i-Tree Eco Batch Run for Mexico in 2015

7/12/2022

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1. Introduction

i-Tree Eco was run for each of primary and secondary partitions in Mexico (Figs.1 and 2, respectively) using 2015 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_{10*}, $PM_{2.5}$, and SO_2) removals (metric tons/year).
2. Monetary value (US dollars/year) associated with air pollutant removal (externality values for CO, PM_{10*}, 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 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 files for primary and secondary partitions, respectively.

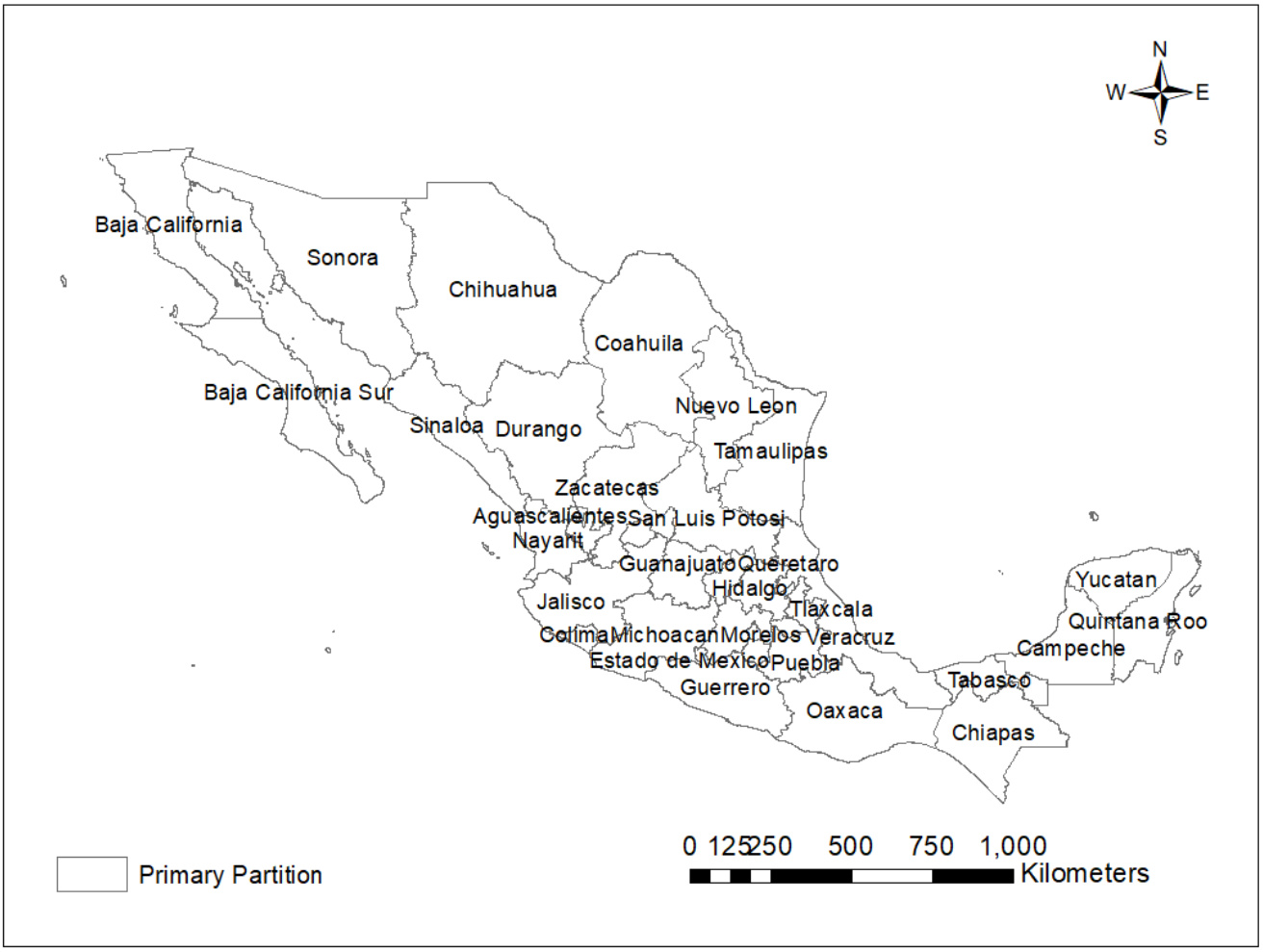

Figure 1 Primary partitions in Mexico

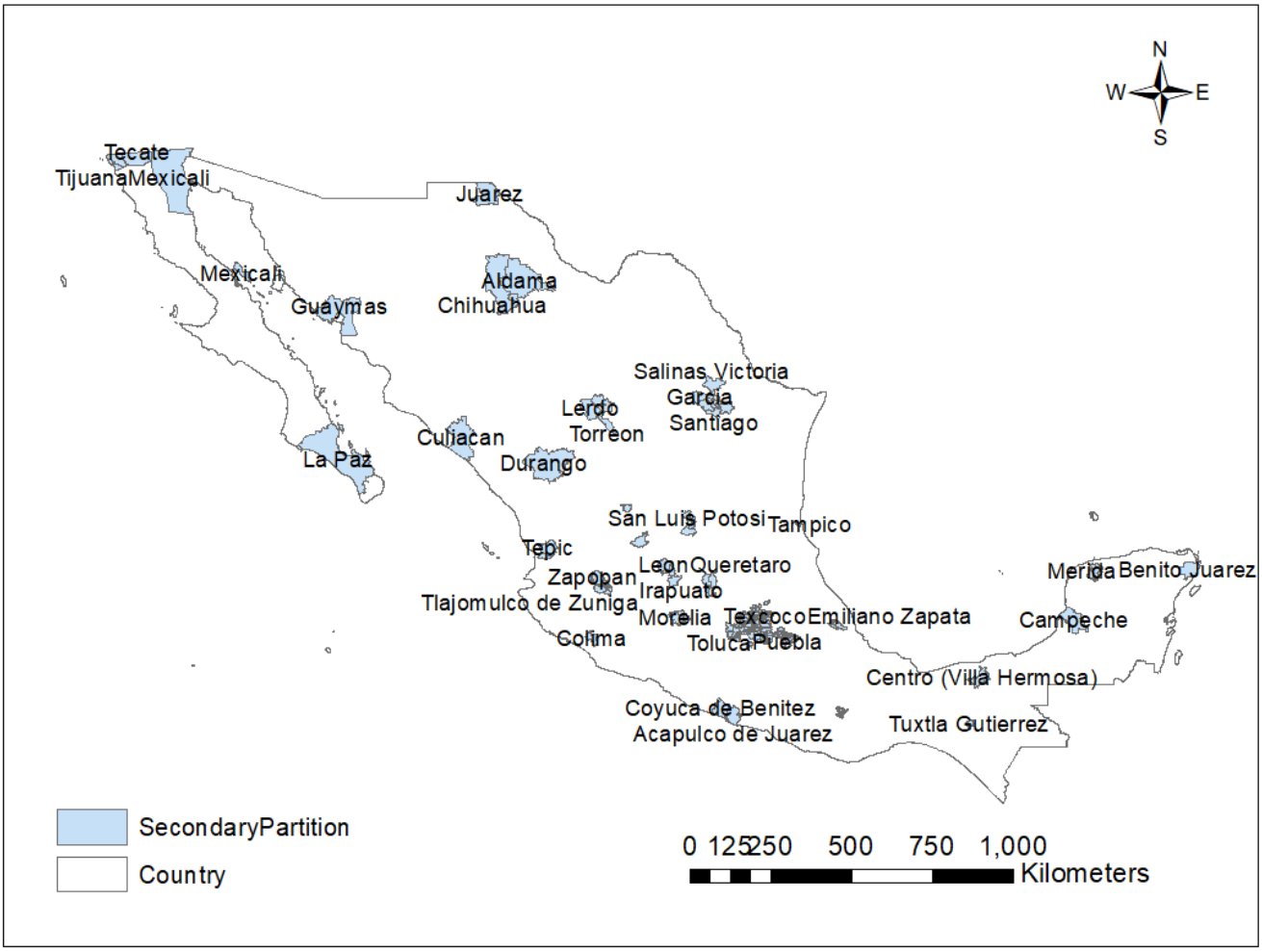

Figure 2 Secondary partitions in Mexico

2. Data Employed

2.1. Land Cover

Land cover data from the Multi-Resolution Land Characteristics Consortium (MRLC)'s 2015 North American Land Change Monitoring System (NALCMS) (Multi-Resolution Land Characteristics Consortium 2022) (Fig.3) was employed.

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 primary and secondary partitions (Figs. 4 and 5, respectively). 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 partitions (Figs. 6 and 7).

