# i-Tree Eco Batch Run for Canada in 2010

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## 1. Introduction

i-Tree Eco was run for each of secondary partitions (equivalent to counties in the United States) in Canada using 2010 data to quantify ecosystem services provided by trees, which include:

1. Minimum, average, and maximum of annual air pollutant (CO, $NO_2$, $O_3$, $PM_{2.5}$, and $SO_2$) removals (metric tons/year).
2. Monetary value (US dollars/year) associated with air pollutant removal (externality values for CO, BenMAP health effects for $NO_2$, $O_3$, $PM_{2.5}$, and $SO_2$).
3. Hydrologic parameters
   a. Transpiration ($m^3$/year)
   b. Evaporation ($m^3$/year)
   c. Rainfall Interception ($m^3$/year)
   d. Avoided Runoff ($m^3$/year)

To calculate these, tree cover (%), evergreen (%), maximum leaf area index (LAI) in the growing season, impervious cover (%) for each secondary partition, as well as hourly surface weather, upper air (height and temperature), and air pollutant concentration data measured within or at the closest monitor station were employed. This document presents maps showing these parameters and measuring locations, as well as the source for these data. The complete list of the metadata is provided in the associated file.

## 2. Data Employed

### 2.1. Land Cover

Land cover data from Earth Observation for Sustainable Development of forest (EOSD) land cover data (Canadian Council of Forest Ministers 2022) (Fig. 1) were employed. As can be seen in Fig. 1, land cover data are for some part in the country. The North American Land Change Monitoring System (NALCMS)'s 2005 North American Land Cover data (Commission for Environmental Cooperation 2022) (Fig. 2) was employed to fill the gap.

Of the EOSD land cover classifications, Broadleaf (Dense, Open, Sparse), Coniferous (Dense, Open, Sparse), and Mixed Wood (Dense, Open, Sparse) were used to derive tree cover percent (Fig. 3), while the ratio of

Coniferous vs. Coniferous+Broadleaf was used to derive the evergreen tree percent (Fig.4) for each of the secondary partitions.

Of the NALCMS land cover classifications, "Temperate or sub-polar needleleaf forest", "Sub-polar taiga needleleaf forest", "Tropical or sub-tropical broadleaf evergreen forest", "Tropical or sub-tropical broadleaf deciduous forest", "Temperate or sub-polar broadleaf deciduous forest", and "Mixed forest" were used to derive tree cover percent for the missing part (Fig. 3). Treating "Temperate or sub-polar needleleaf forest", "Sub-polar taiga needleleaf forest" and "Tropical or sub-tropical broadleaf evergreen forest" as evergreen, while "Tropical or sub-tropical broadleaf deciduous forest" and "Temperate or sub-polar broadleaf deciduous forest" as deciduous, evergreen tree percent was derived for the missing part (Fig. 4).

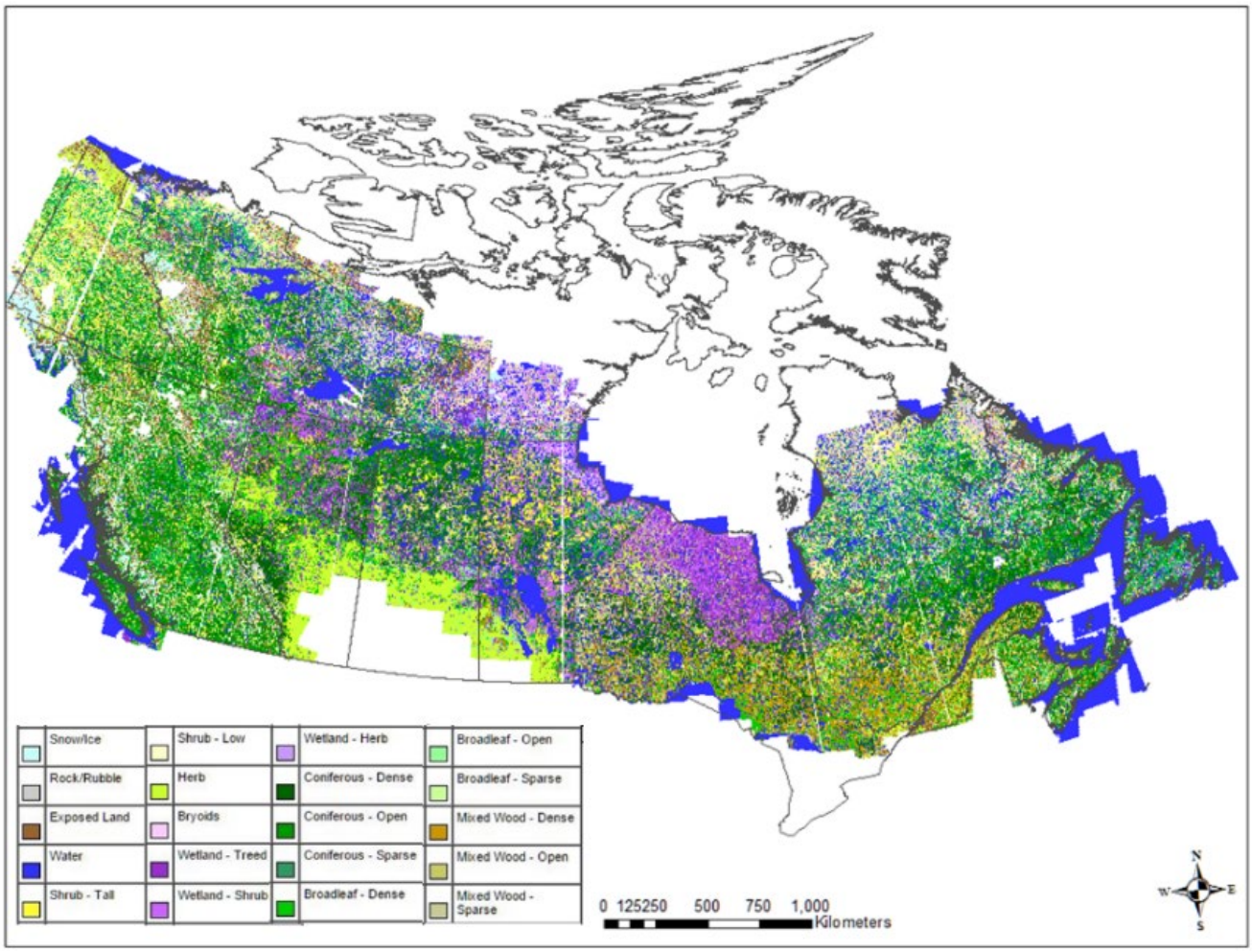


Figure 1 Earth Observation for Sustainable Development of forest (EOSD) land cover data

