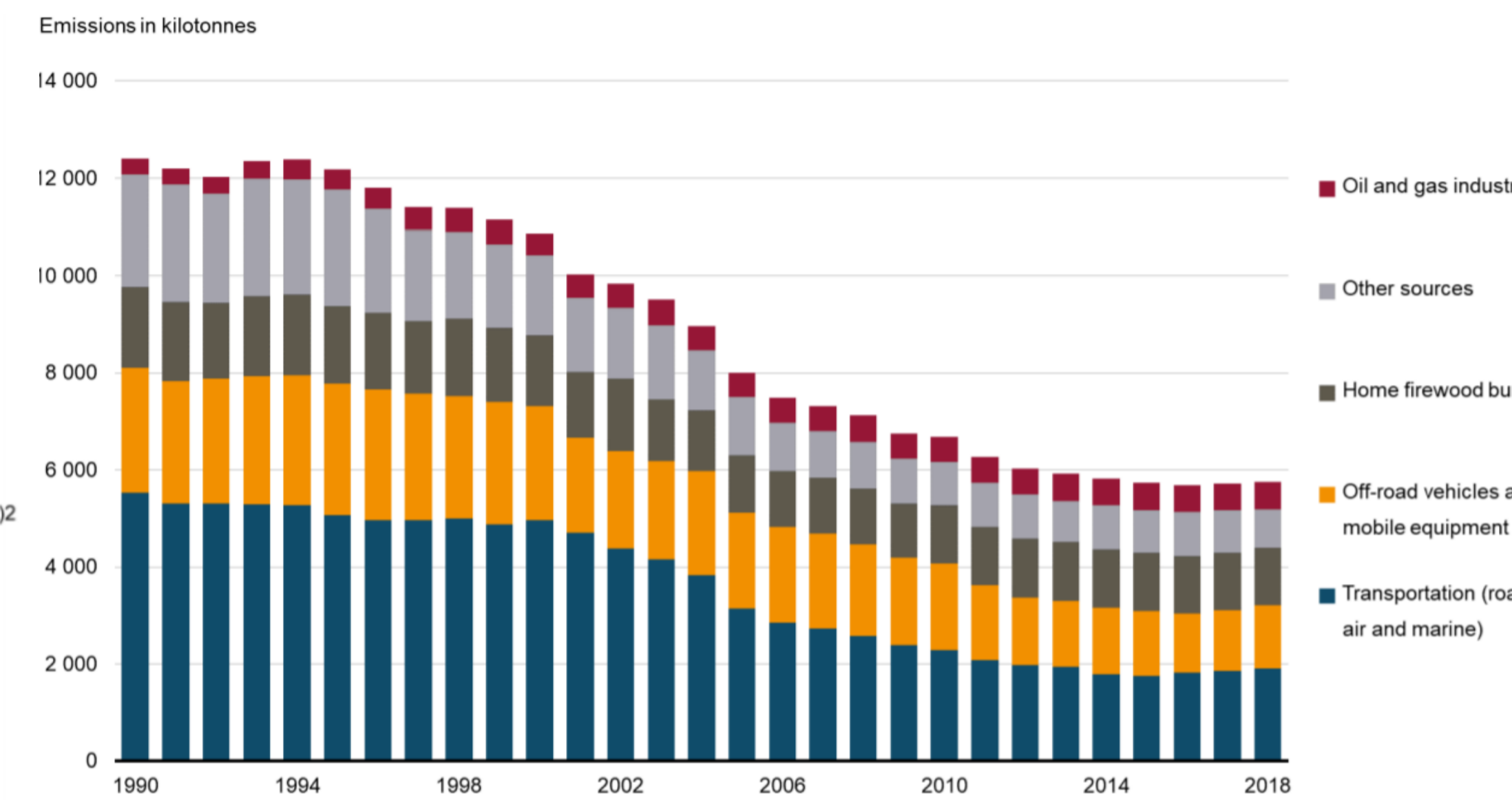Québec

Background

➤ Emission inventories are a key input in Mechanistic Air Quality Models such as Chemical Transport Models (CTMs). Therefore, having accurate and high-resolution emission inventories is crucial for minimizing errors and uncertainties in CTMs, which in turn results in better estimates of population exposure to air pollution.

➤ Residential Wood Burning (RWB) is one of the major sources of air pollution in Canada, specifically in Quebec. In Quebec, RWB is the largest source of fine particulate matter ($PM_{2.5}$), volatile organic compounds (VOCs), Carbon Monoxide (CO) and black carbon BC (ECCC, 2020).

➤ In addition to being one of the largest sources of air pollution in Canada, emissions from RWB are of particular importance since they are emitted at low elevations and in residential areas.

➤ Currently, the RWB emissions inventory in Canada is spatially distributed based on population density (Samaali et al., 2019). However, this method tends to overestimate emissions in urban areas, since these areas usually rely on different heating sources (Plejdrup et al., 2016).