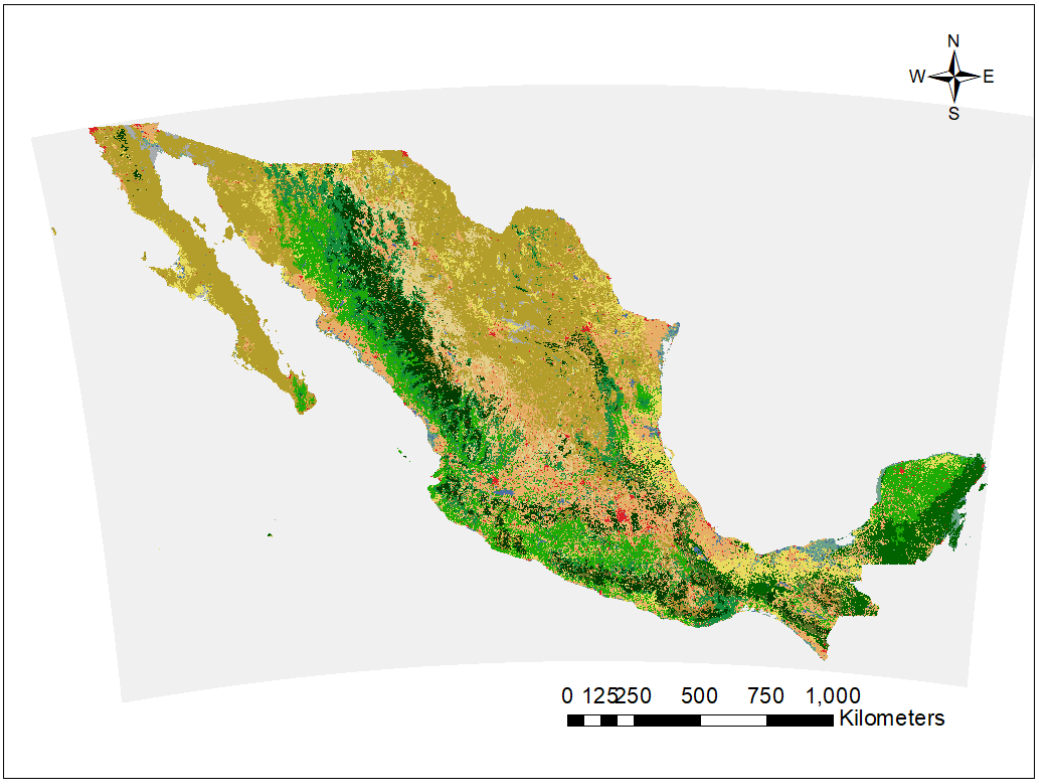

Figure 3 Land cover

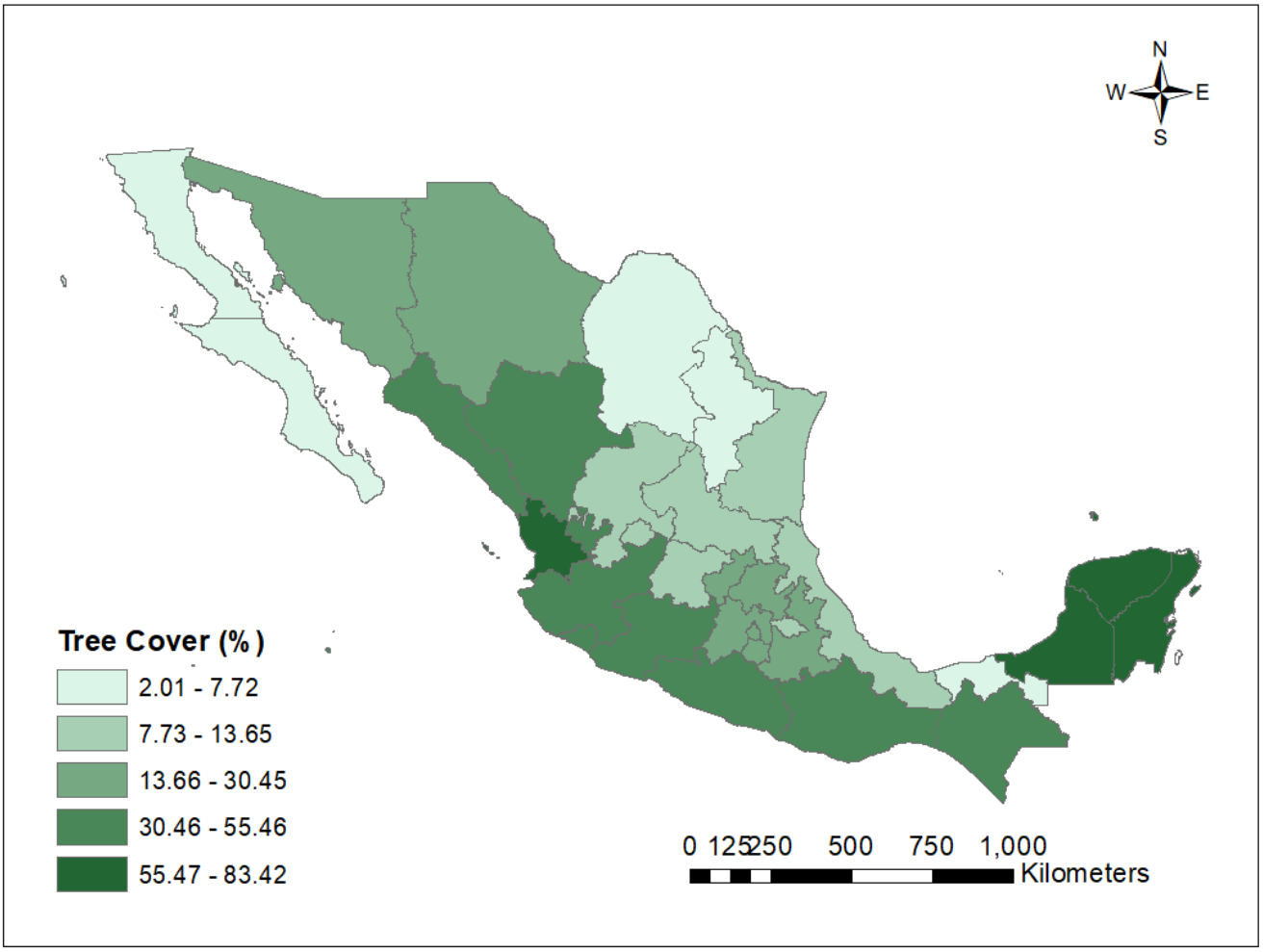

Figure 4 Tree cover percent for primary partitions

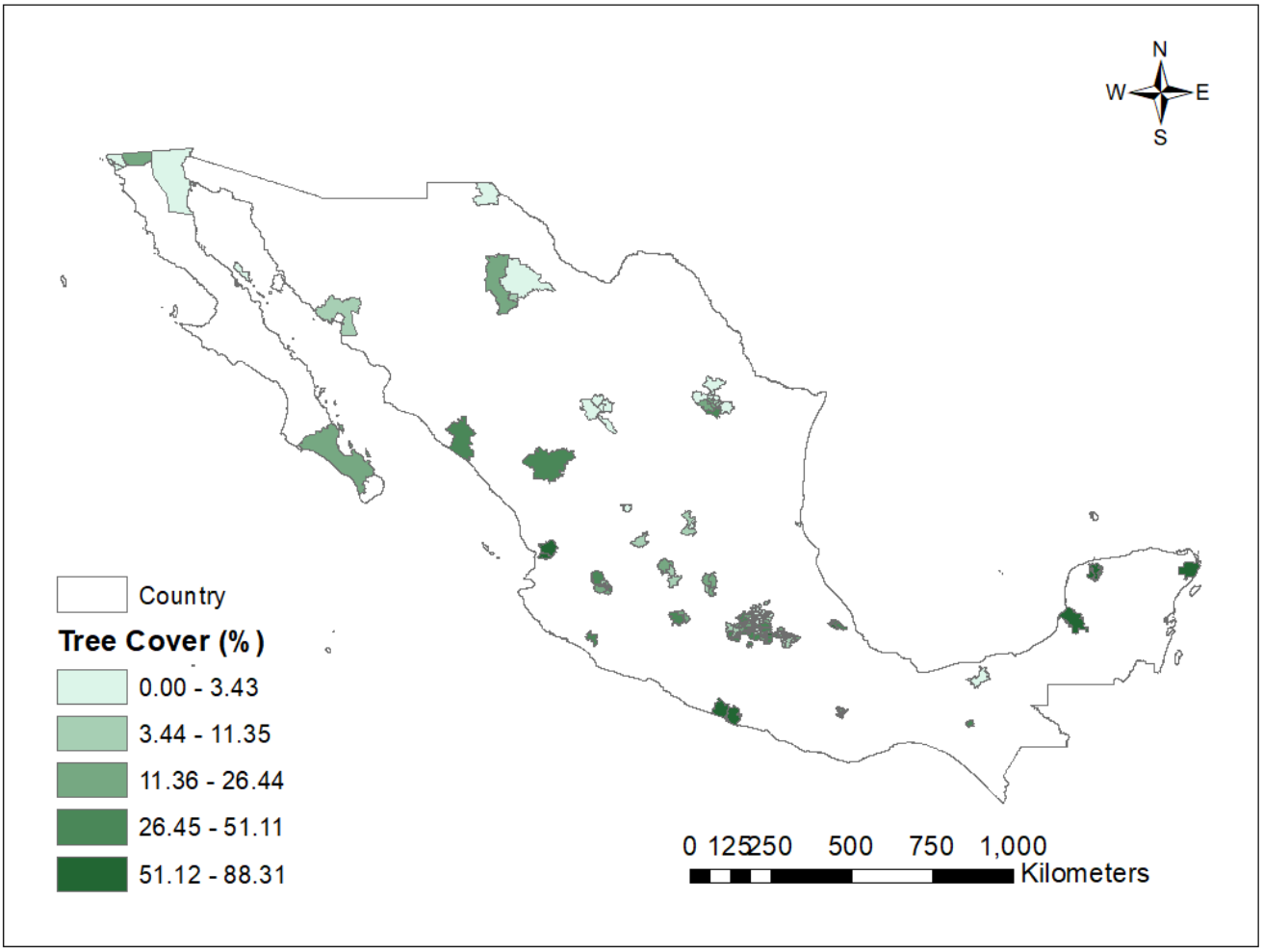

Figure 5 Tree cover percent for secondary partitions

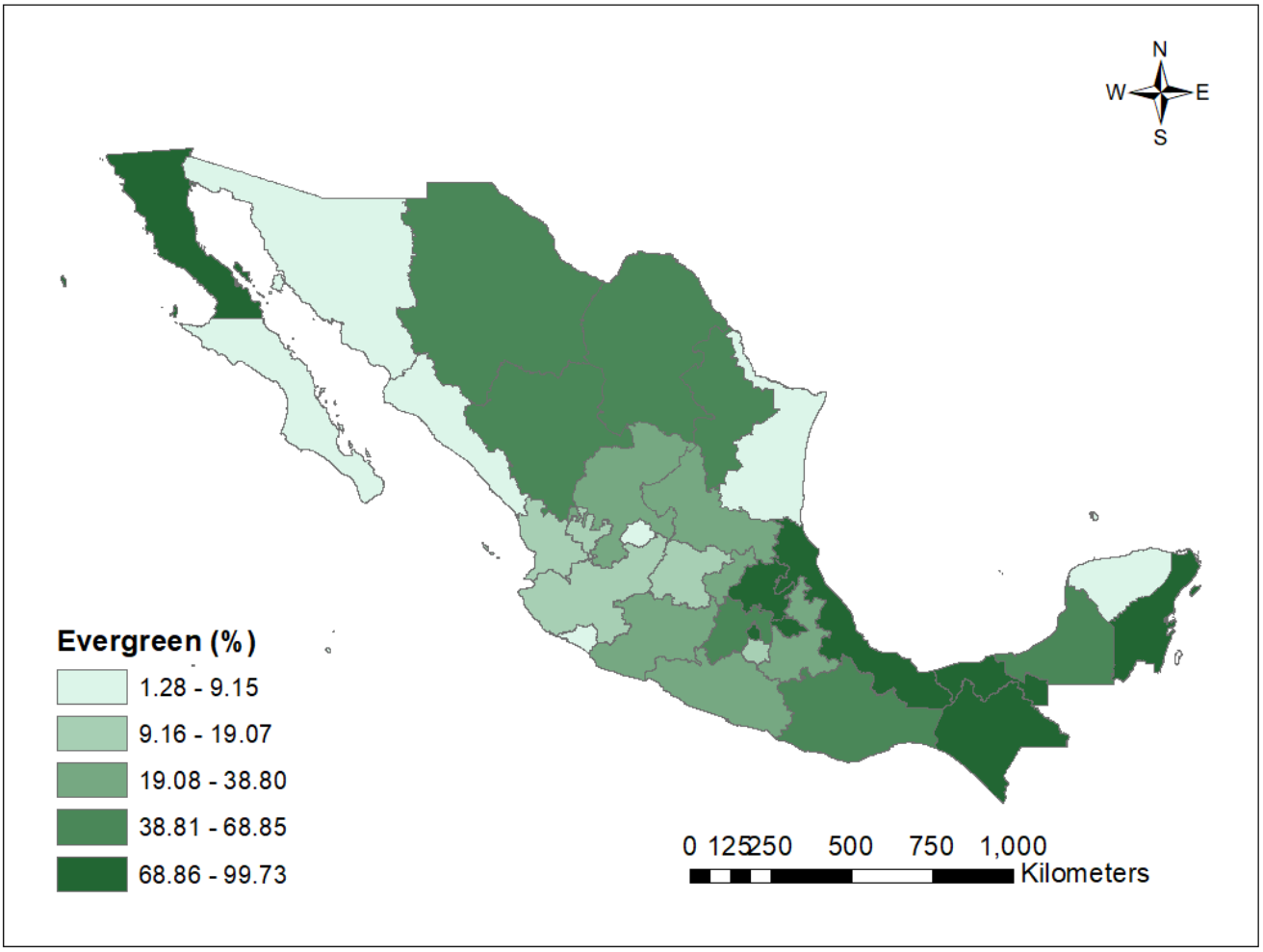

Figure 6 Evergreen percent for primary partitions

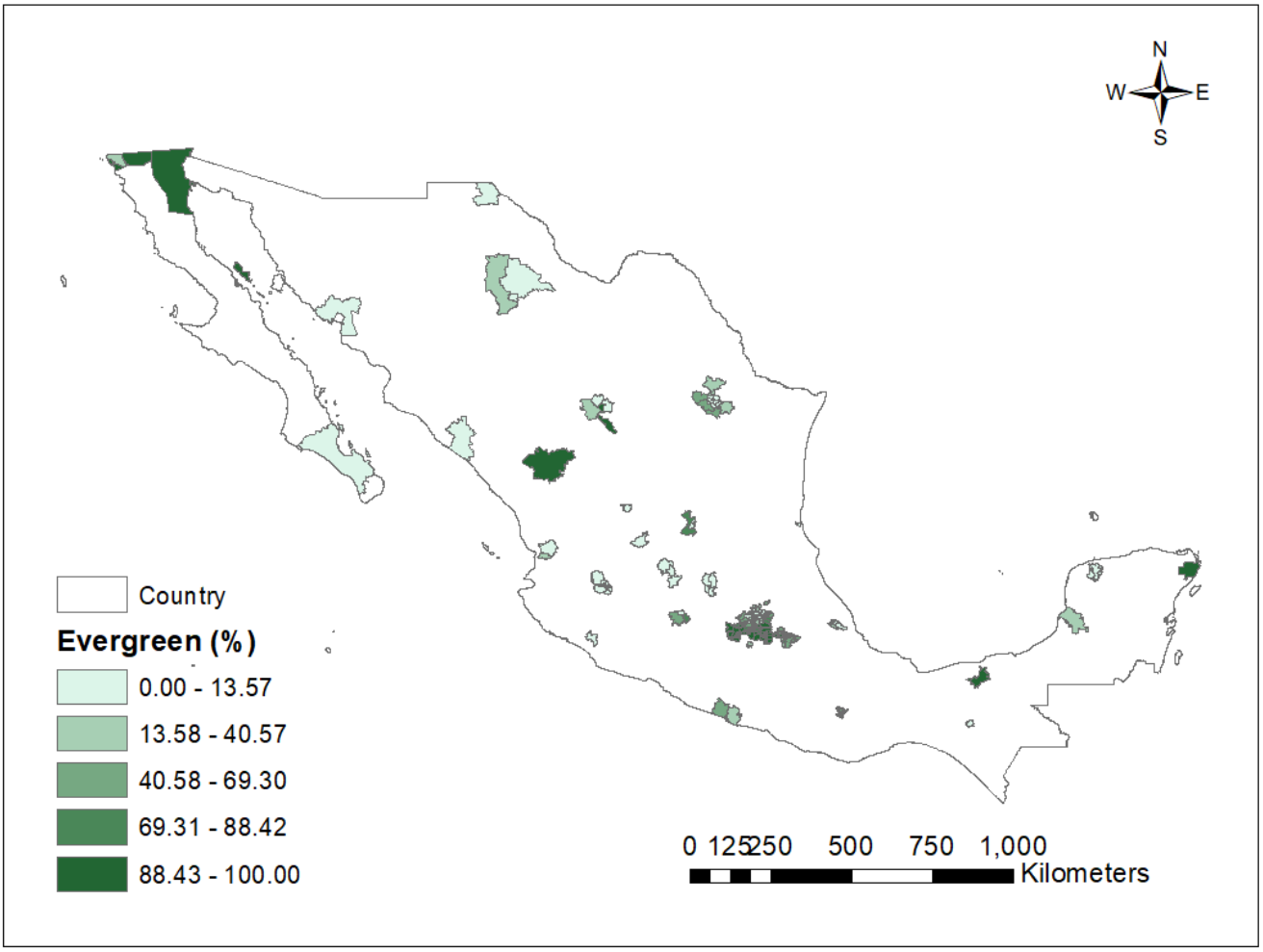

Figure 7 Evergreen percent for secondary partitions

Maximum (mid-summer) leaf area index (LAI: m^2 leaf area per m^2 projected ground area of canopy) values for each primary and secondary partition (Figs. 8 and 9) were derived from the level-4 MODIS/Terra global Leaf Area Index product (NASA 2022) for the growing season. The year 2015 was used.

