

# i-Tree Eco Batch Run for Puerto Rico in 2015

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## 1. Introduction

i-Tree Eco was run for each of secondary partitions (counties) in Hawaii using 2015 data to quantify ecosystem services provided by trees, which include:

1. Minimum, average, and maximum of annual air pollutant (CO, NO<sub>2</sub>, O<sub>3</sub>, PM<sub>10</sub>\*, PM<sub>2.5</sub>, and SO<sub>2</sub>) removals (metric tons/year).
2. Monetary value (US dollars/year) associated with air pollutant removal (externality values for CO, PM<sub>10</sub>\*, BenMAP health effects for NO<sub>2</sub>, O<sub>3</sub>, PM<sub>2.5</sub>, and SO<sub>2</sub>).
3. Hydrologic parameters
  - a. Transpiration (m<sup>3</sup>/year)
  - b. Evaporation (m<sup>3</sup>/year)
  - c. Rainfall Interception (m<sup>3</sup>/year)
  - d. Avoided Runoff (m<sup>3</sup>/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 the Multi-Resolution Land Characteristics Consortium (MRLC)'s 2001 Puerto Rico National Land Cover Database (NLCD) (Multi-Resolution Land Characteristics Consortium 2022) (Fig. 1) was employed.

Of the NLCD land cover classifications, "Deciduous Forest", "Evergreen Forest", and "Mixed Forest" were used to derive tree cover percent for each of the secondary partitions (Fig. 2). Evergreen percent was calculated based on the area ratio between "Evergreen Forest" and "Evergreen Forest" + "Deciduous Forest" for the secondary partitions (Fig. 3).