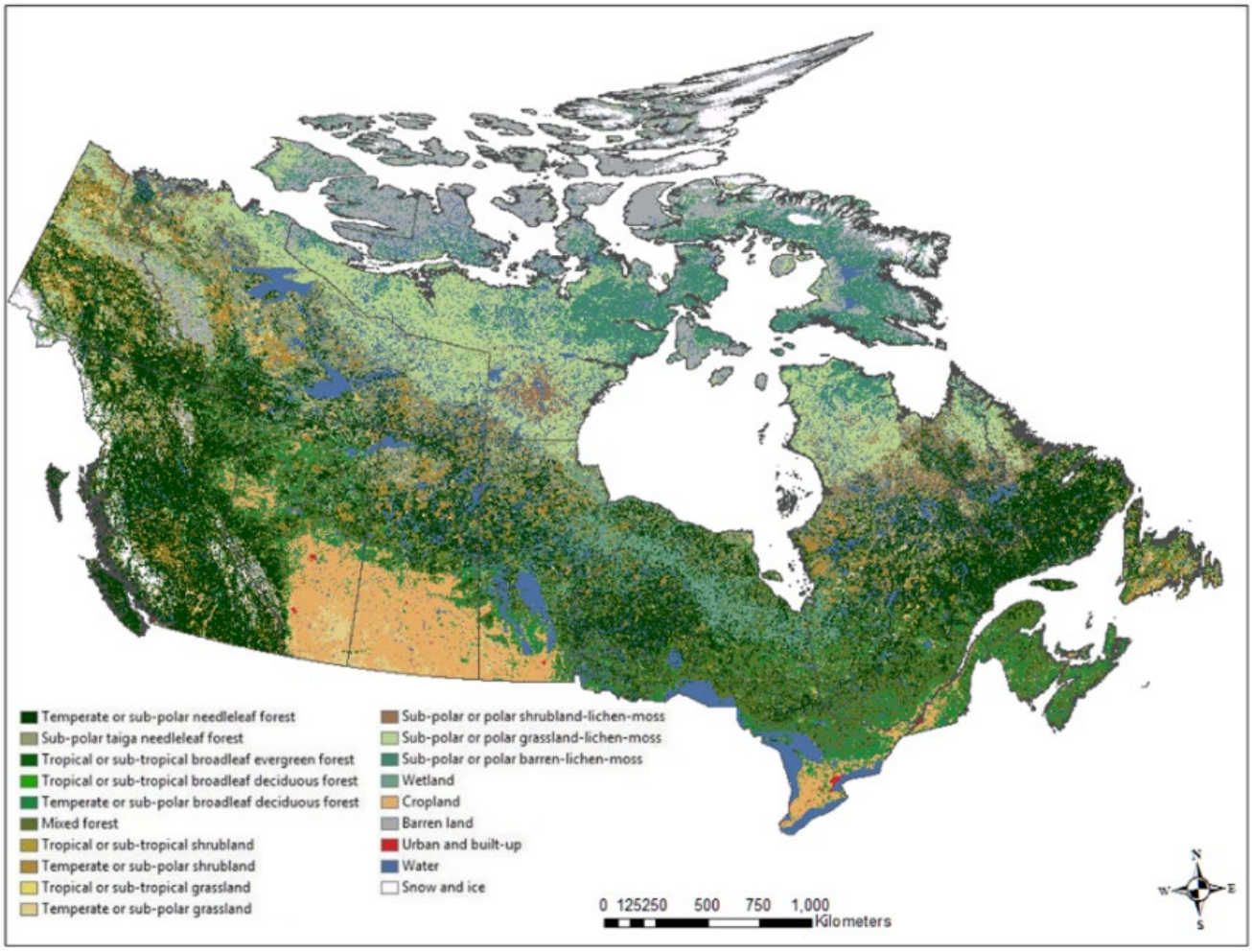


Figure 2 2005 North American Land Cover at 250 m spatial resolution data

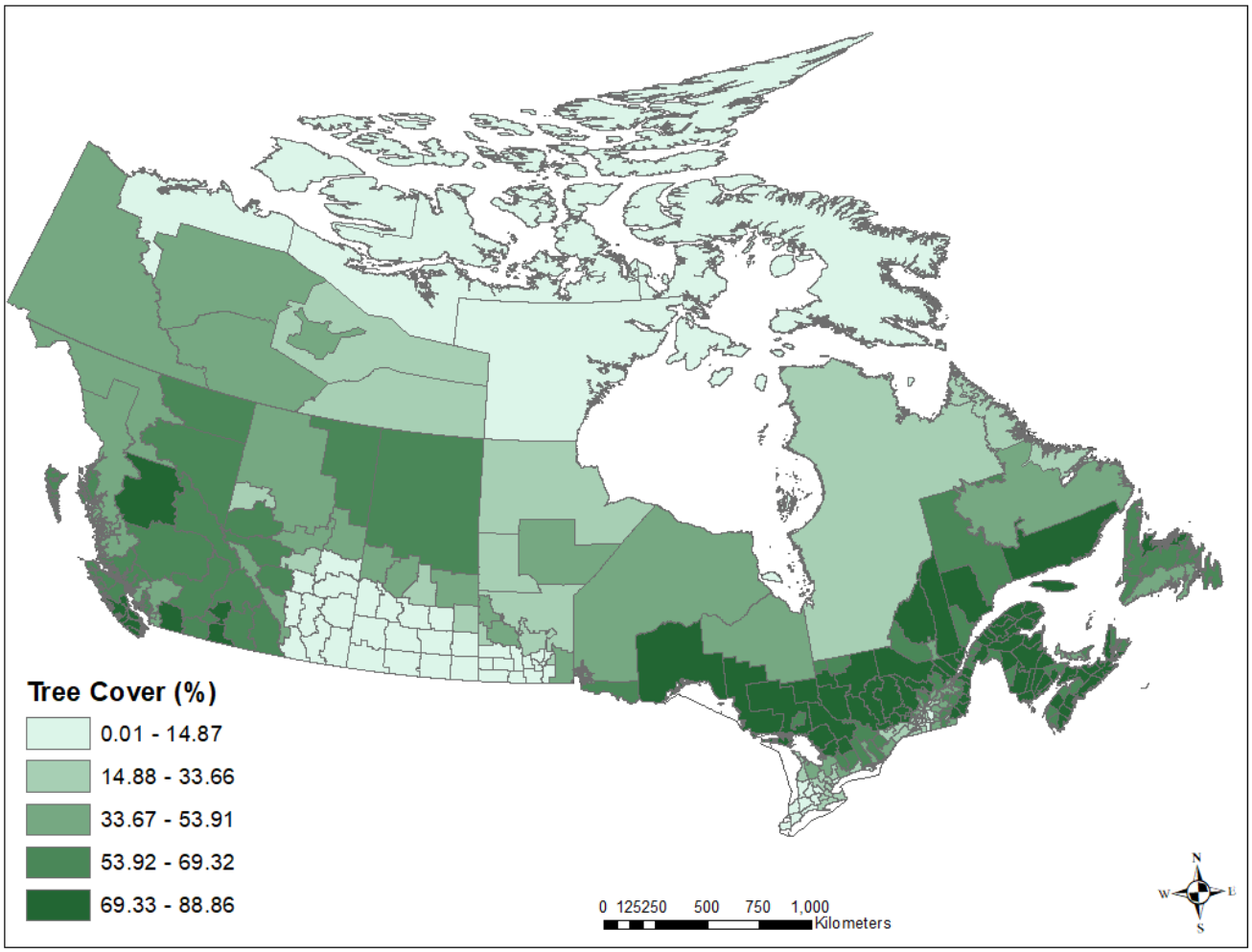


Figure 3 Tree cover percent

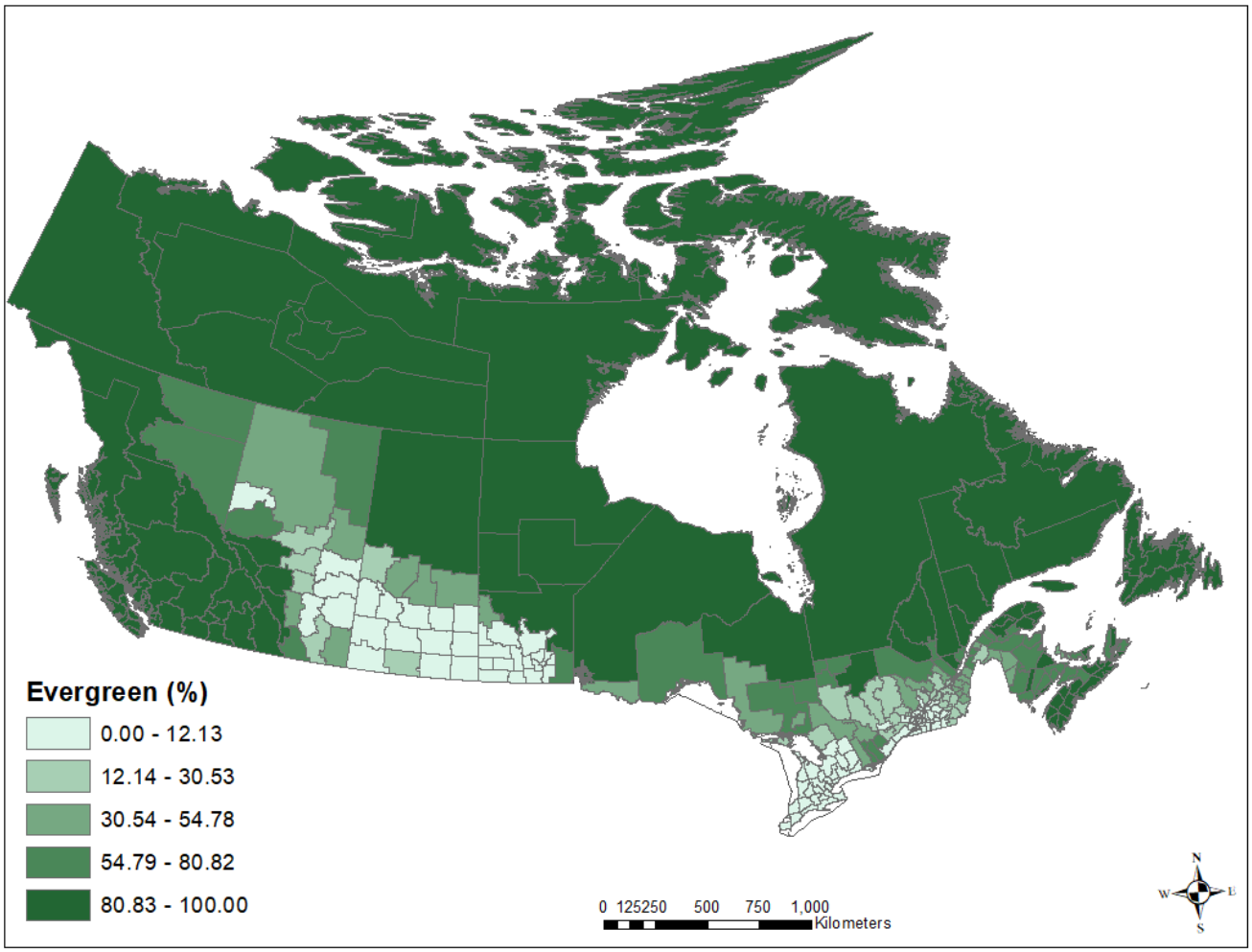


Figure 4 Evergreen tree percent

Maximum (mid-summer) leaf area index (LAI: $m^2$ leaf area per $m^2$ projected ground area of canopy) values