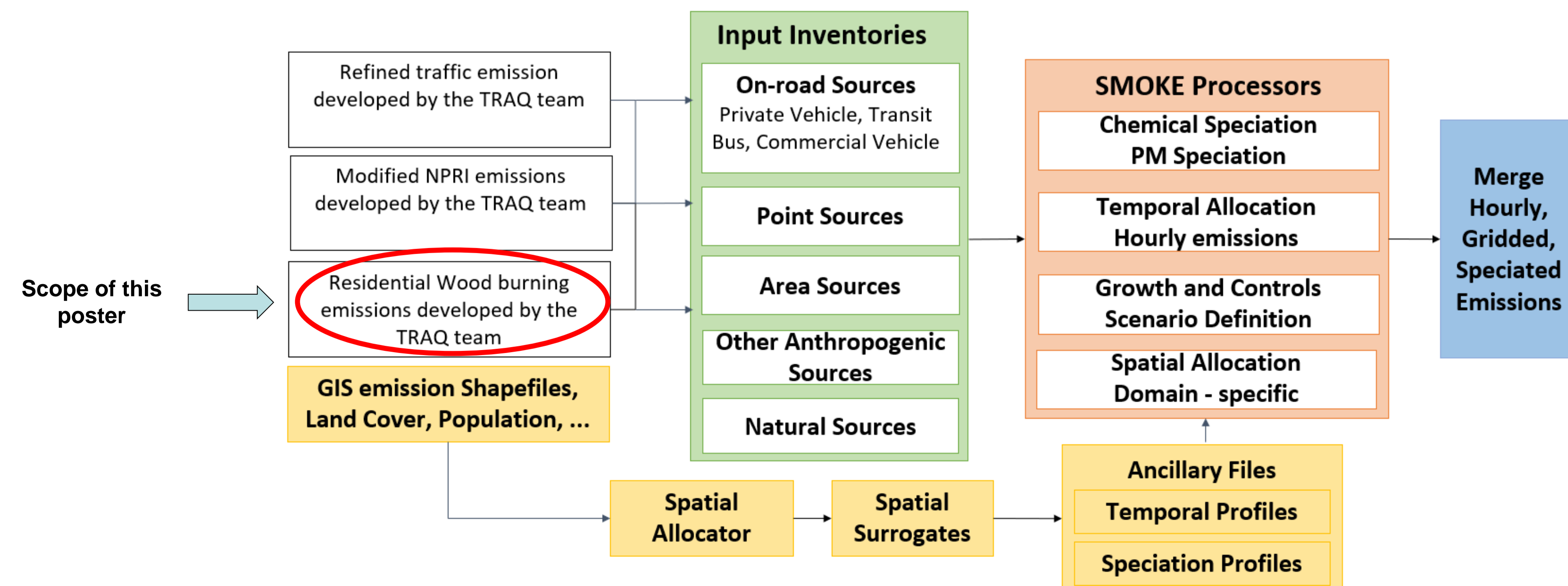Black Carbon Emissions in Canada (ECCC, 2020)

Carbon Monoxide Emissions in Canada (ECCC, 2020)

Scope of the project

This poster presents the proposed methodology for downscaling and spatially distributing RWB emissions in the province of Quebec. This project is part of a larger project aimed at modeling future concentrations of $PM_{2.5}$, Ozone (O_3), and Nitrogen Oxides (NO_x) in Quebec, given different emission scenarios.

For more details, please refer to Sara Torbatian and Shayamila Gamage's poster entitled "Estimate the impacts of Greenhouse Gas (GHG) reduction on population health in Quebec"

Methodology

Part 1: Determining the location of RWB appliances for all of Quebec

1-Extract data from real estate websites on building characteristics and source of heating (wood stove, wood fireplace, gas, electricity...)

Data extracted:
- Coordinates of building
- Type of building
- Year of construction
- Price
- Size
- Source of heating

2-Extract data from the Canada Mortgage and Housing Corporation (CMHC) on building and population characteristics per census tract and census subdivision

Data extracted:
Household and Population Data: Population per age group, Age of primary household maintainer, Household type, size and income, etc.

Housing Stock Data: Type of building, Value of house per type, Period of construction, Number of rooms, etc.

3- Generate a model that predicts the probability of having a RWB appliance given certain building/neighborhood characteristics and a certain location

6- Select neighborhoods to be mapped and monitored as part of a winter, nighttime mobile monitoring campaign. The final neighborhoods will be selected to capture variability in housing and population characteristics (Refer to Part 2)

Example of route 1: Rivière-des-Prairies. Route covers 19,420 houses.

5-Validate results with data available from municipalities. The following figure provides an example of the number of RWB appliances in 19 municipalities in Montreal

4- Determine the number of RWB appliances per census subdivision in rural areas and per census tract in metropolitan areas and distribute them over residential land use

Part 2: Determining the location of operational RWB appliances: Montreal case-study

➤ The detection of operational RWB appliances will be done by mapping certain pre-defined neighborhoods in the Greater Montreal Area using the urban scanner mounted with a thermal camera. The aim is to detect heat loss through operation residential chimney stacks.

➤ Air quality measurements will be taken during the mobile campaign to determine the contribution of RWB to ambient concentrations.

Monitoring campaign:
- Will take place from December 2021-February 2022
- 6 neighborhoods will be mapped twice per month between 7pm and 1am
- UFP, BC and $PM_{2.5}$ concentrations will be measured

Acknowledgements/References