CSCE Annual Conference

Growing with youth – Croître avec les jeunes

Laval (Greater Laval)

June 12 – 15, 2019

AN ASSESSMENT OF GREENHOUSE GAS EMISSION FROM MUNICIPAL ACTIVITIES

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Abstract: GHGs can be produced from a broad range of anthropogenic activities at different spatial and temporal scales. In particular, emission from urban area is an import source of GHGs. City is a complicated system consisting of various component and processes. Efforts have been made to reduce the urban GHG emission. However, there is a lack of available methods for effective assessment of such emissions. Many urban sources and factors which can influence the emissions are still unknown. In the present study, the GHG emission from municipal activities was assessed. A model for the assessment of urban GHG emission was developed. Based on the collected data, a case study was conducted to evaluate the urban GHG emission. The comprehensive assessment included the emission from transportation (i.e. public, personal and port), electricity consumption, natural gas, waste disposal, and wastewater treatment. There was a variation for GHG emission from these sectors in different years. This study provided a new approach for comprehensive evaluation of urban GHG emissions. The results can help better understand the emission process and identify the major emission sources.

1 PROJECT OVERVIEW

There is an increasing concern for earth temperature increase caused by anthropogenic perturbation. The rising greenhouse gas (GHG) emission results in the change of radiative pattern in atmosphere, which would increase the average surface temperature and eventually lead to the change global climate. GHGs can be produced from a broad range of anthropogenic activities at different spatial and temporal scales. In particular, emission from urban area is an import source of GHGs. 49.4% of the global population are living in urban areas. By 2050, this ratio will increase to 70% of the global population (Dhakal, 2010). About 75% of energy consumption and 80% of GHG emissions globally can be attributed to the urban activities (Dodman, 2009). Cities may consume a large amount of energy to meet the demands of transport, industrial and commercial, heating and cooling activities. In addition, solid wastes and domestic, commercial and industrial effluents are also mostly produced in urban agglomerations (Dubeux, 2007). There is a clear linkage between GHG emissions and urban areas that is why municipalities may contribute to the mitigation of climate change and thereby benefit from reductions in the GHG emissions.

GHG inventory is a tool to evaluate the status of emissions and the potential for mitigation. The Intergovernmental Panel on Climate Change (IPCC) provides a detailed methodological framework to accomplish the inventories. It assesses the greenhouse gases emitted from four main sectors including energy, industrial processes and product use, agriculture, forestry and other land use, and waste. These emissions inventories provide a general picture of global patterns of greenhouse gas emissions. City is a complicated system consisting of various component and processes. Efforts have been made to reduce

the urban GHG emission. However, there is a lack of available methods for effective assessment of such emissions. Many urban sources and factors which can influence the emissions are still unknown. Therefore, there is an urgent need to determine the urban GHG sources and evaluate the emission in a comprehensive manner.

In the present study, the GHG emission from municipal activities was assessed. A model was developed for the assessment of urban GHG emission. Based on the collected data of Montreal in Canada, a case study was conducted to evaluate the urban GHG emission. The comprehensive assessment included the emission from transportation (i.e. public, personal and port), electricity consumption, natural gas, waste disposal, and wastewater treatment. There was a variation for GHG emission from these sectors in different years. The emission results were compared with some results from other studies. This study provided a new approach for comprehensive evaluation of urban GHG emissions. The results can help better understand the emission process and identify the major emission sources. The strategy for GHGs reduction can be further proposed based on the findings from this study.

2 Methodology

Emissions in Montreal Island have been calculated over a time period of2016. The emission factor-based approach was used to for investigating the source categories of natural gas, transportation, solid waste disposal, wastewater treatment and electricity. Public transportation in the estimation has been divided by two categories of Urban Transportation Network (UTN) included metros and buses and Suburban Transportation Network (STN) which included trains travel within Montreal Island to connect the Island to suburb. The general model as follows was used to calculate urban GHG emission.

E_Urban=E_NG + E_UTN + E_STN + E_VEH + E_SWD + E_WT + E_ELEC

Where:

E_NG: GHG emissions from the use of natural gas (kg CO_2-eq)

E_UTN: Direct GHG emission from bus and subway (kg CO_2-eq)

E_STN: Emission of suburban transportation network (kg CO_2-eq)

E_VEH: Emission of compound (i) (kg CO_2-eq)

E_SWD: Emission of solid waste disposal (kg CO_2-eq)

E-WT: Emission produced by wastewater (kg CO_2-eq)

E_ELEC: Emission from electricity (kg CO_2-eq)