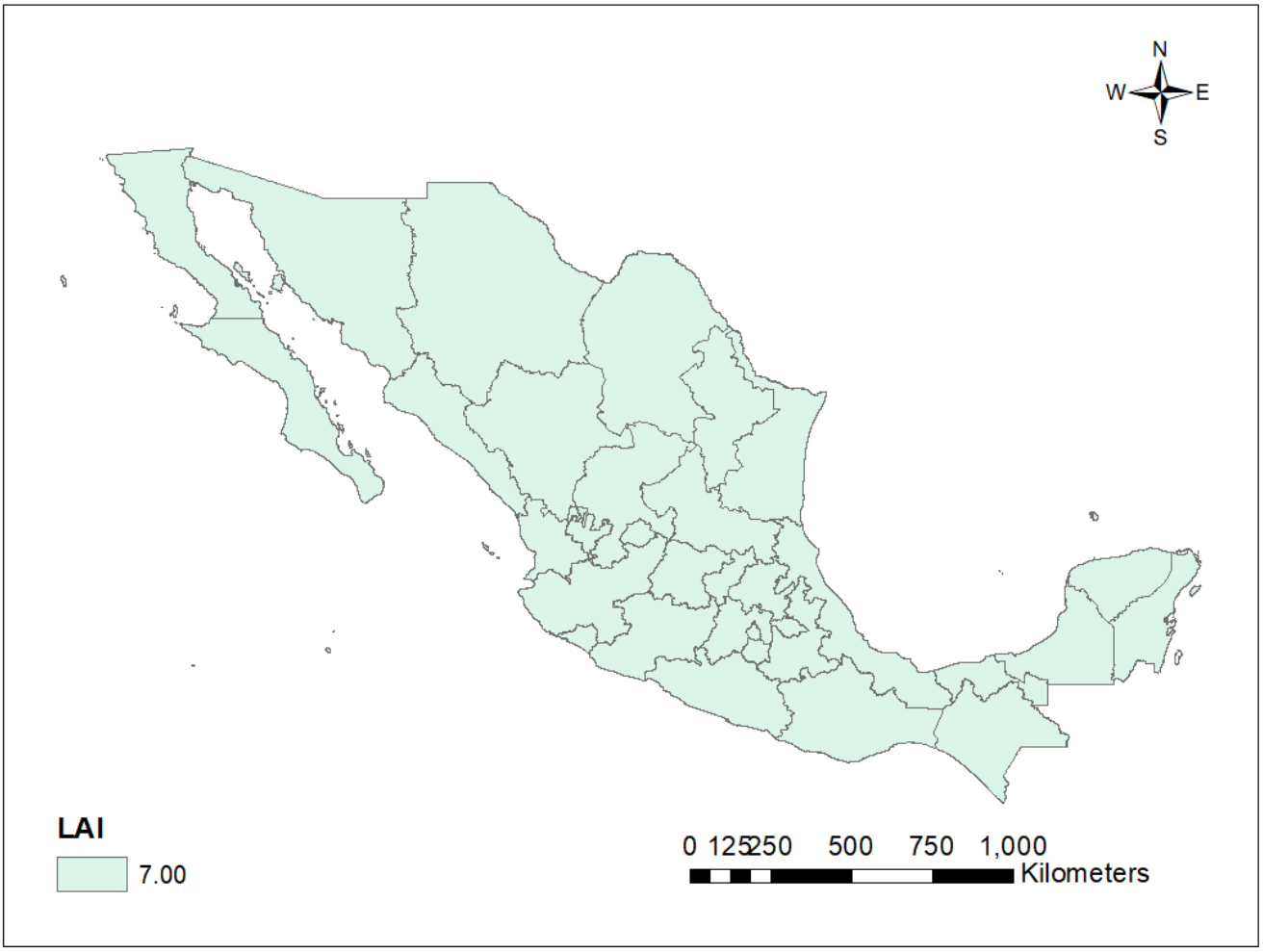

Figure 8 Leaf Area Index for primary partitions

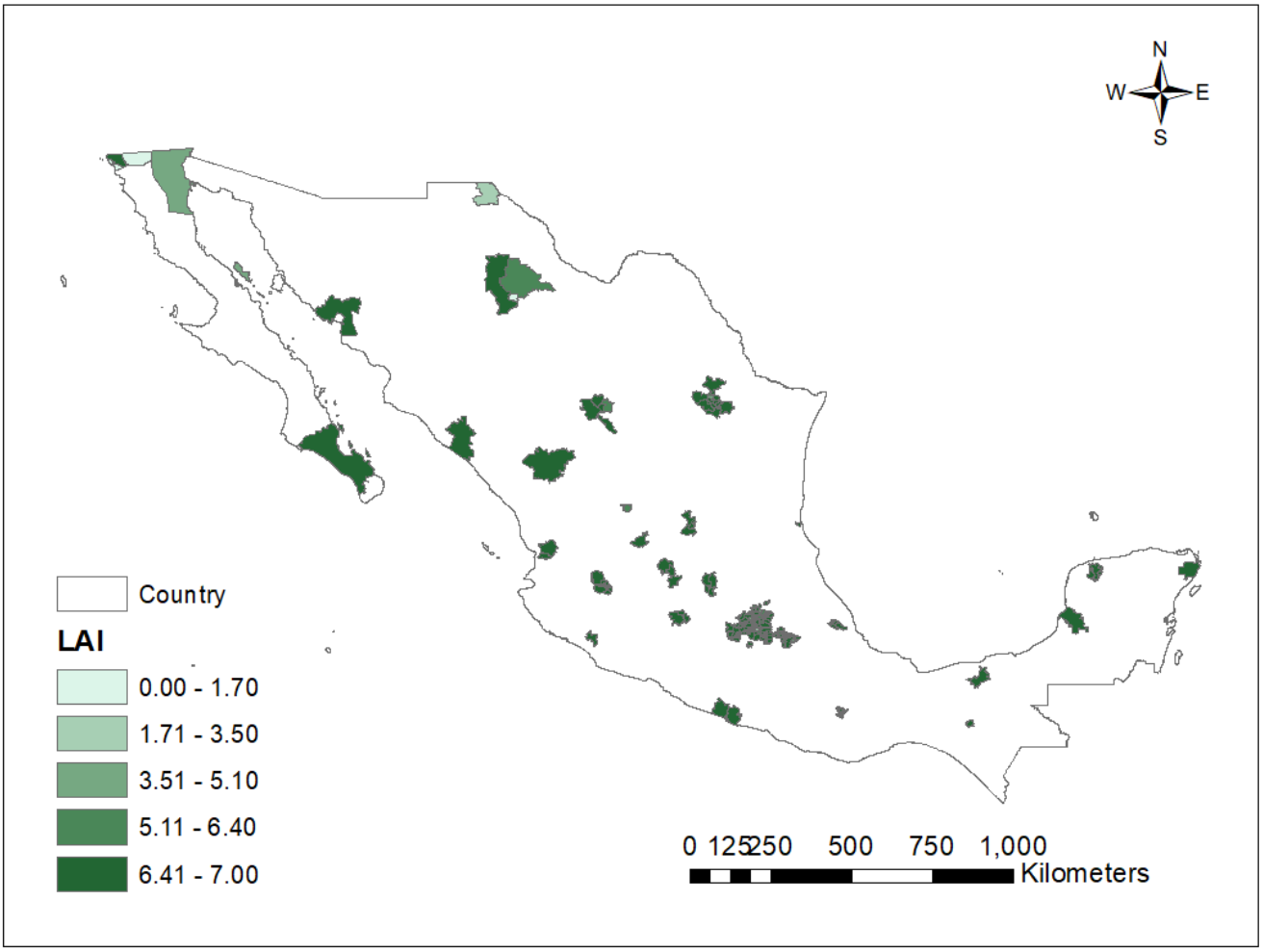

Figure 9 Lear Area Index for secondary partitions

"Urban and built-up" class in the NALCMS land cover data was used to derive impervious cover for the primary and secondary partitions (Figs. 10 and 11).