for each secondary partition (Fig. 5) were derived from the level-4 MODIS/Terra global Leaf Area Index product (NASA 2022) for the growing season. The year 2010 was used.

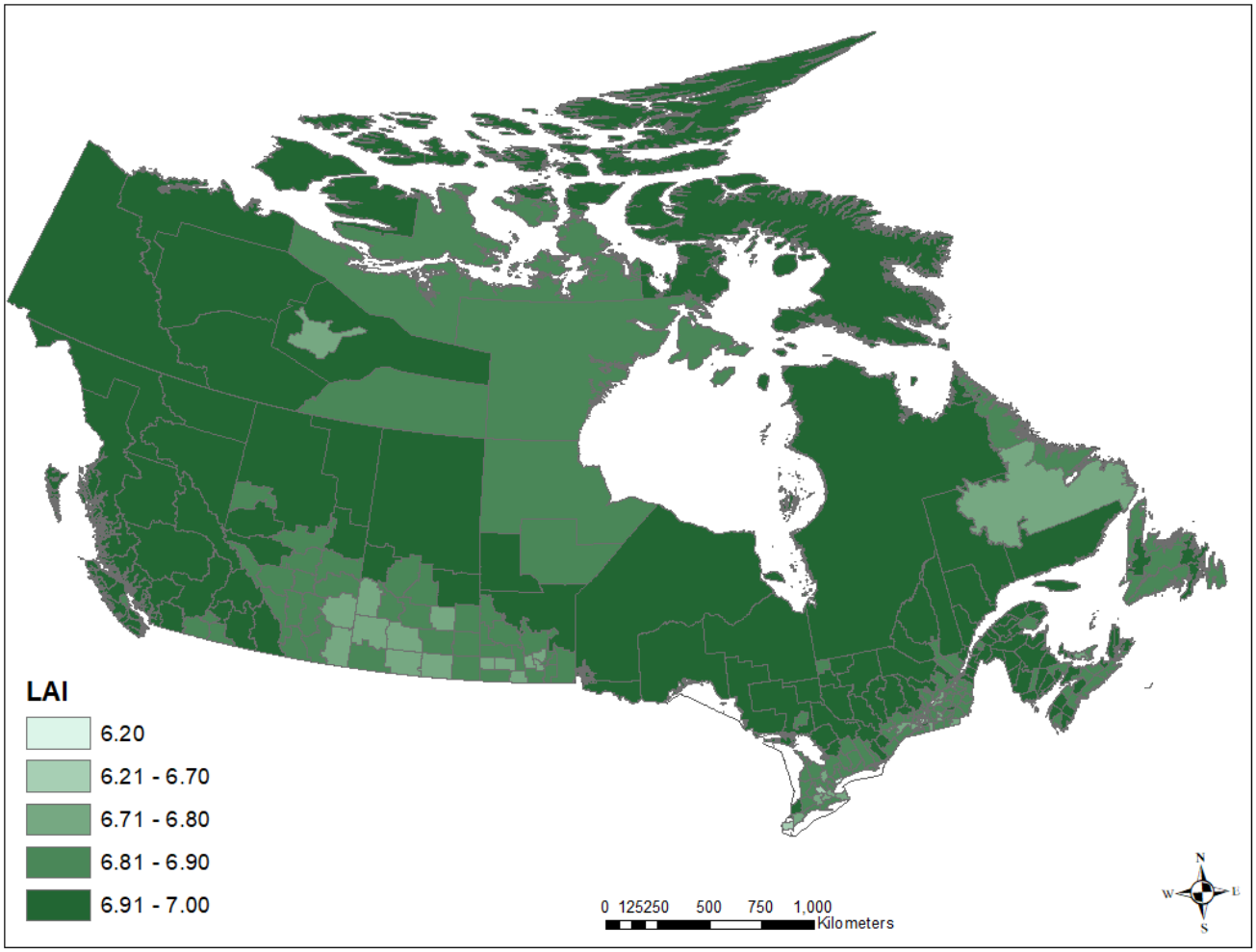


Figure 5 Leaf Area Index

"Urban" class in the NALCMS' Land Cover data was used to derive impervious cover for the secondary partitions (Fig. 6).