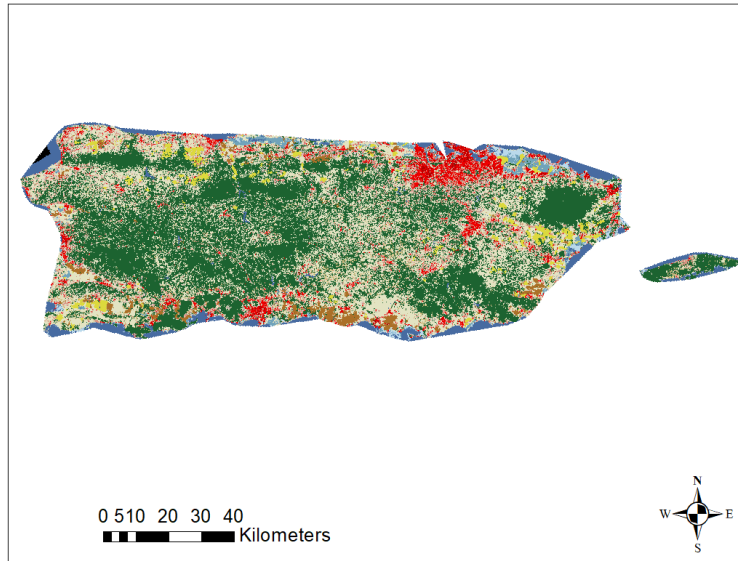


Figure 1 Land cover

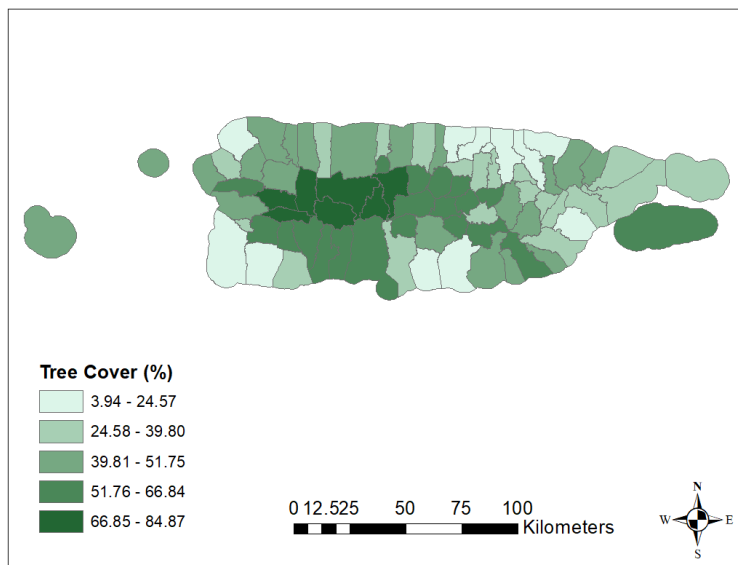


Figure 2 Tree cover percent

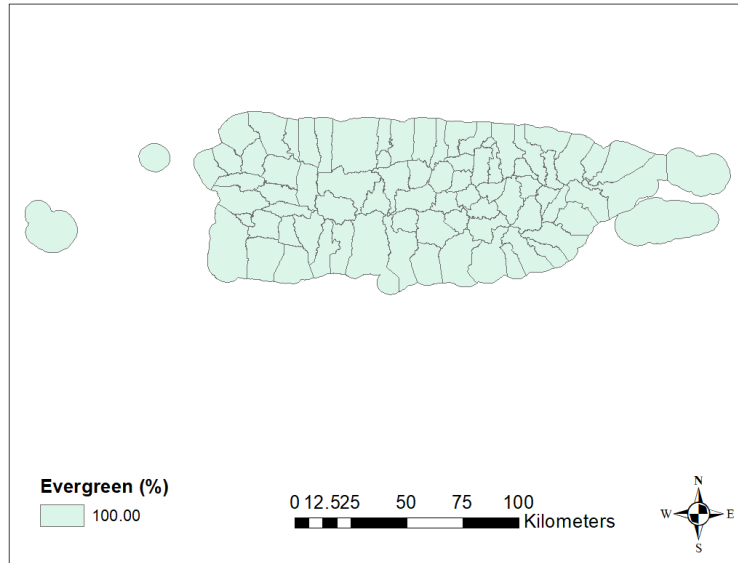


Figure 3 Evergreen percent

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. 4) were derived from the level-4 MODIS/Terra global Leaf Area Index product (NASA 2022) for the growing season. The year 2015 was used.

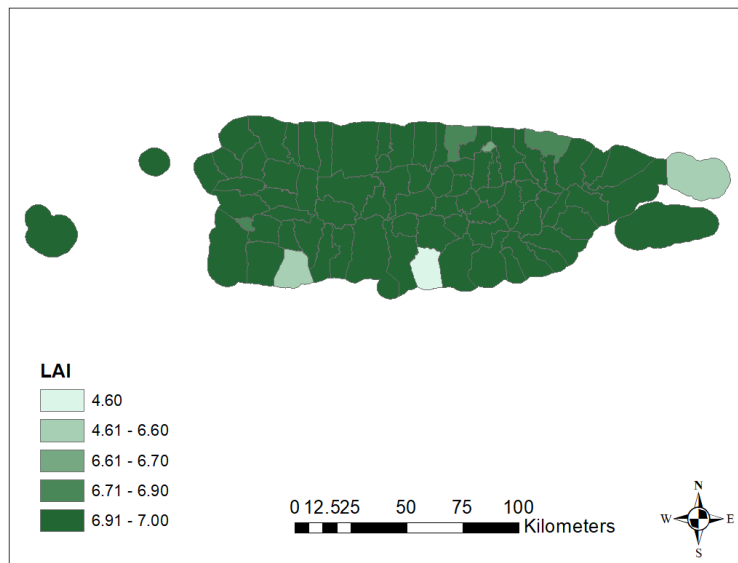


Figure 4 Leaf Area Index

“Developed, Open Space”, “Developed, Low Intensity”, “Developed, Medium Intensity”, and “Developed, High Intensity” classes in the NLCD were used to derive impervious cover for the secondary partitions (Fig. 5).