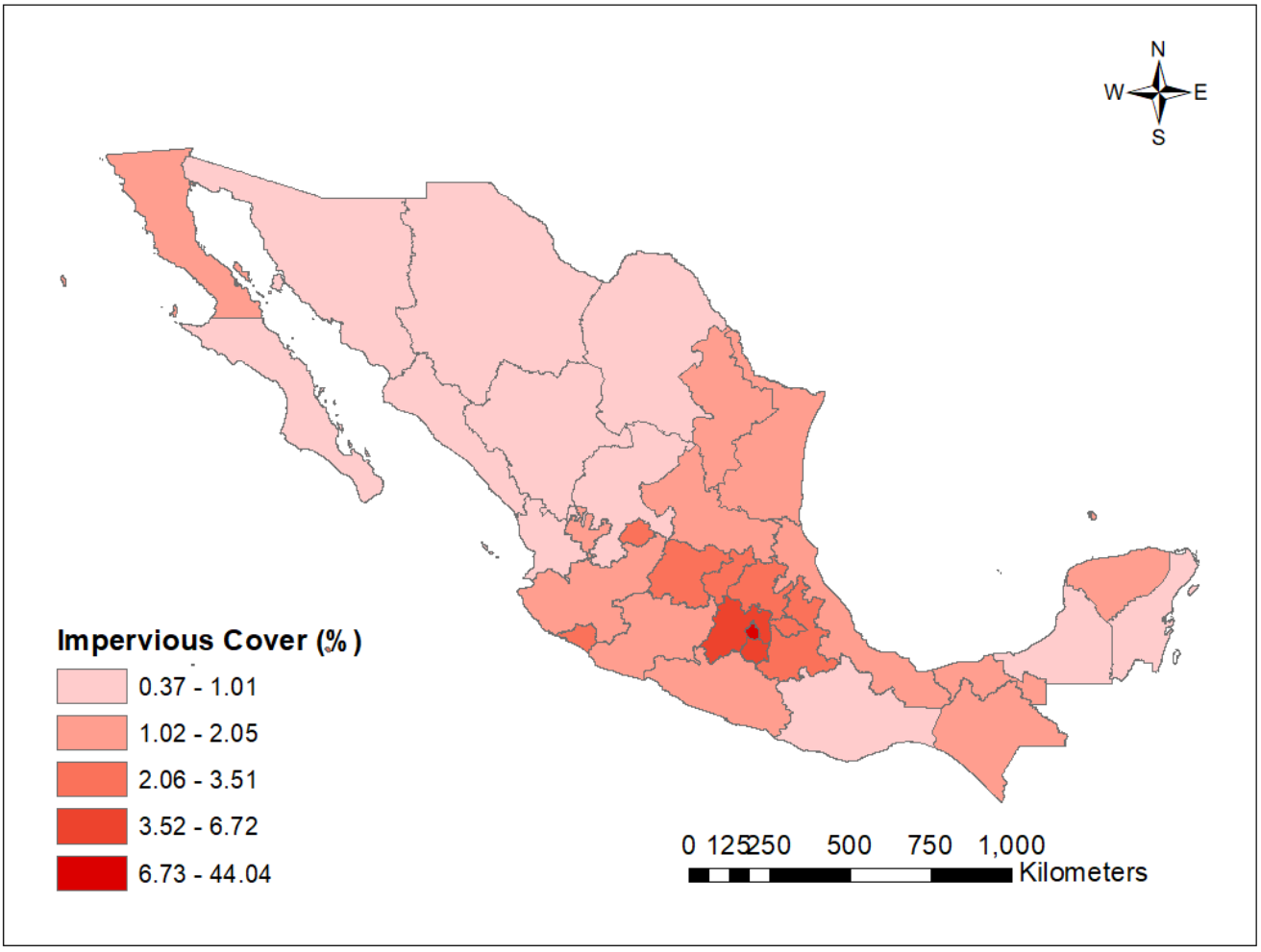

Figure 10 Impervious cover percent for primary partitions

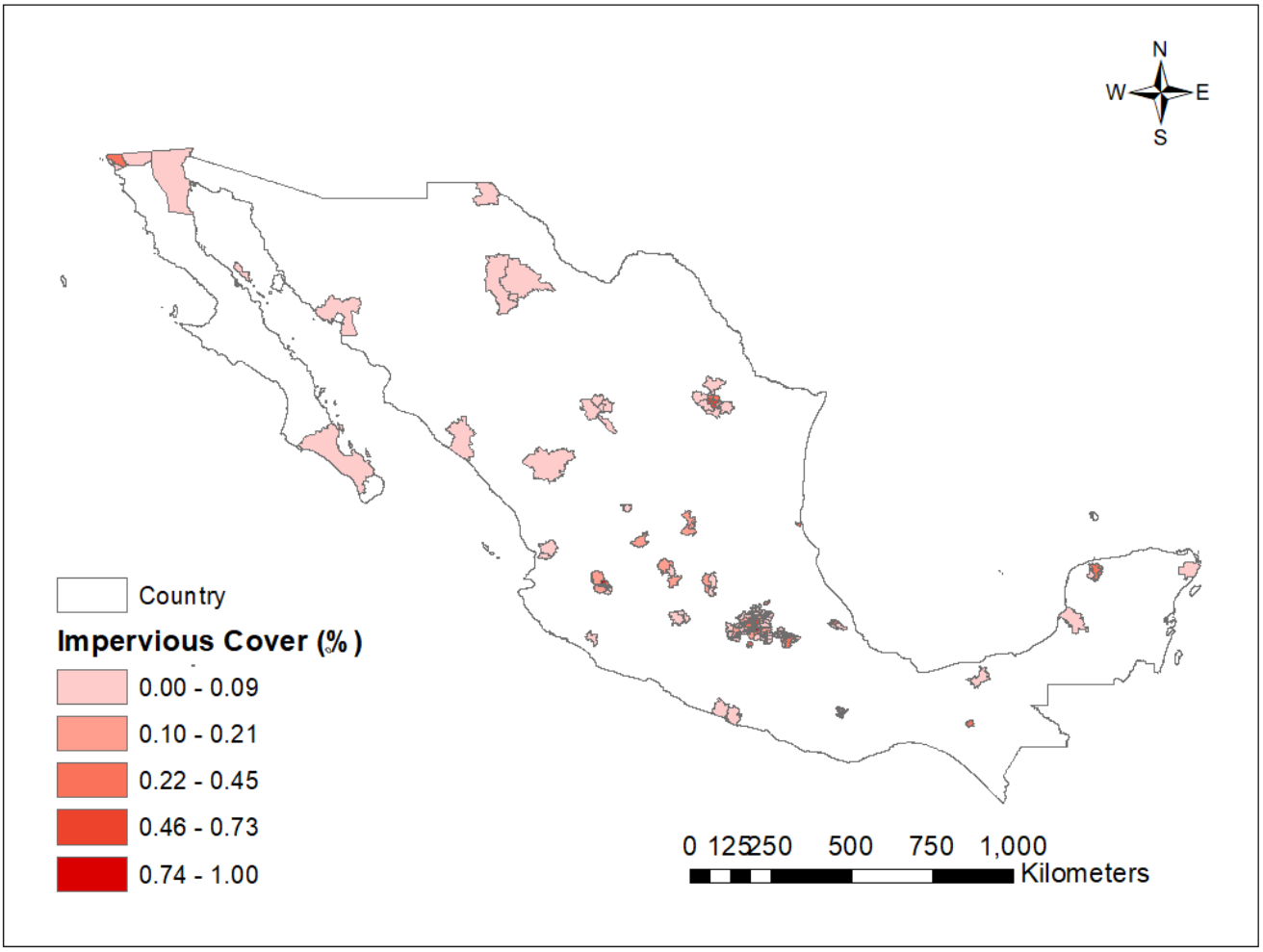

Figure 11 Impervious cover percent for secondary partitions

2.2. Monitoring Stations

1.1.1. Surface Weather Stations

Hourly surface weather data for 2015 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. 6.

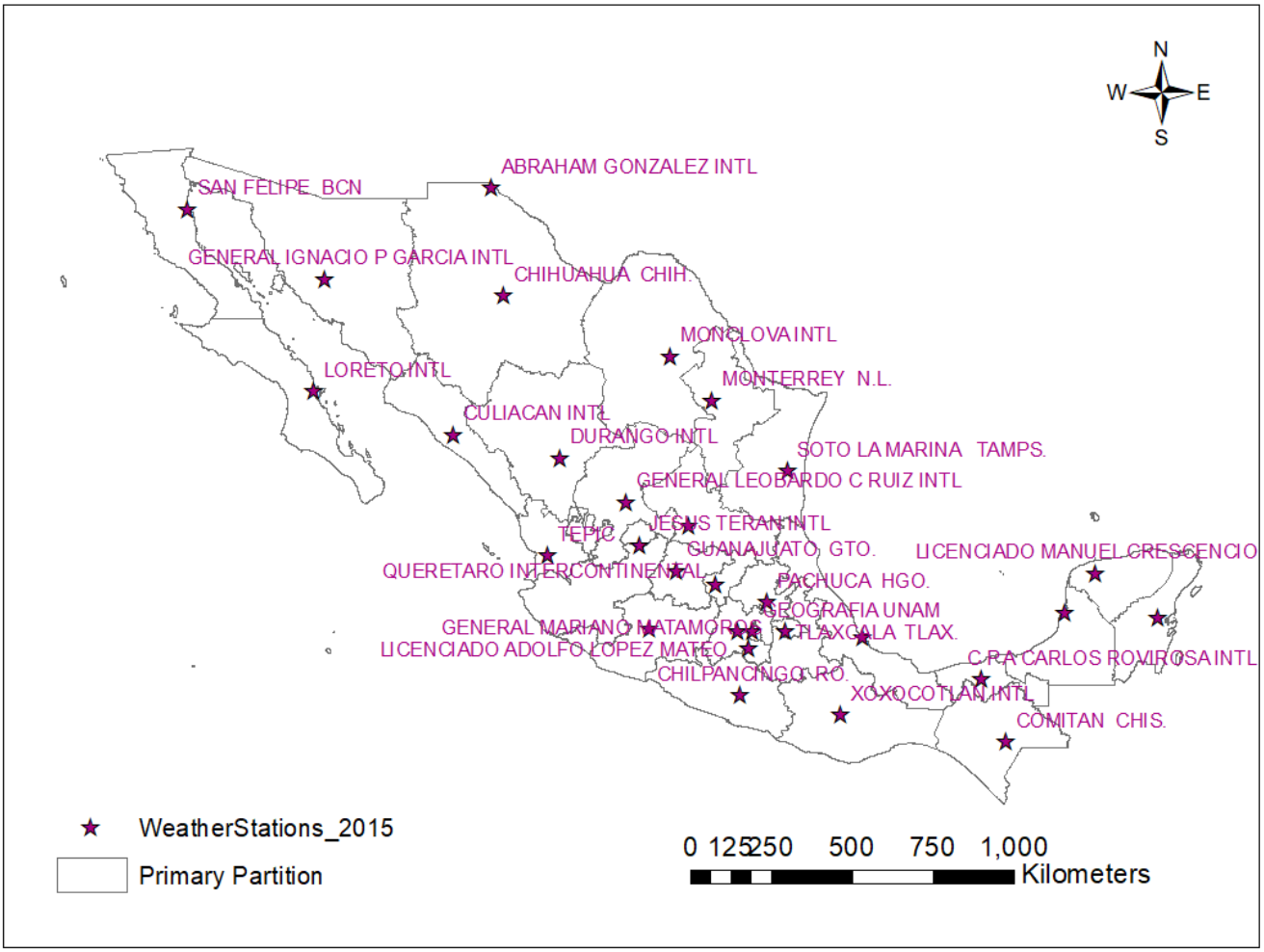

Figure 12 Surface weather stations used for primary partitions

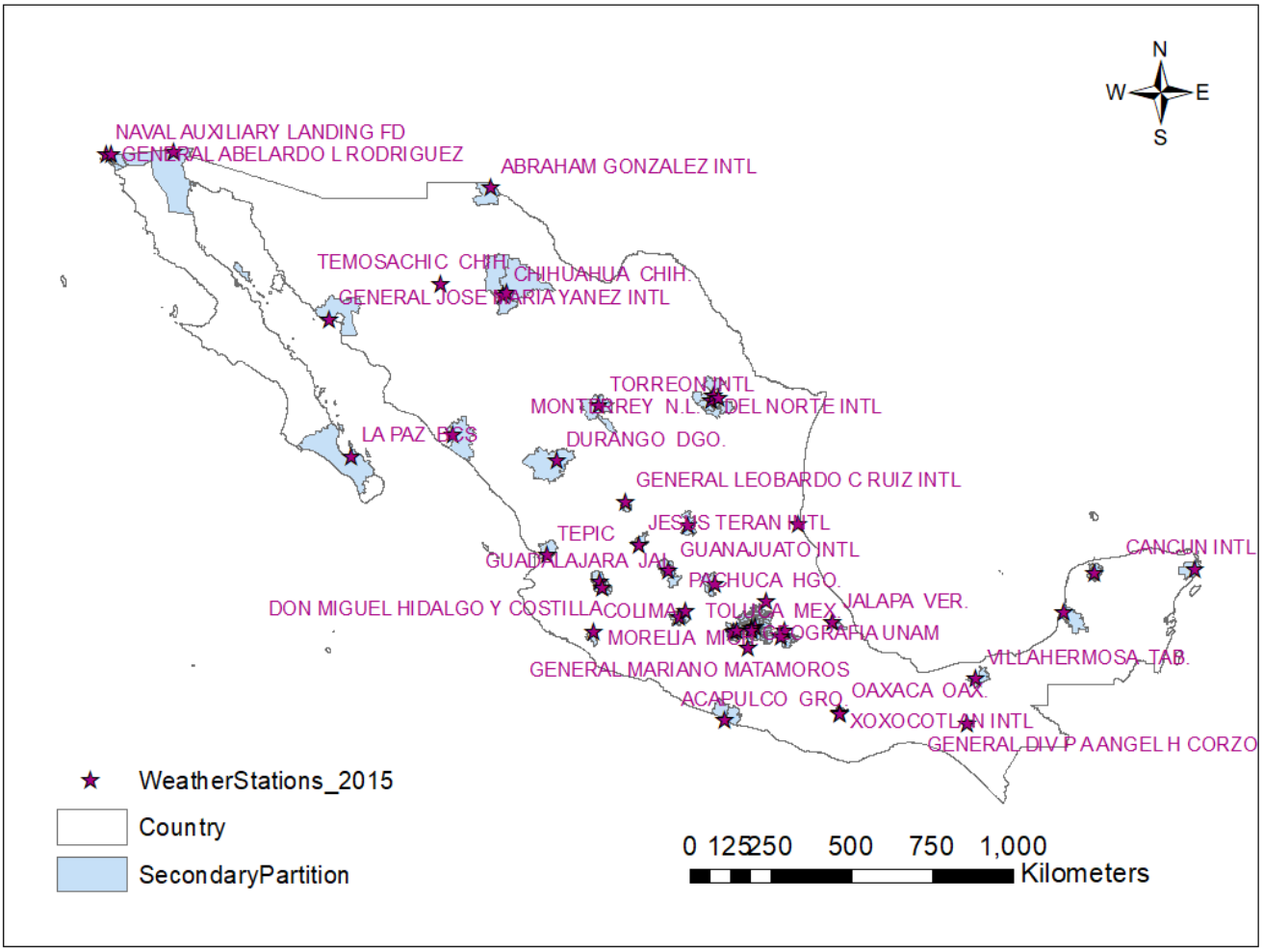

Figure 13 Surface weather stations used for secondary partitions

1.1.2. Precipitation

The NCEI surface weather data in Mexico generally lack hourly precipitation data (PCP01). To complement this, Global Precipitation Measurement (GPM) The Integrated MultisatellitE Retrievals for GPM (IMERG) Final Precipitation L3 Half Hourly 0.1 degree × 0.1 degree V06 (GPM_3IMERGHH) (NASA 2022) was employed. Half hourly precipitation data were aggregated into hourly data and attached to the location of each NCEI weather station used in the batch process (Hirabayashi 2022).

1.1.3. Radiosonde Stations (Upper Air)

Radiosonde data for 2015 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. 7.