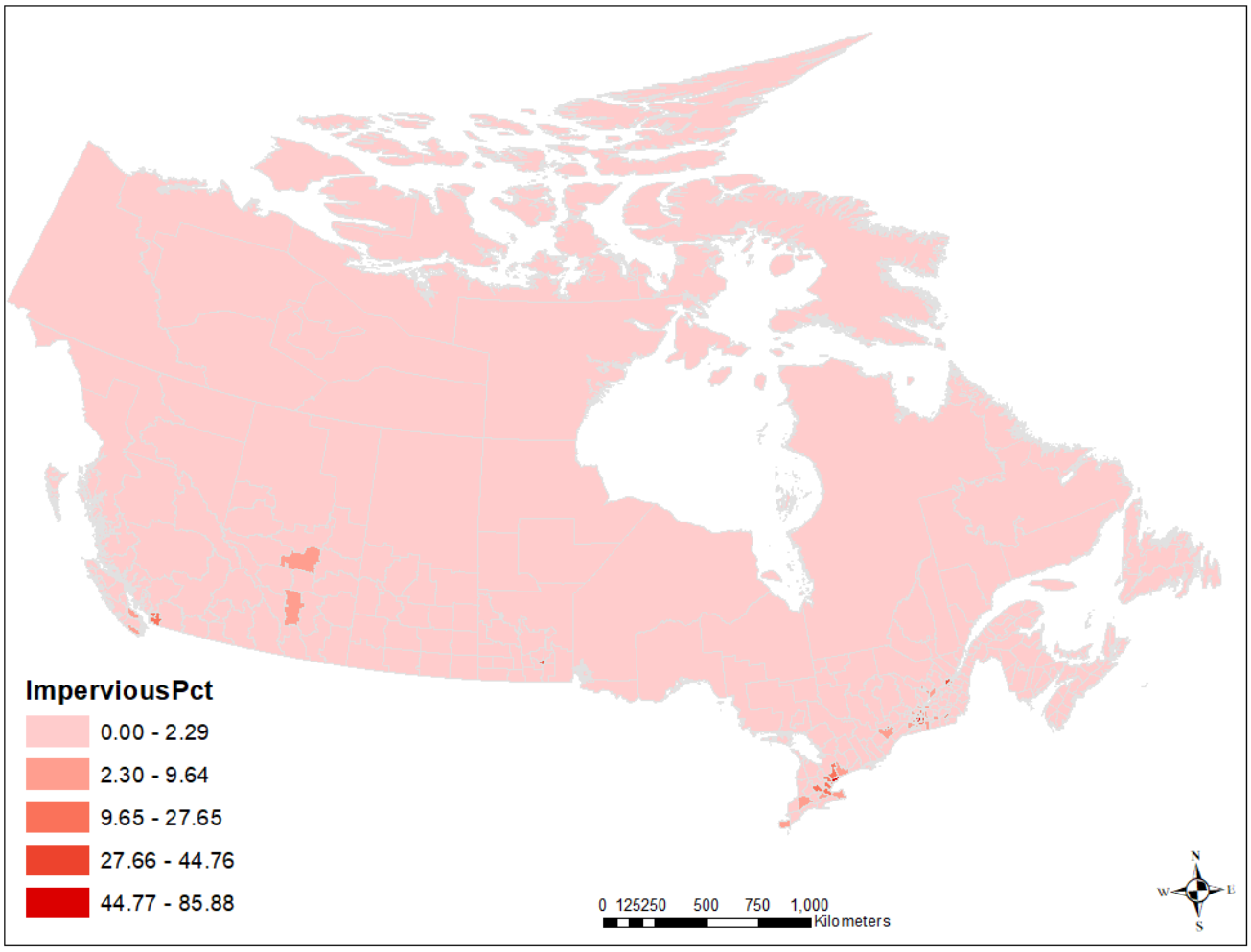


Figure 6 Impervious cover percent

## 2.2. Monitoring Stations

### 1.1.1. Surface Weather Stations

Hourly surface weather data for 2010 were employed from National Centers for Environmental Information (NCEI) of National Oceanic and Atmospheric Administration (NOAA) (National Centers for Environmental Information (NCEI) 2022). Measurements at the station closest to the centroid of each secondary partition were used. The station names and locations were presented in Fig. 7. Since the measurements in Canada generally lack hourly precipitation data (PCP01), 6-hour data (PCP06) were disaggregated into the previous 6 hours.