3 Results and discussion

The main sources of GHG emission are shown in Figure 1. The largest GHG emission source in Montreal Island in 2016 is from vehicles. The common vehicles in this assessment can be categorized by three types including light, medium and heavy vehicles. The calculation was based on the number of vehicles registered in the area. Among these three vehicle types, light vehicles have the greatest number in 2016 and this category of light vehicles was also associated with the highest GHG emission. Natural gas used for heating in the city contributed to 10% of the total GHG emission in 2016. Under the regulation respecting the mandatory reporting of certain emissions of contaminants into the atmosphere, only the facilities emitting 10 kt CO_2-eq /yr or more are required to report their GHG emissions (Government of Canada, 2018). Industry sector in Montreal has low emission and is not among facilities require to publish their GHG emissions. The natural gas consumption mainly comes from residential (76%) and commercial (24%). Natural gas in building sector becomes the major source of GHGs in Los Angeles, Toronto and New York City. Particularly, Toronto natural gas for heating was also the largest source of GHG emissions in buildings (City of Toronto, 2017).

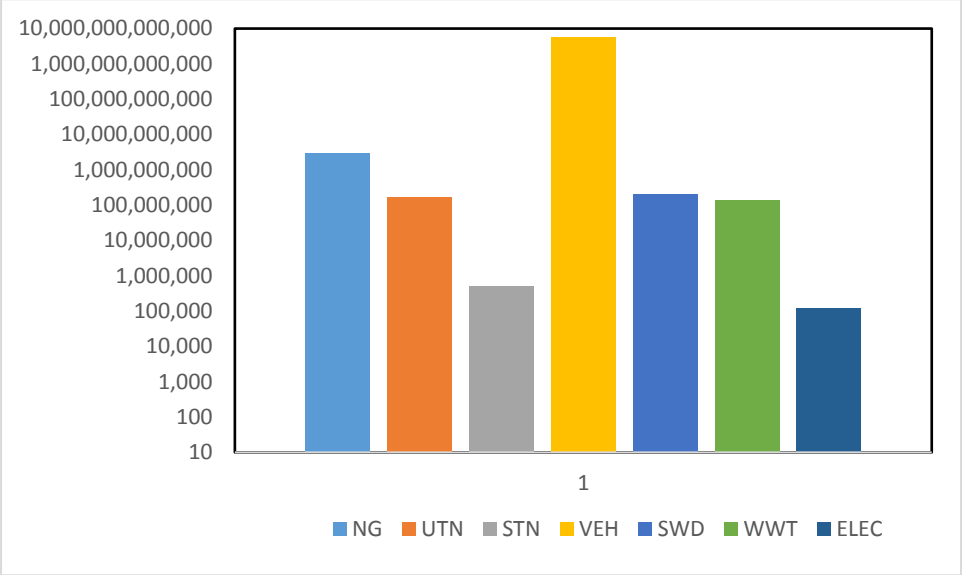

Figure 1. The sources of GHG emissions in Montreal Island in 2016

Solid waste disposal is the third largest producer of GHGs in Montreal Island. In the last five years, Montreal had a considerable increase in recovered materials, except for organic matter. The overall recovery rate for the Montréal agglomeration was 31% in 2008 (City of Montreal, 2018). Compared with Vancouver, the GHGs produced by solid waste disposal in Montreal Island are less. The fourth GHG emission source in the city was attributed to urban transportation network with 172,773 tone kg CO_2-eq. Diesel and natural gas represents the first and second major fuels for metros and buses in the area, respectively. In New York City, the main fuel source in public transportation is diesel (City of New York, 2016). The main source of trains in the city is diesel. however, owing to the travelled distance based on the calculation, STN stands in the second lowest level of CO_2-eq. Hydro Quebec is in charge of supplying the electricity in the city and the province as well. It can provide electricity from hydropower with the ratio of 99% and they just generate electricity by thermal power plants in the rate of 1% (HydroQuebec, 2018). Therefore, GHGs produced by electricity could be negligible. Wastewater contributes to the third lowest level of GHG emission in Montreal Island. But when compared with other cities in Canada such as Calgary, Toronto, and Hamilton, it still has the highest level of wastewater per capita.

4 Conclusion

GHG emissions of each sector in 2016 in Montreal Island has been estimated. The study has found that the main source of GHGs was coming from the vehicle part and then the second largest source was natural gas consumed in residential, commercial and institutional sector. Solid waste has the third highest level of CO_2 production. Urban transportation network stands in the fourth level of produced GHGs and the trains connecting Montreal Island to suburb had the second lowest GHG production. Wastewater treatment and green space are the fourth and third lowest GHG producer. To reduce urban GHG emissions, some measures such as improving the use hydropower for vehicles could be helpful for future reduction of GHG emission.

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