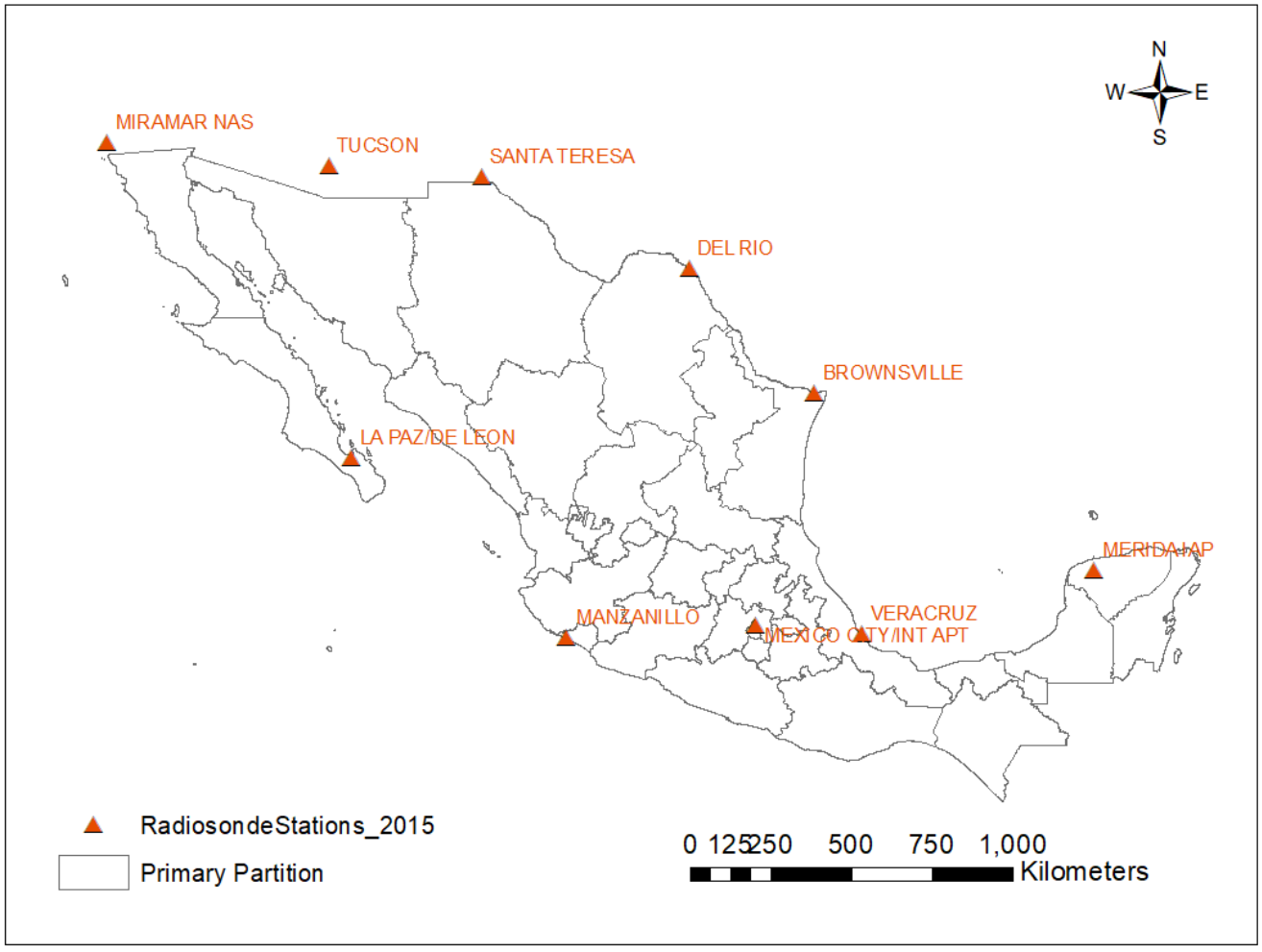

Figure 14 Radiosonde stations used for primary partitions

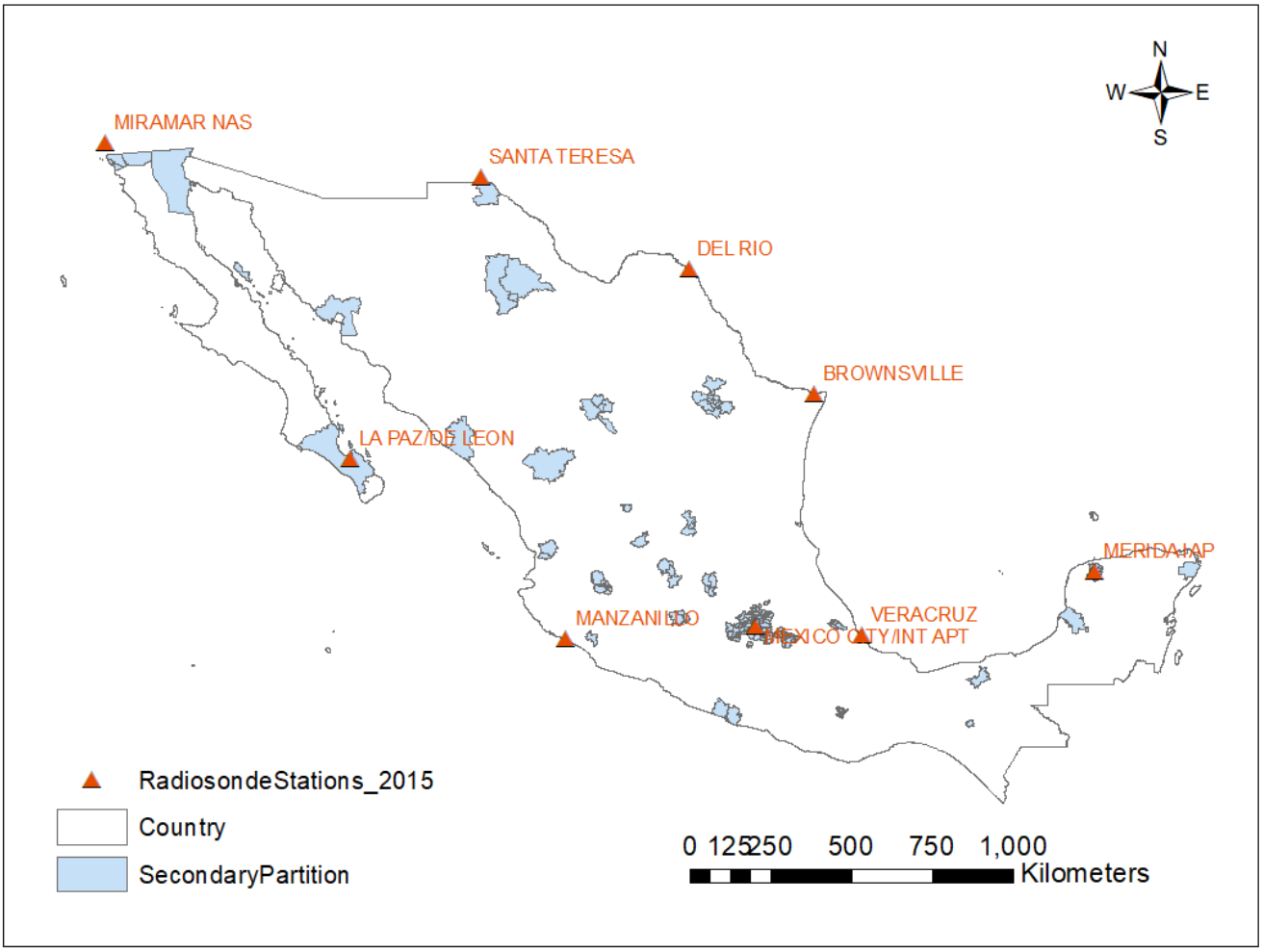

Figure 15 Radiosonde stations used for secondary partitions

1.1.4. Air pollutant monitors

CO, NO_2, O_3, PM_{10}, $PM_{2.5}$, and SO_2 data for 2012 obtained from United States Environmental Protection Agency (US EPA)'s Air Data (United States Environmental Protection Agency 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. 8 – 13.