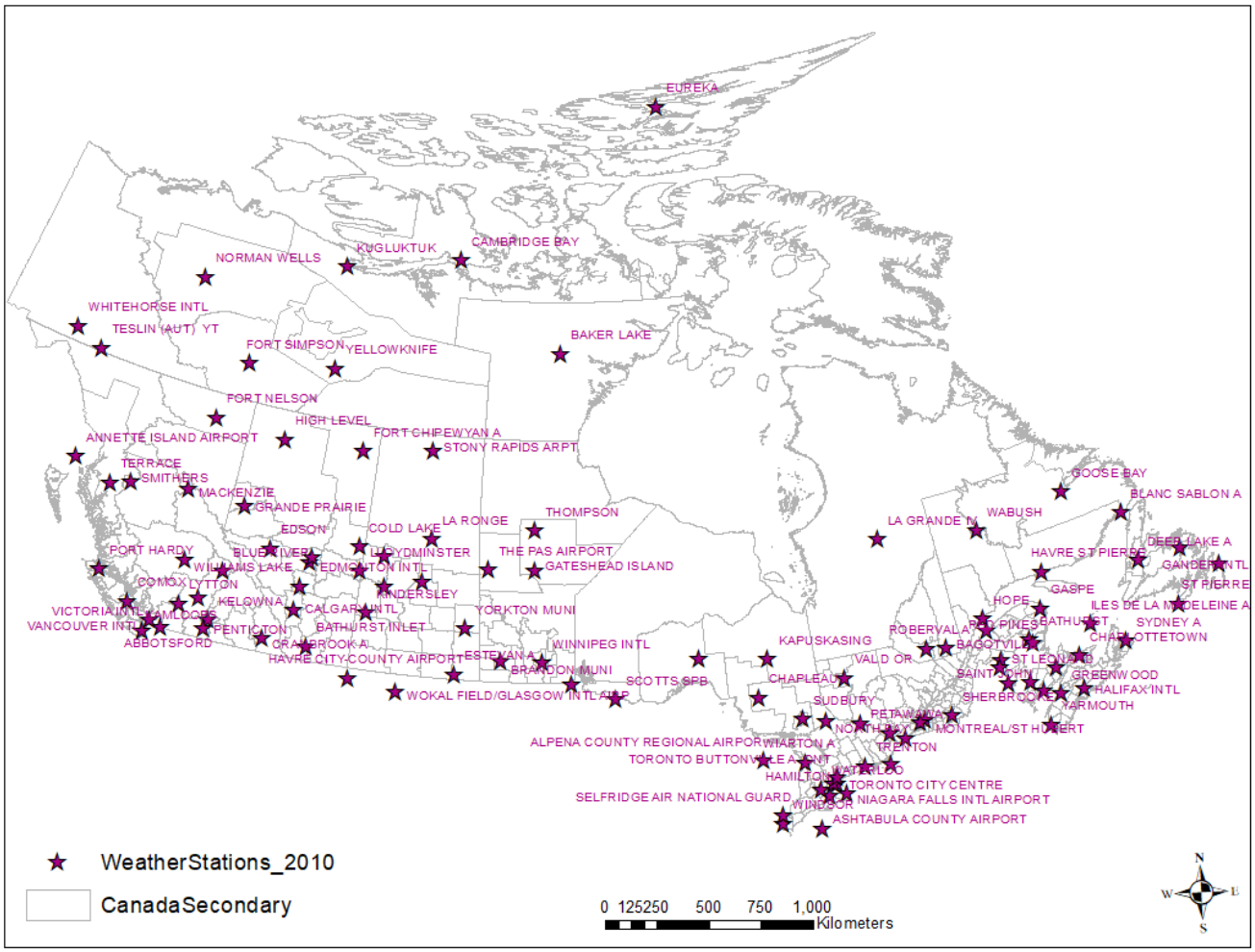


Figure 7 Surface weather stations

### 1.1.2. Radiosonde Stations (Upper Air)

Radiosonde data for 2010 obtained from Earth System Research Laboratory (ESRL) of NOAA (Earth System Research Laboratory (ESRL) 2022) were used. Measurements at the station closest to the centroid of each secondary partition were used. The station names and locations were presented in Fig. 8.

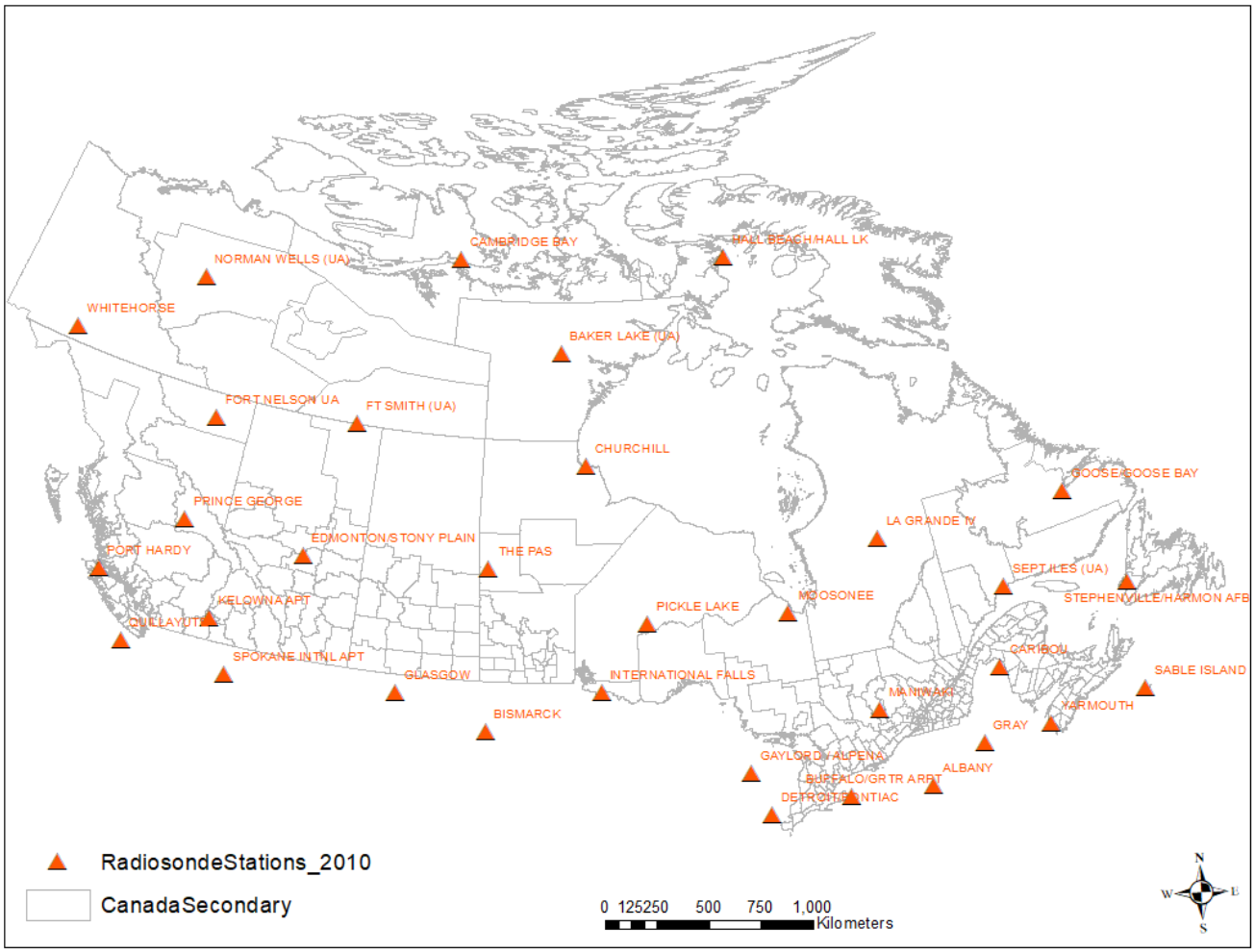


Figure 8 Radiosonde stations

### 1.1.3. Air pollutant monitors

CO, $NO_2$, $O_3$, $PM_{2.5}$, and $SO_2$ data for 2010 obtained from National Air Pollution Surveillance (NAPS) Program (Government of Canada 2022) were used. When multiple monitors were located within the boundary of a secondary partition these monitor data were all used to calculate hourly air pollutant removal estimates and the average across the monitor location was taken for the yearly estimate. When only one monitor was included in a secondary partition, that monitor was used, while when no monitor was included the one closest to the centroid of the partition was used. The location and monitor ID's used in i-Tree Eco for monitors used in the batch processes were presented in Figs. 9 – 13.