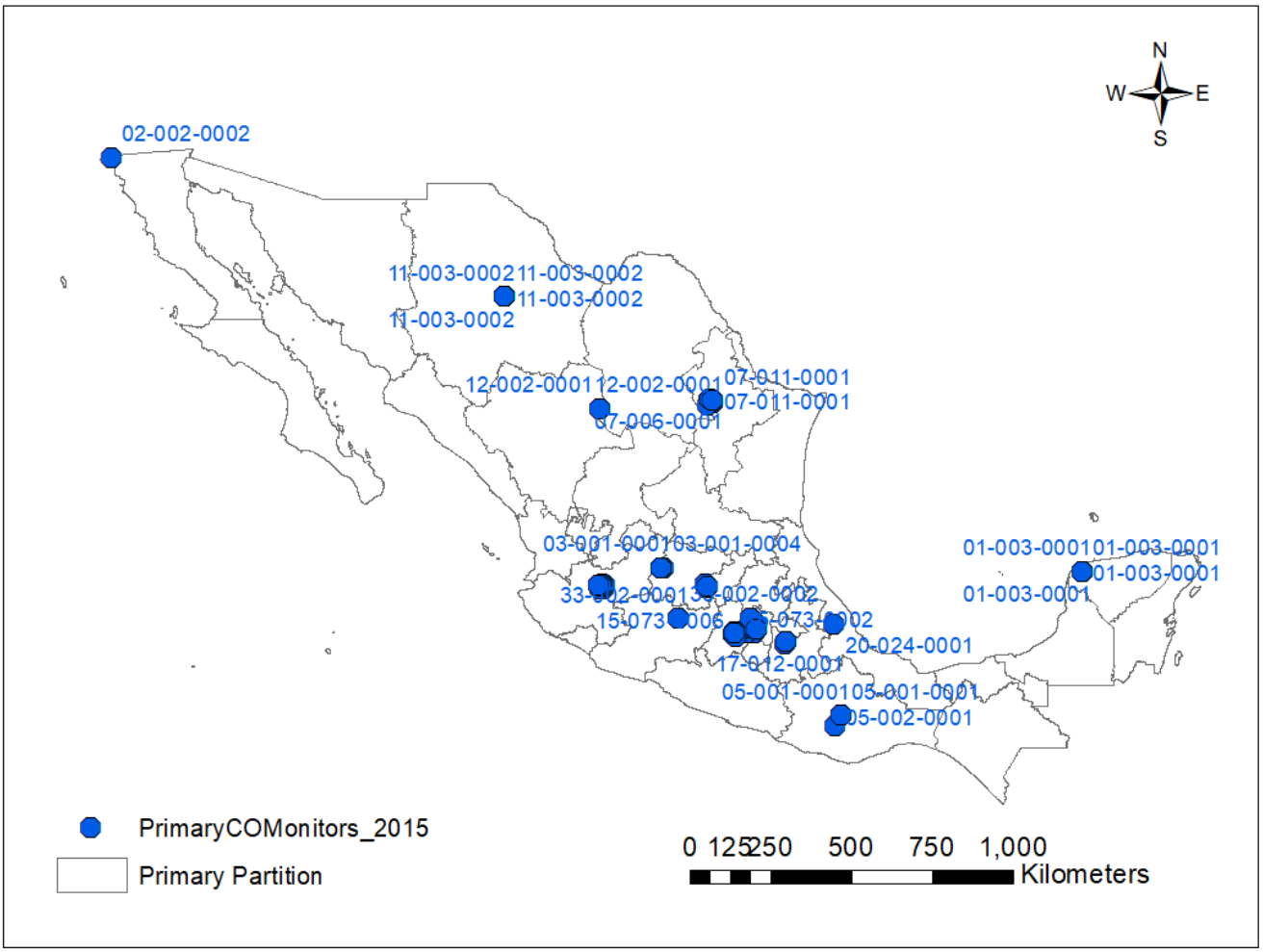

Figure 16 CO monitors used for primary partitions

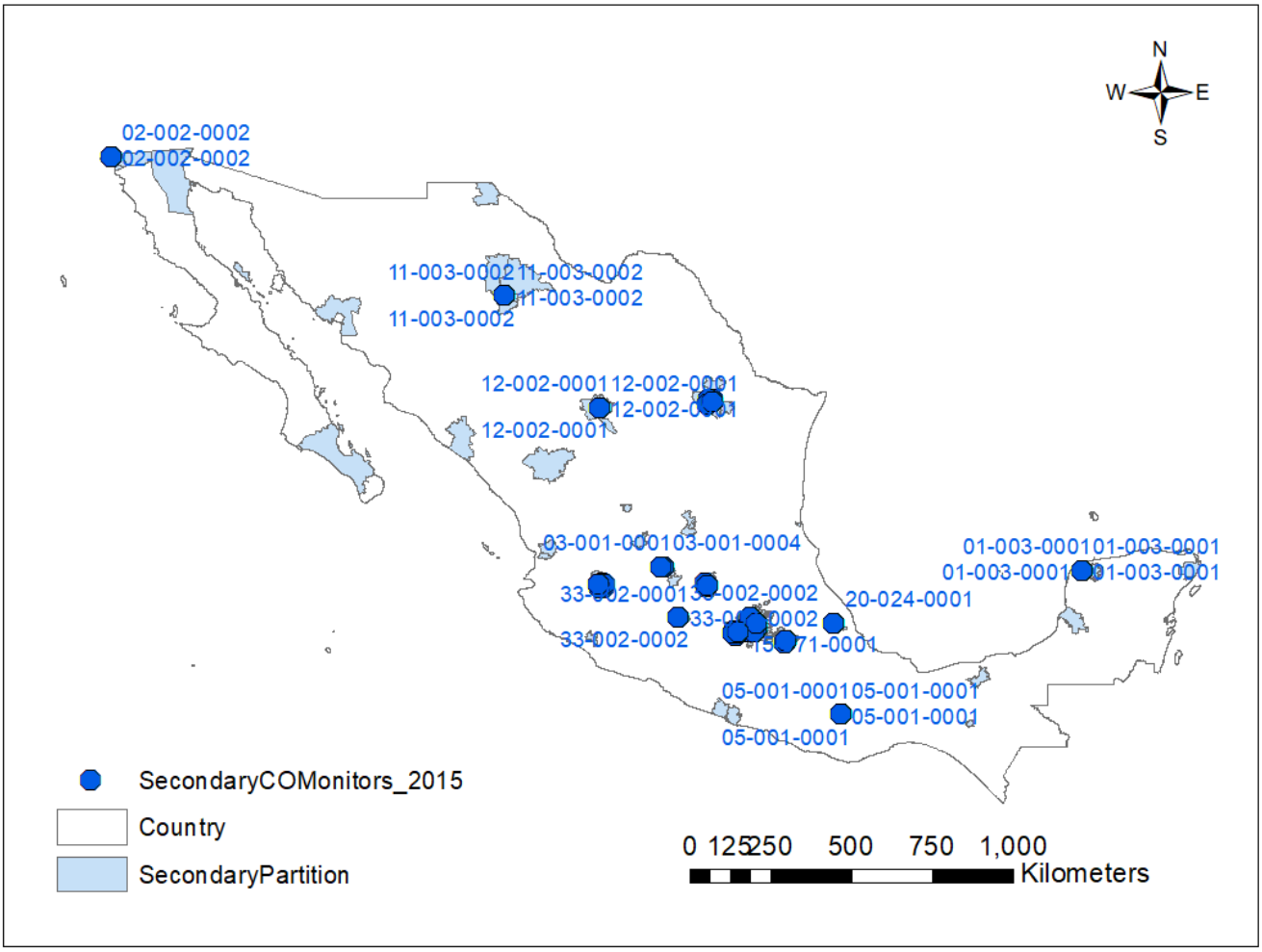

Figure 17 CO monitors used for secondary partitions

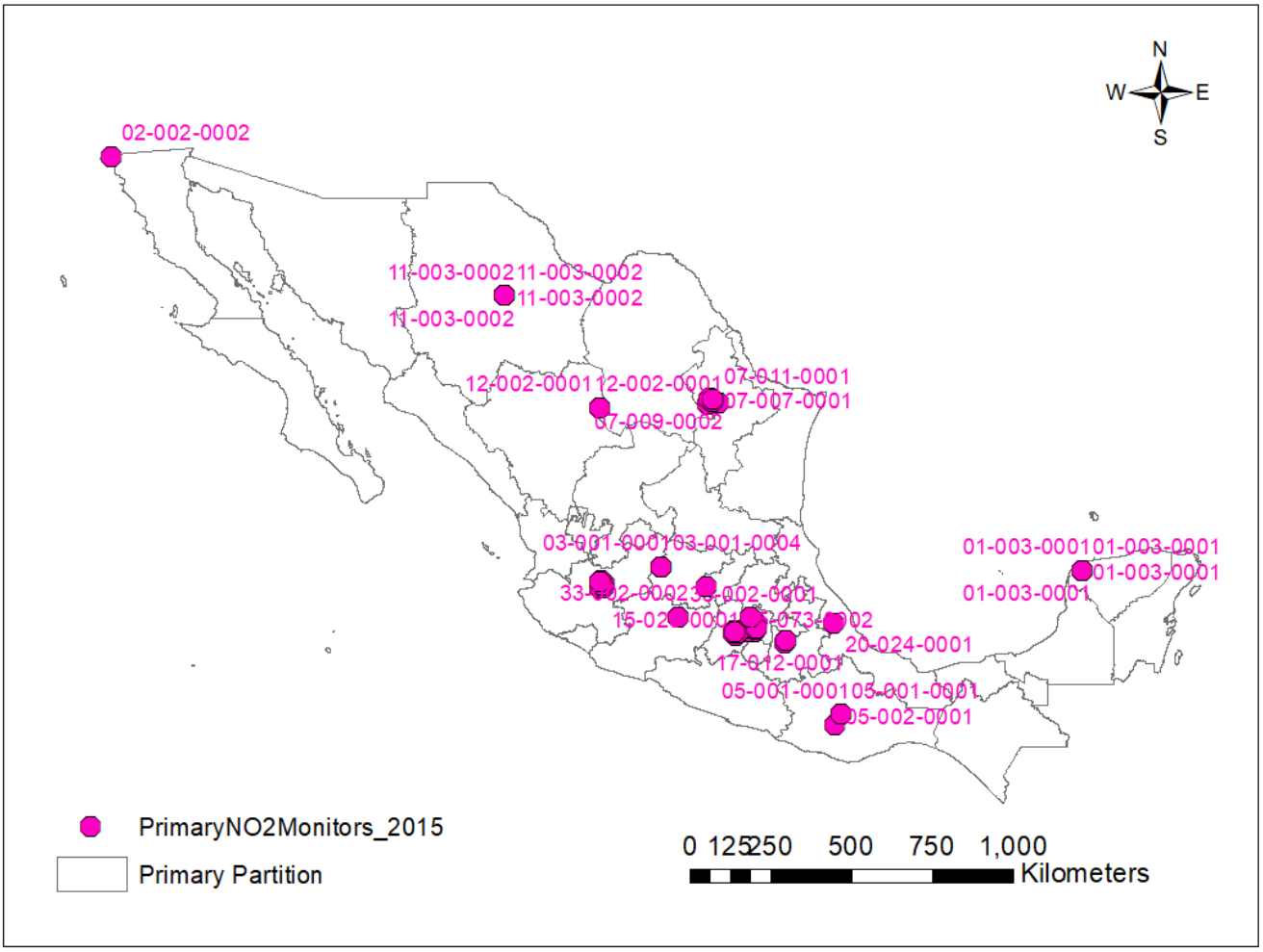

Figure 18 NO_2 monitors used for primary partitions

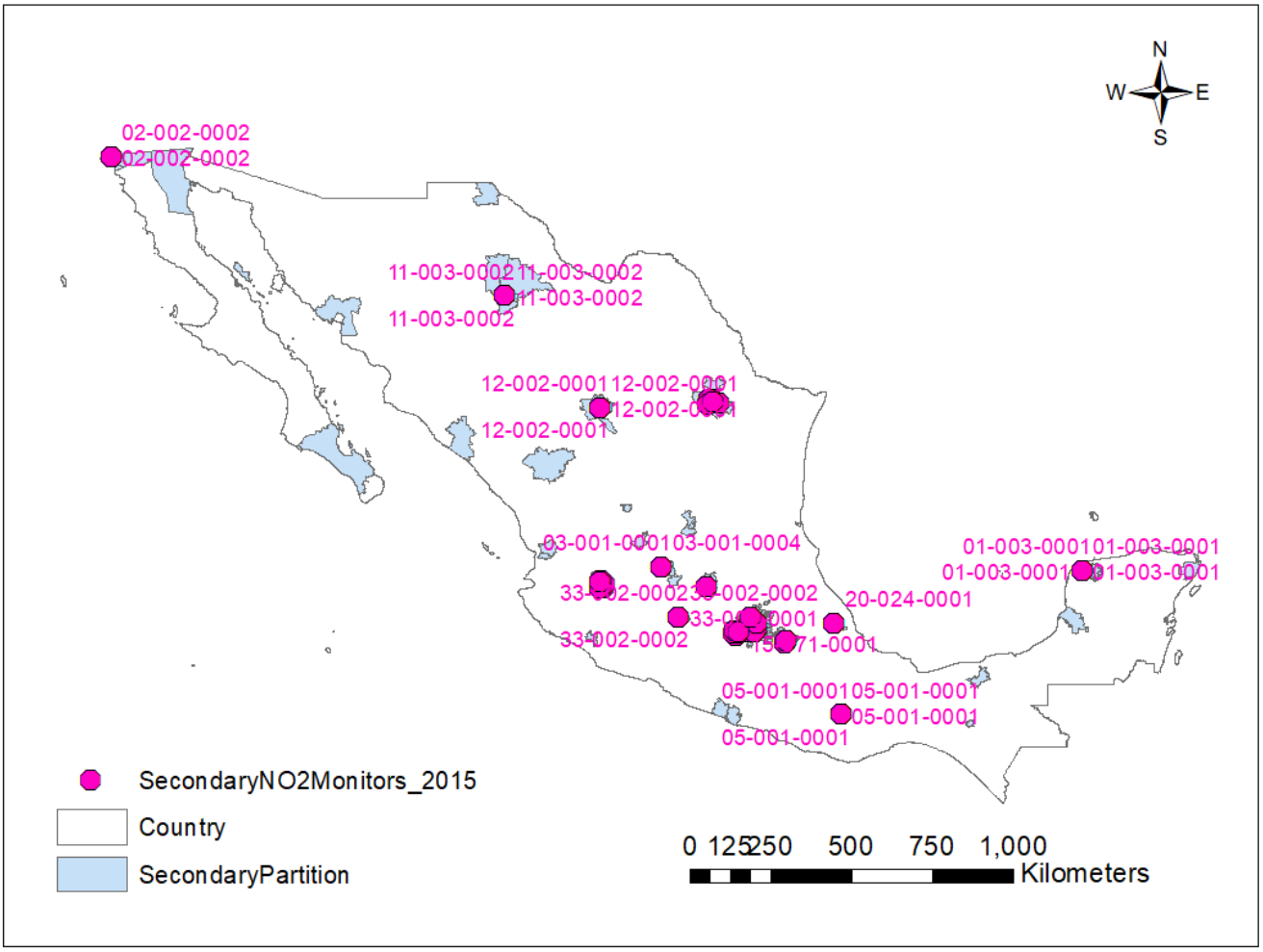

Figure 19 NO_2 monitors used for secondary partitions

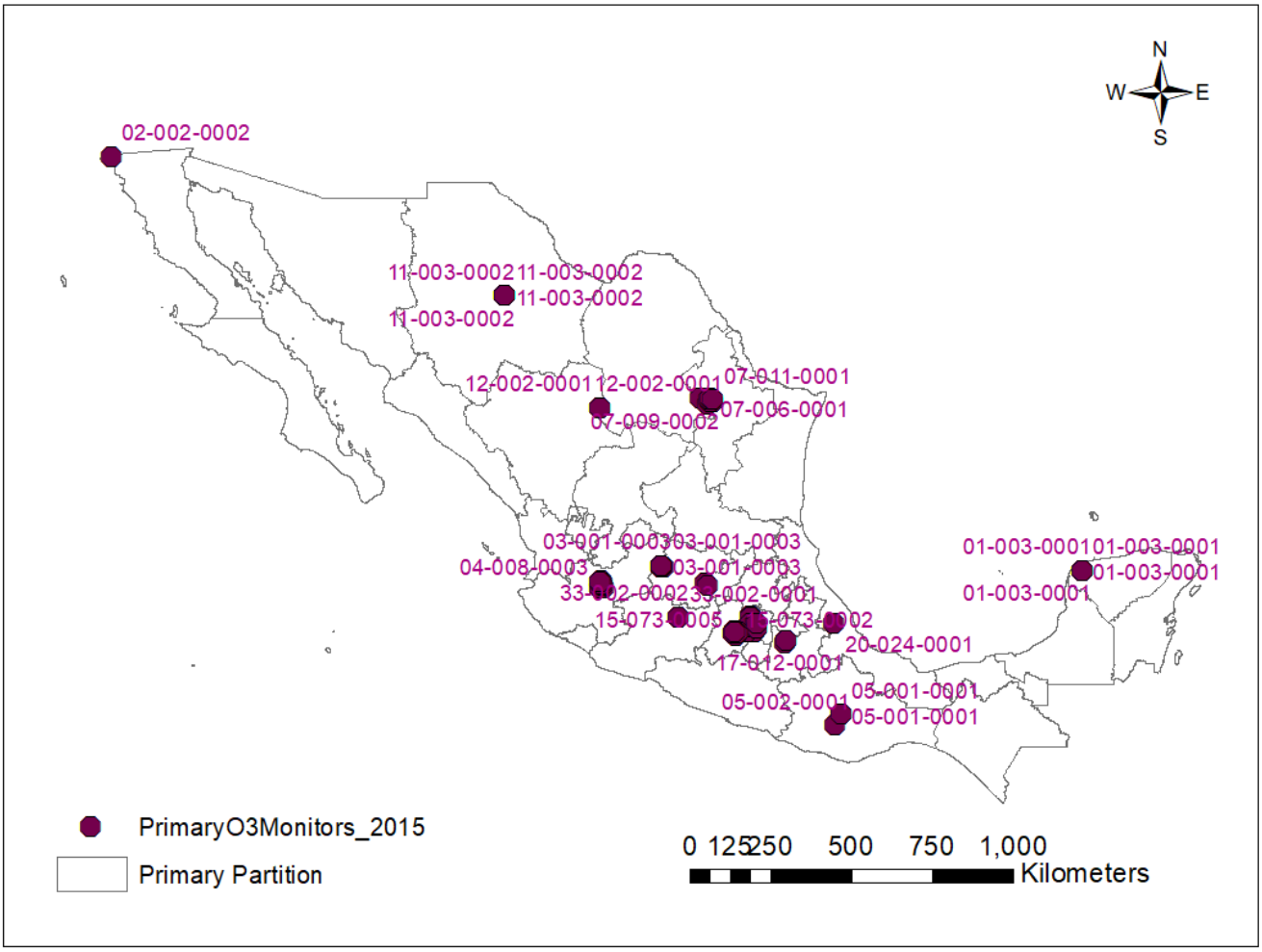

Figure 20 O_3 monitors used for primary partitions

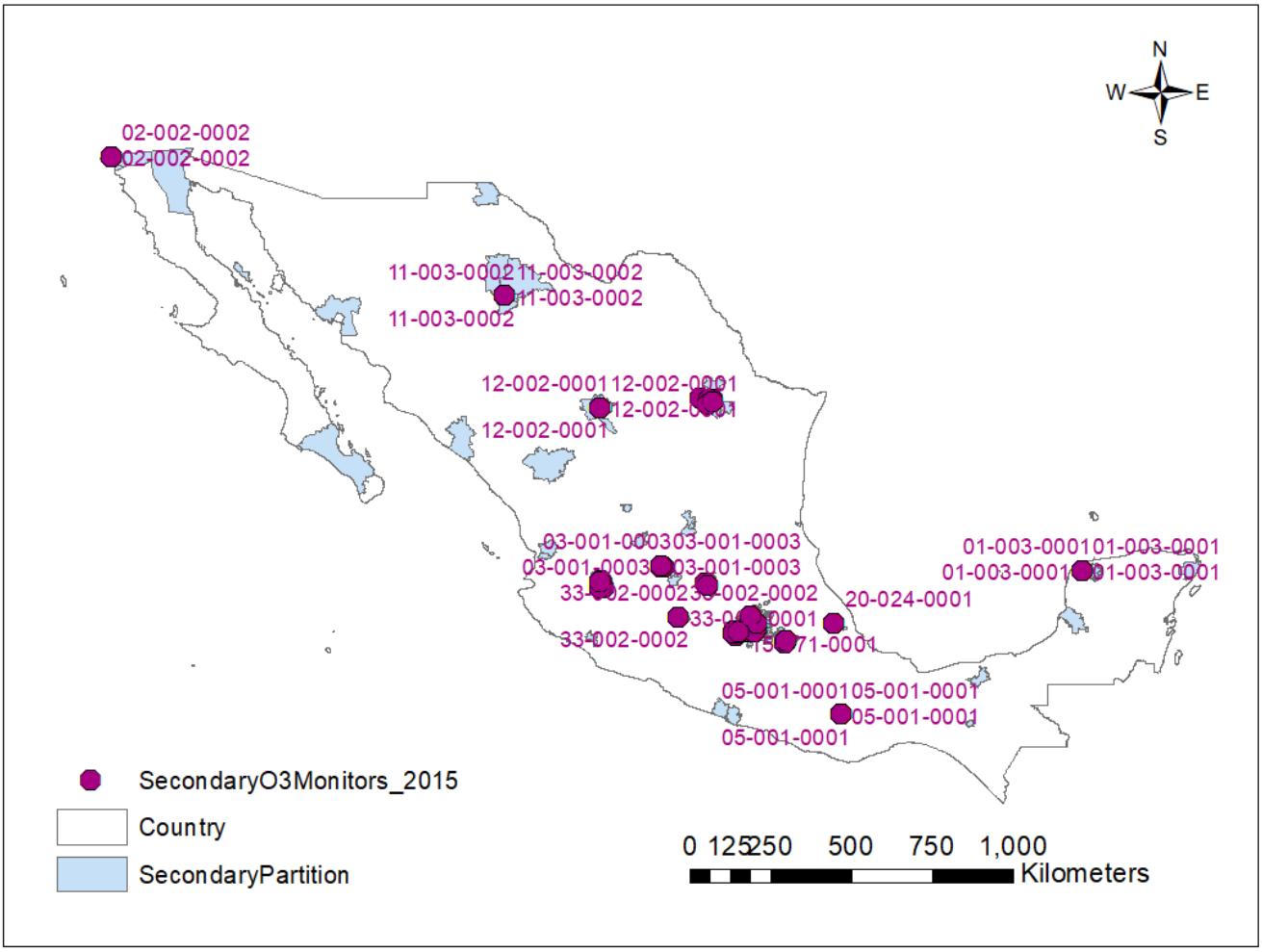

Figure 21 O_3 monitors used for secondary partitions

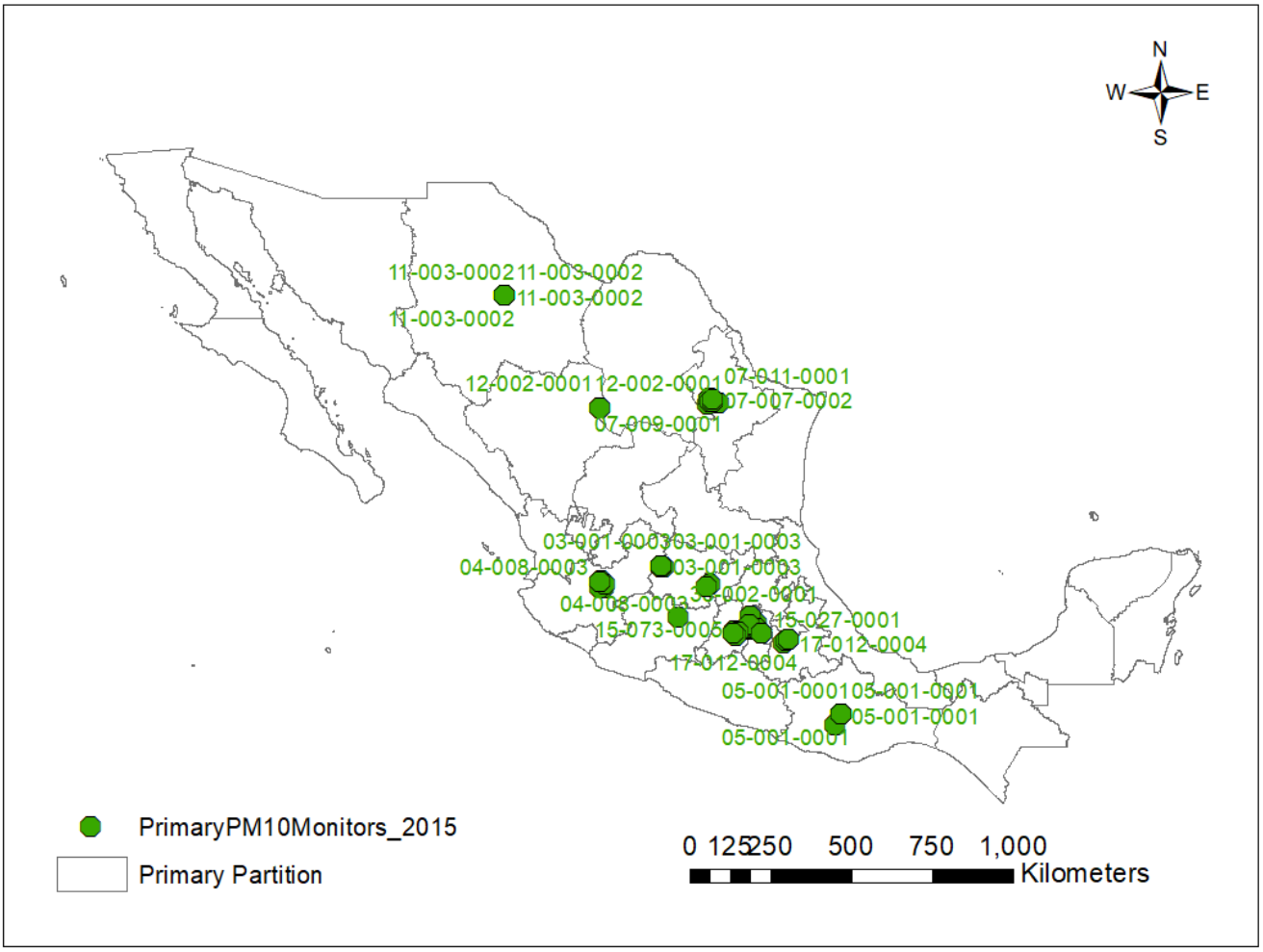

Figure 22 PM_{10} monitors used for primary partitions

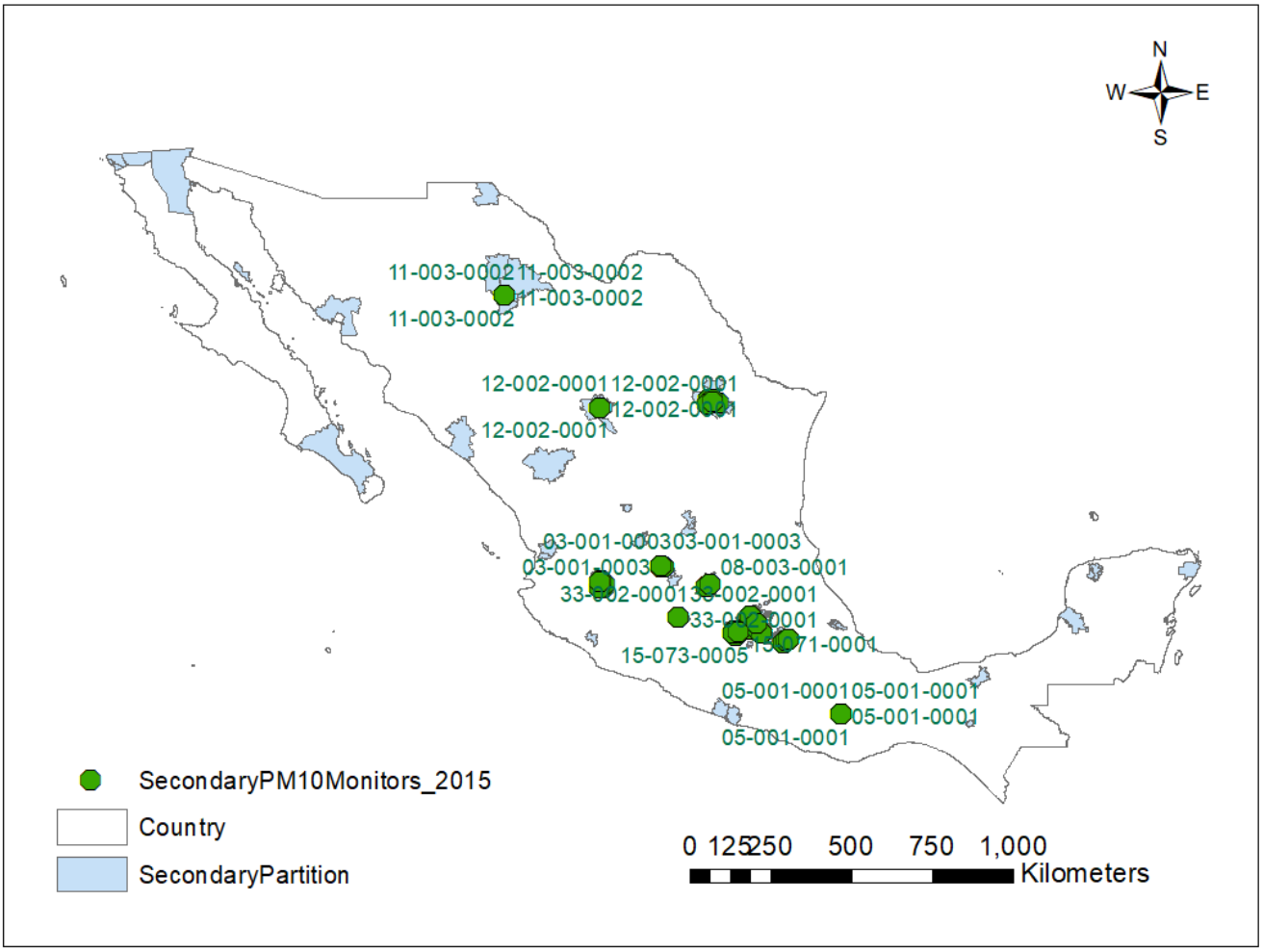

Figure 23 PM_{10} monitors used for secondary partitions

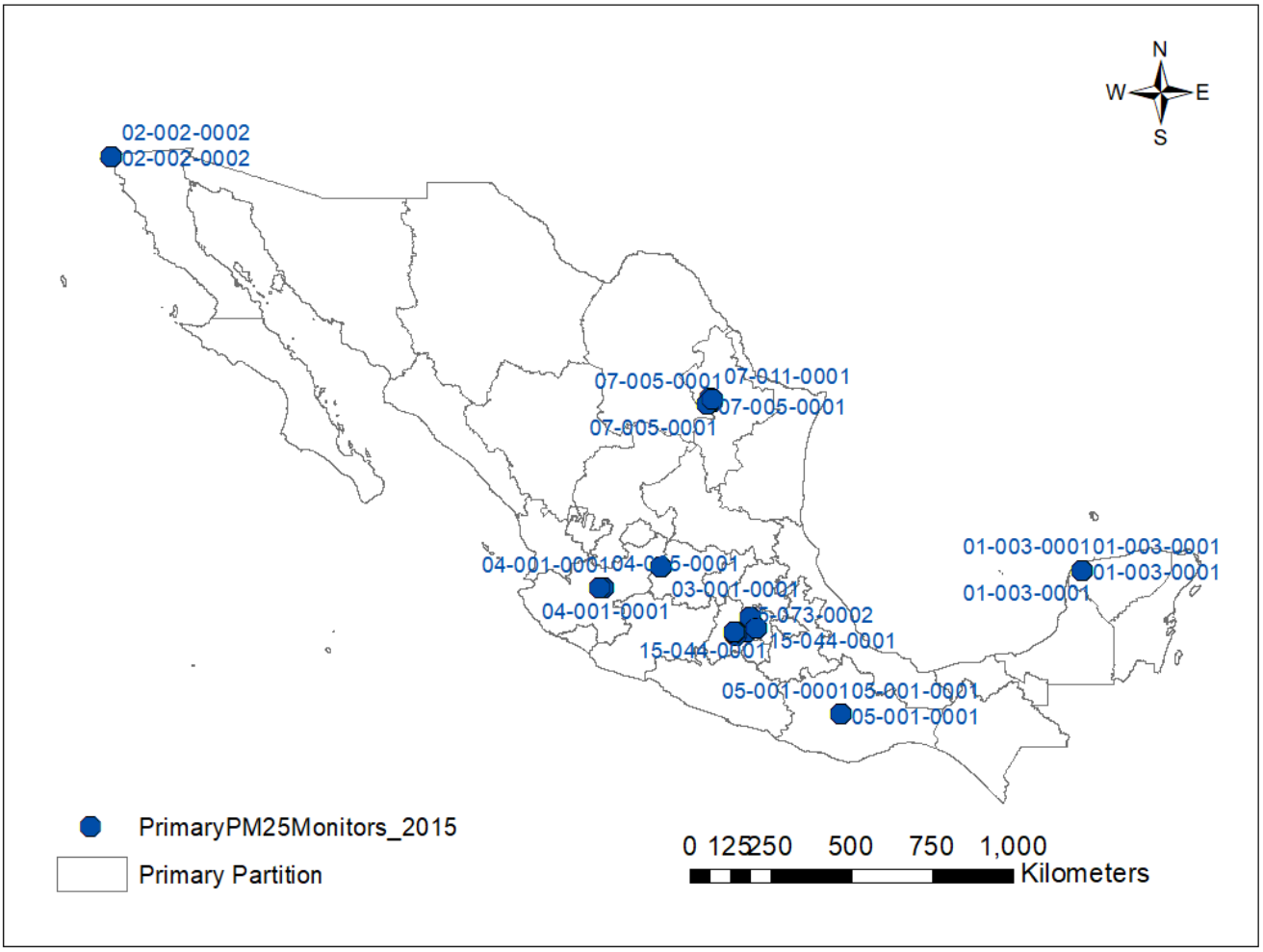

Figure 24 $PM_{2.5}$ monitors used for primary partitions