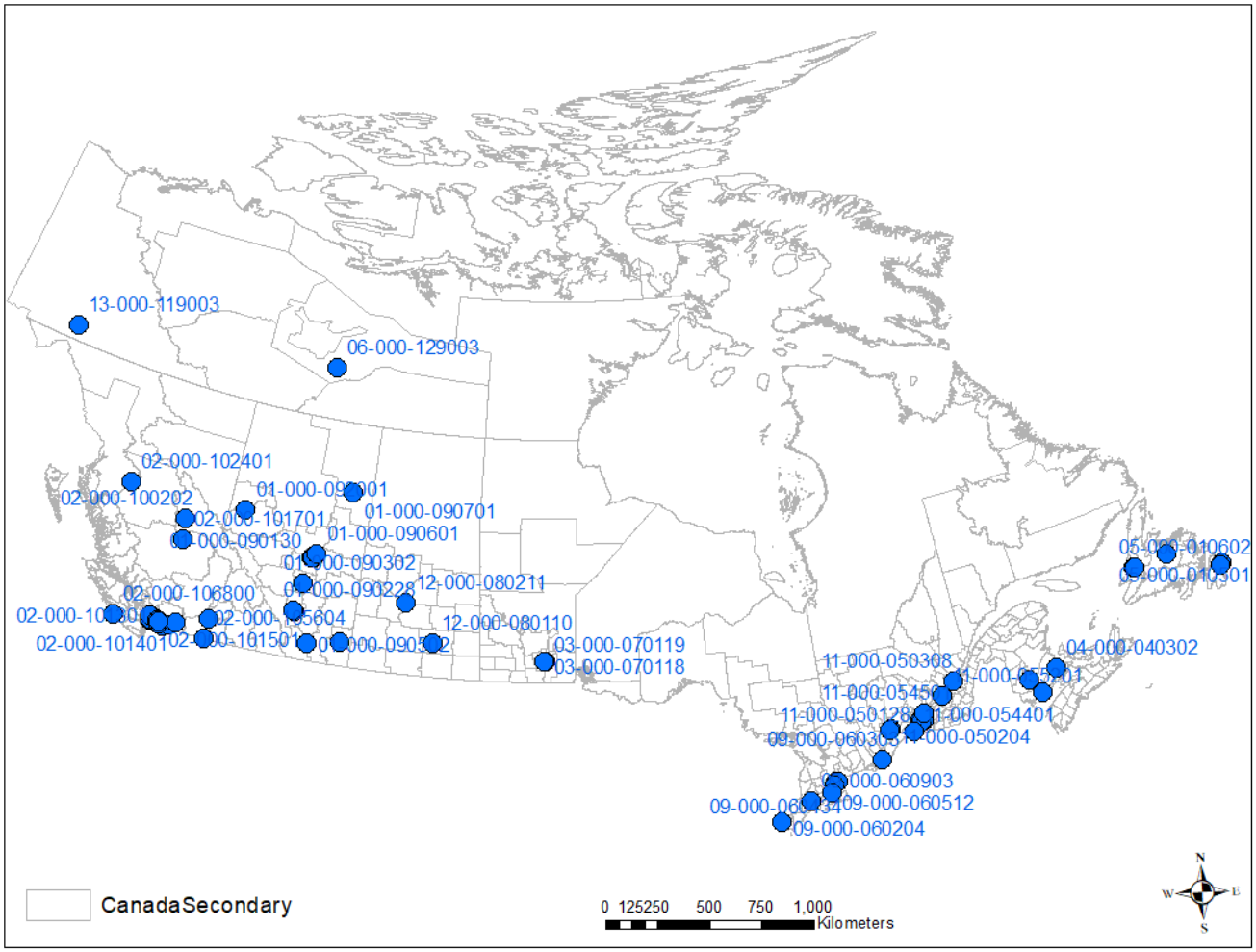


Figure 9 CO monitors

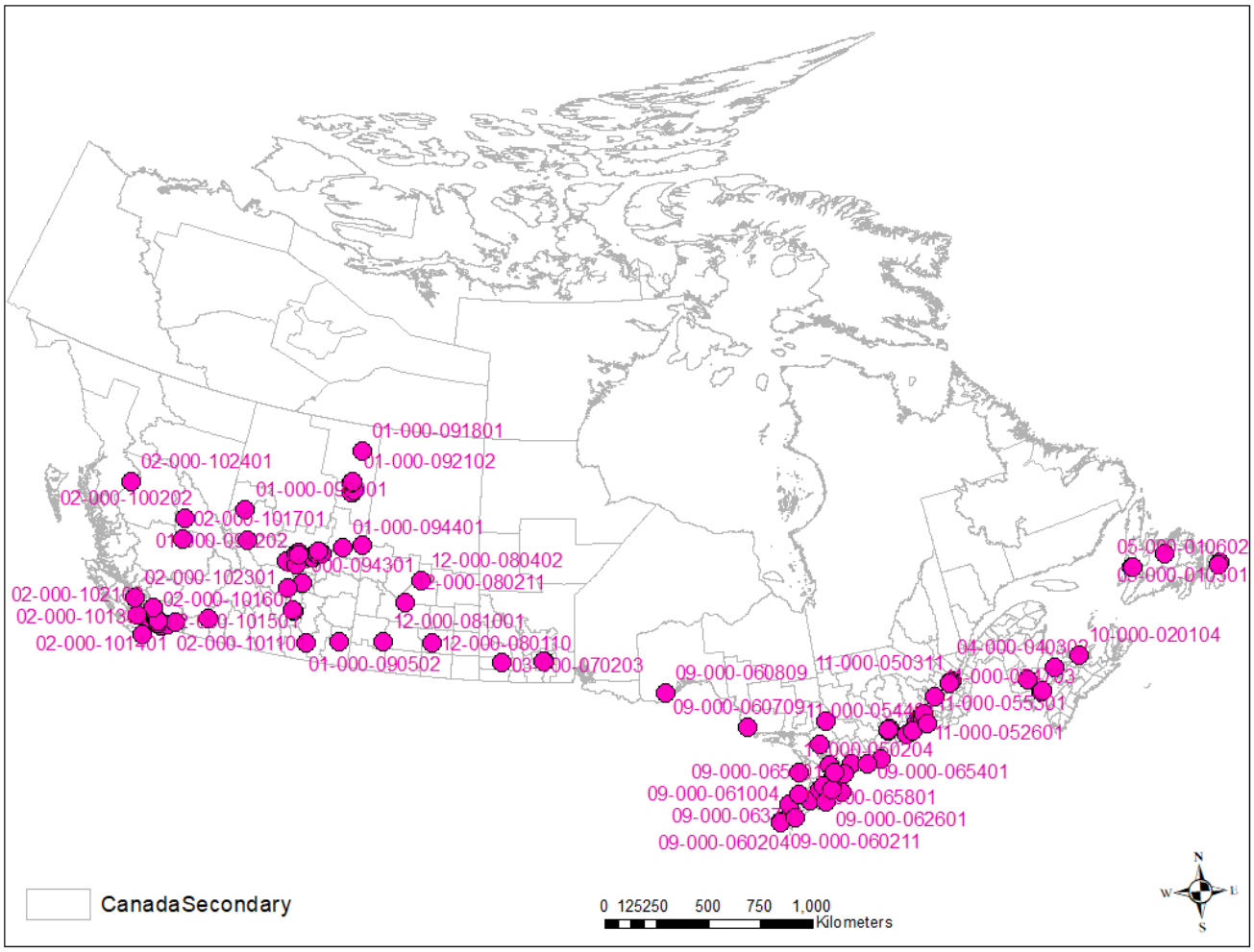


Figure 10 $NO_2$ monitors

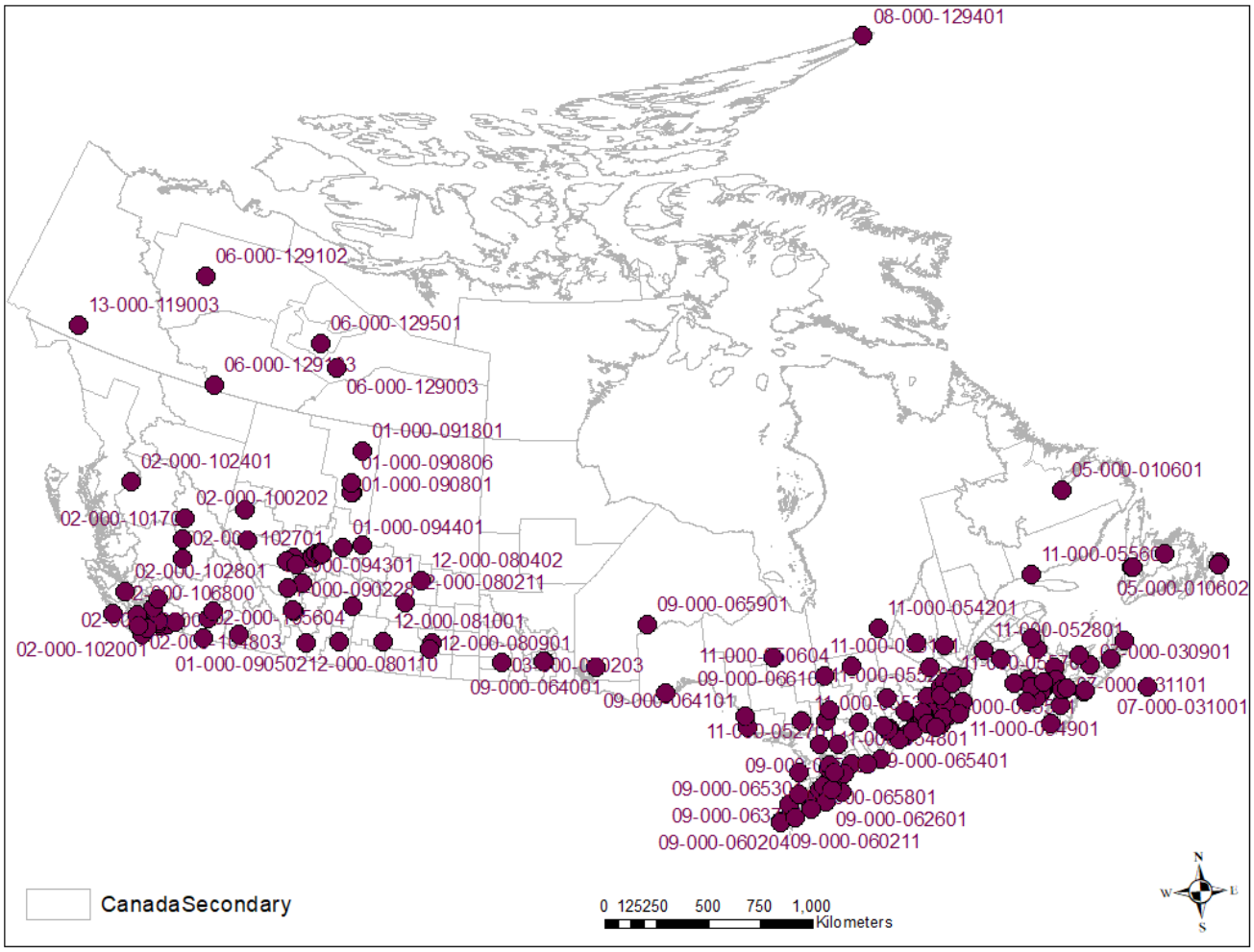


Figure 11 $O_3$ monitors

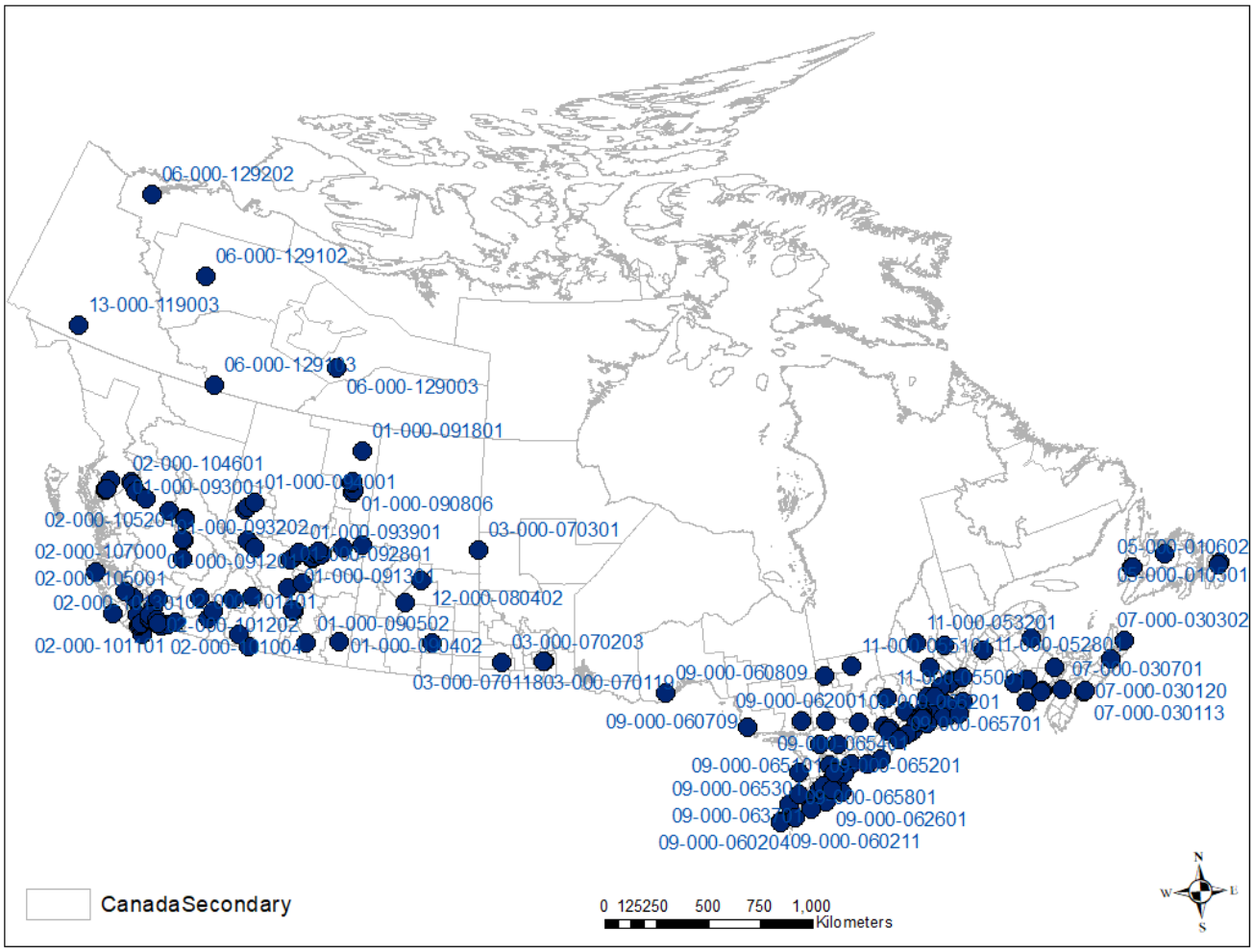


Figure 12 $PM_{2.5}$ monitors

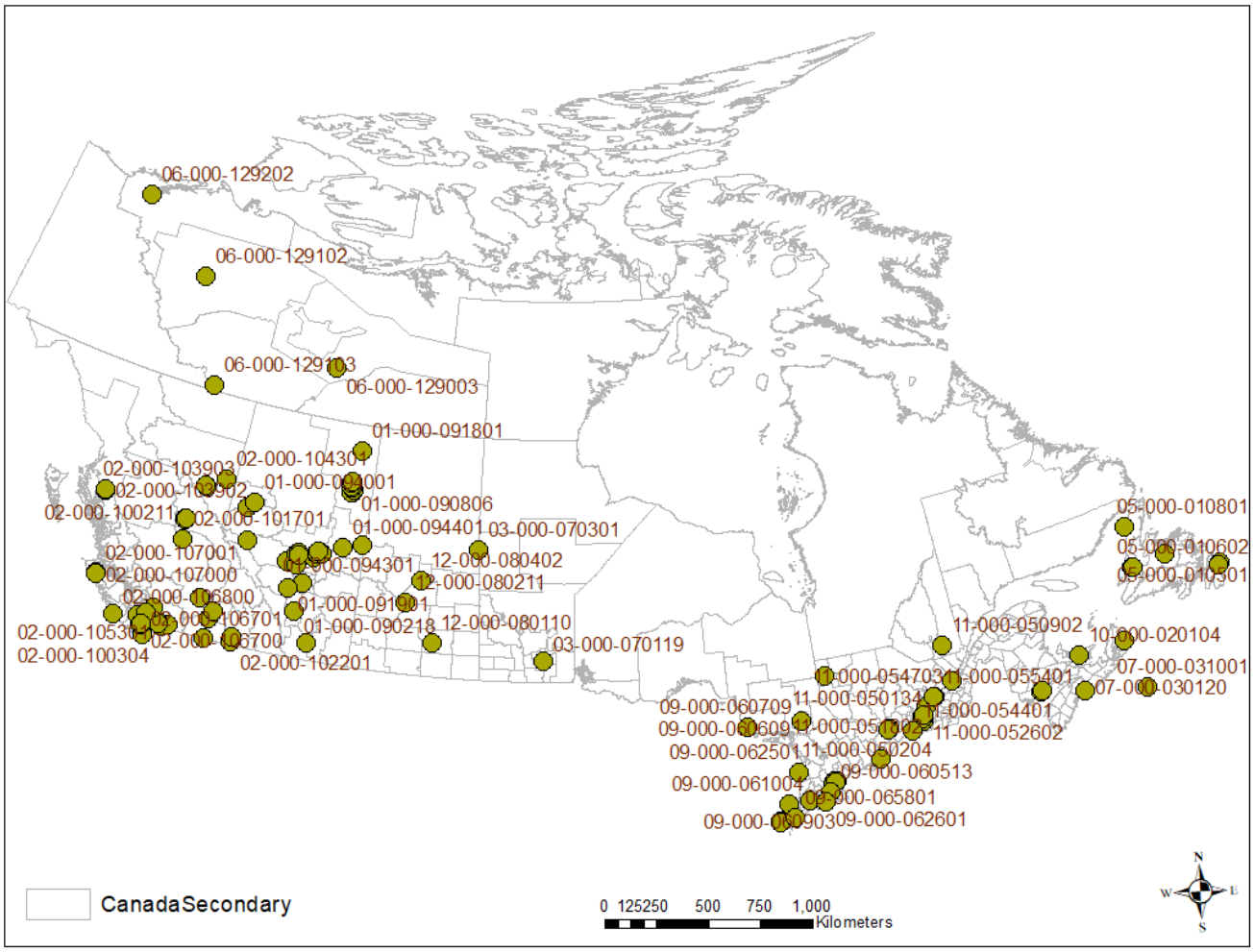


Figure 13 $SO_2$ monitors

## 3. Results

Tables 1 and 2 present examples for air pollutant removal and hydrologic parameters, respectively, estimated by batch-running i-Tree Eco for secondary partitions.

Table 1 Example of air pollutant removal results

| Primary Partition ID | Primary Partition Name | Secondary Partition ID | Secondary Partition Name | Pollutant | Benefit Value (US$/yr) | Avg Removal Rate (t/yr) | Min Removal Rate (t/yr) | Max Removal Rate (t/yr) |
|---|---|---|---|---|---|---|---|---|
| 01 | Alberta | 001 | Division No. 1 | CO | 7046.5 | 4.7 | 4.7 | 4.7 |
| 01 | Alberta | 001 | Division No. 1 | NO2 | 326.2 | 119.1 | 98.3 | 129.0 |
| 01 | Alberta | 001 | Division No. 1 | O3 | 19249.1 | 839.9 | 533.9 | 998.8 |
| 01 | Alberta | 001 | Division No. 1 | PM2.5 | 53775.8 | 60.1 | 9.4 | 165.5 |
| 01 | Alberta | 001 | Division No. 1 | SO2 | 3.1 | 3.5 | 3.3 | 3.8 |

Table 2 Example of hydrologic parameter results

| Primary Partition ID | Primary Partition Name | Secondary Partition ID | Secondary Partition Name | Transpiration (m3/yr) | Evaporation (m3/yr) | Vegetation Interception (m3/yr) | Avoided Runoff (m3/yr) |
|---|---|---|---|---|---|---|---|
| 01 | Alberta | 001 | Division No. 1 | 24758207 | 13275790 | 13424225 | 16119.65 |
| 01 | Alberta | 002 | Division No. 2 | 12832985 | 9951359 | 9987361 | 20752.15 |
| 01 | Alberta | 003 | Division No. 3 | 1.85E+08 | 2.22E+08 | 2.23E+08 | 145244.3 |
| 01 | Alberta | 004 | Division No. 4 | 7255236 | 5424044 | 5440071 | 791.2827 |
| 01 | Alberta | 005 | Division No. 5 | 8627727 | 4628278 | 4658865 | 2524.123 |

## 4. References

Canadian Council of Forest Ministers. 2022. *Earth Observation for Sustainable Development of Forests (EOSD).* Accessed 7 7, 2022. https://ca.nfis.org/maps_eng.html.

Commission for Environmental Cooperation. 2022. *Land Cover, 2005 (MODIS, 250m).* Accessed 7 7, 2022. http://www.cec.org/north-american-environmental-atlas/land-cover-2005-modis-250m/.

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NASA. 2022. *MODIS - MODERATE RESOLUTION IMAGING SPECTRORADIOMETER -.* 7 6. https://modis.gsfc.nasa.gov/data/dataprod/mod15.php#:~:text=MODIS%20Leaf%20Area%20Index%2FF

PAR,-
Overview&text=LAI%20is%20defined%20as%20the,nm)%20absorbed%20by%20green%20vegetation.

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