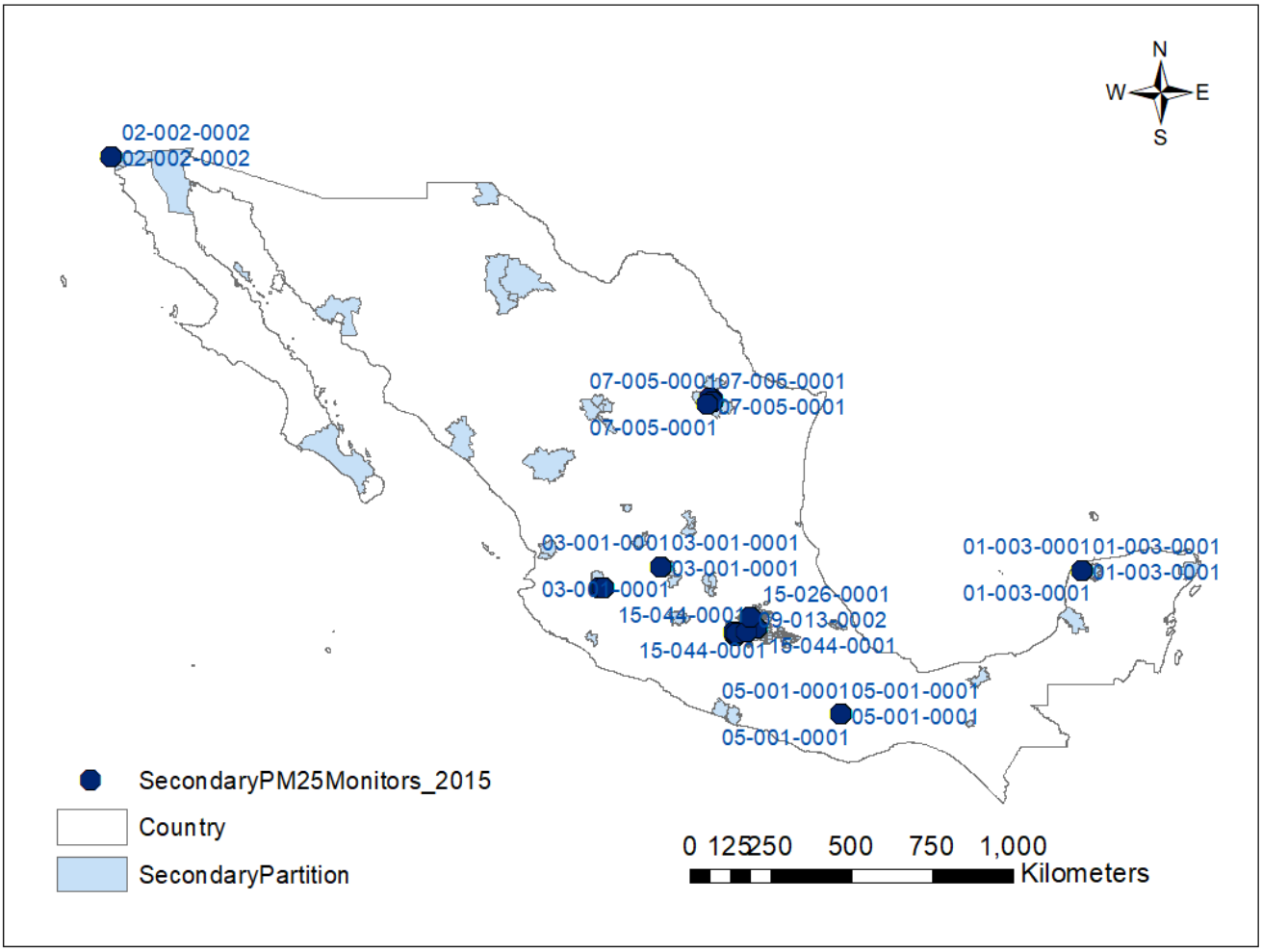

Figure 25 $PM_{2.5}$ monitors used for secondary partitions

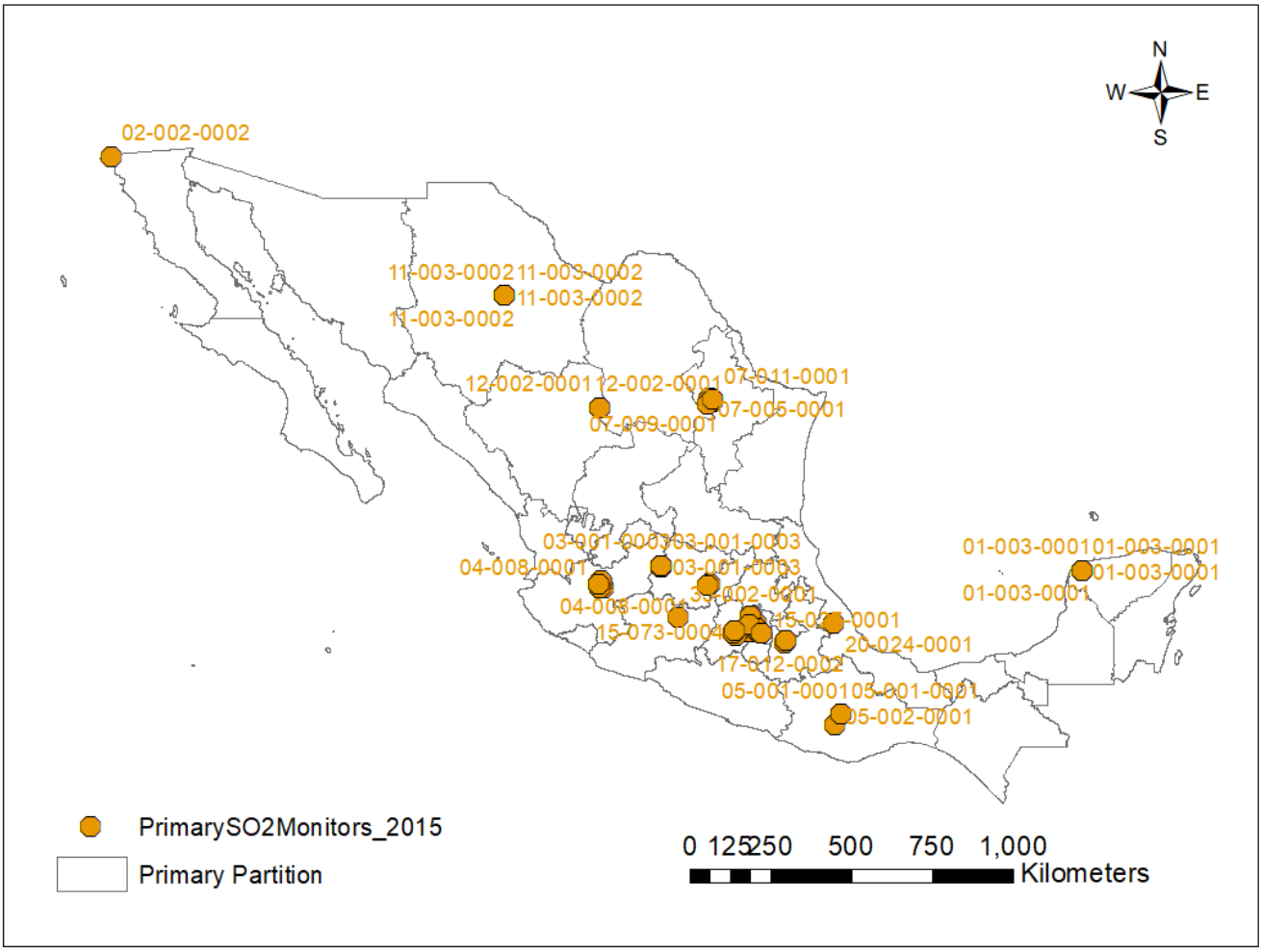

Figure 26 SO_2 monitors used for primary partitions

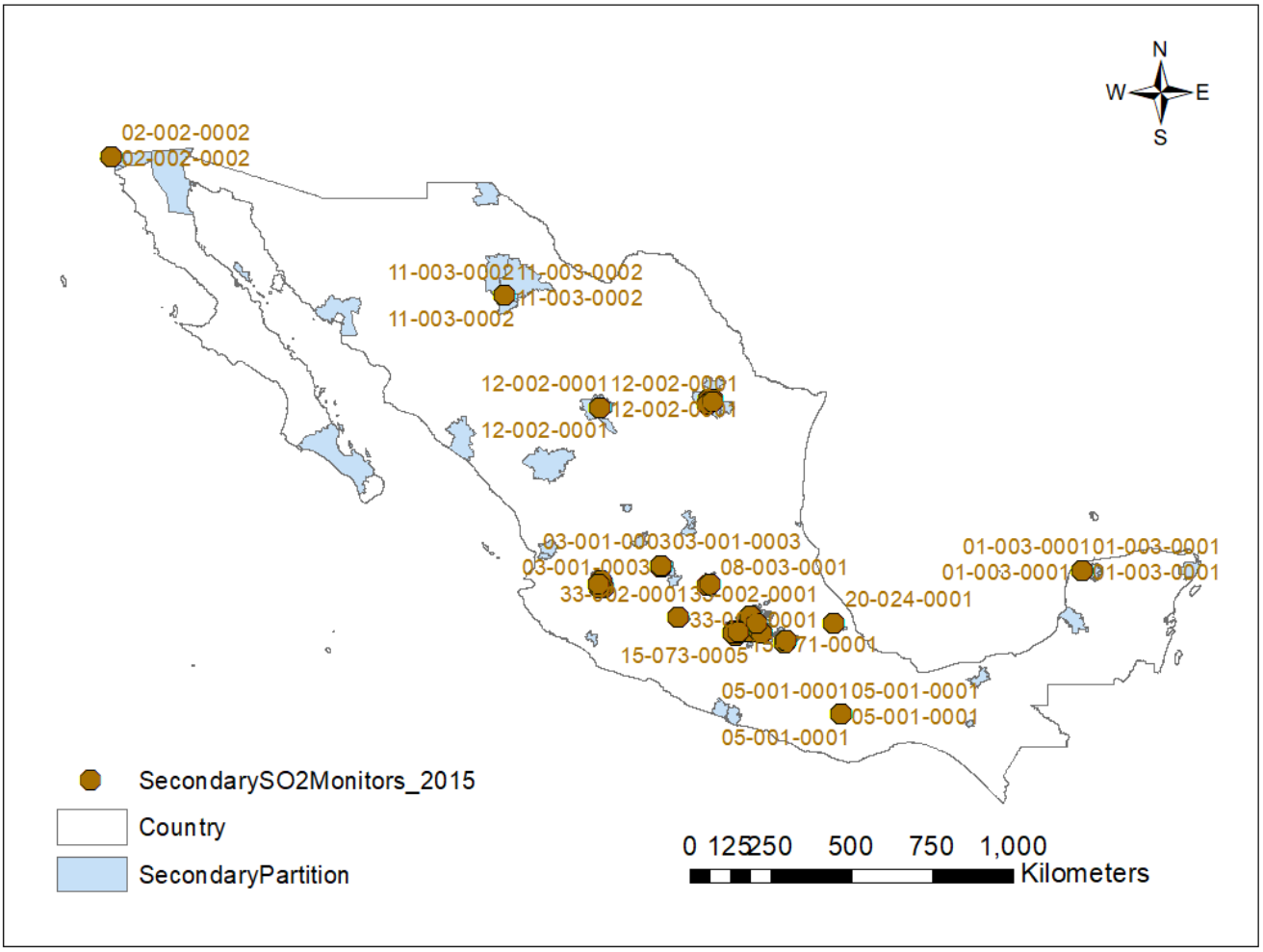

Figure 27 SO_2 monitors used for secondary partitions

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	Yucatan	001	Conkal	CO	836754.9	26.0	26.0	26.0
01	Yucatan	001	Conkal	NO2	720.2	7.7	2.5	9.4
01	Yucatan	001	Conkal	O3	40197.4	64.1	16.2	84.7
01	Yucatan	001	Conkal	PM10*	0.0	0.0	0.0	0.0
01	Yucatan	001	Conkal	PM2.5	472855.8	21.6	2.9	51.5
01	Yucatan	001	Conkal	SO2	216.0	6.4	2.7	10.8

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	Yucatan	001	Conkal	6.0	4646101.6	4662103.7	2390.6
01	Yucatan	002	Kanasin	7.9	6065138.5	6085994.2	3120.2
01	Yucatan	003	Merida	117.3	90403092.5	90713977.7	46509.4
01	Yucatan	004	Ucu	25.1	19336841.8	19403353.1	9948.8
01	Yucatan	005	Uman	59.6	45885116.5	46042685.4	23603.4

4. References

Earth System Research Laboratory (ESRL). 2022. *NOAA/ESRL Radiosonde Database.* Accessed 7 7, 2022. https://ruc.noaa.gov/raobs/.

Hirabayashi, Satoshi. 2022. "Global Precipitation Measurement (GPM) Integration." *i-Tree Eco Methods, Model Descriptions, & Journal Articles.* 5 17. Accessed 7 12, 2022. https://www.itreetools.org/documents/793/GPM_integration_into_i-Tree_Eco.pdf.

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National Centers for Environmental Information (NCEI). 2022. Accessed 7 7, 2022. https://www1.ncdc.noaa.gov/pub/data/noaa/.

United States Environmental Protection Agency. 2022. *Hourly Data.* Accessed 7 7, 2022. https://aqs.epa.gov/aqsweb/airdata/download_files.html#Raw.