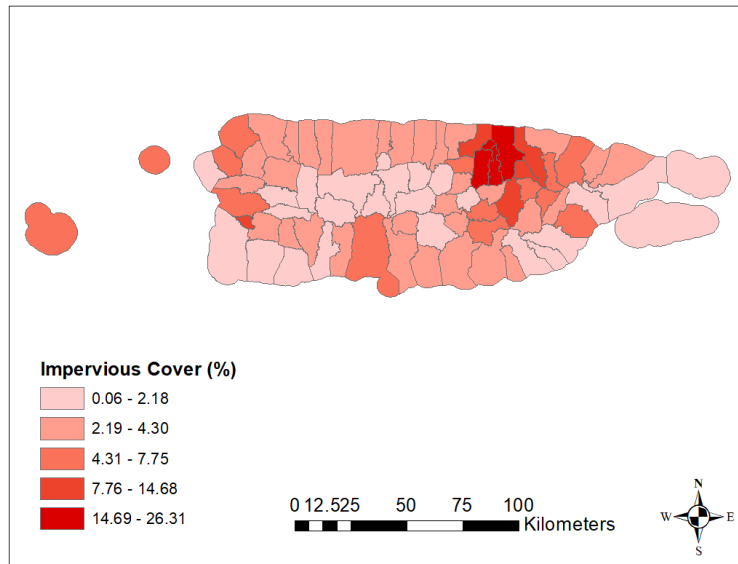


Figure 5 Impervious cover percent

## 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.

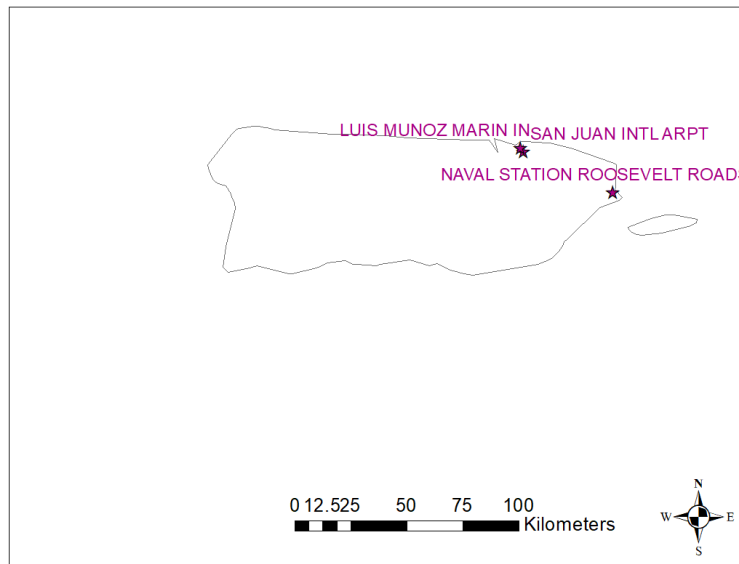


Figure 6 Surface weather stations

### 1.1.2. 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.

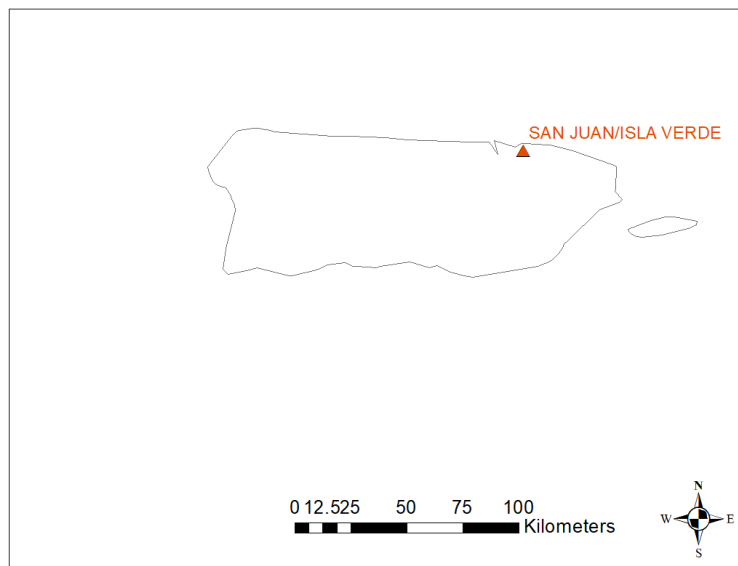


Figure 7 Radiosonde stations

### 1.1.3. Air pollutant monitors

CO, NO<sub>2</sub>, O<sub>3</sub>, PM<sub>10</sub>, PM<sub>2.5</sub>, and SO<sub>2</sub> 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.

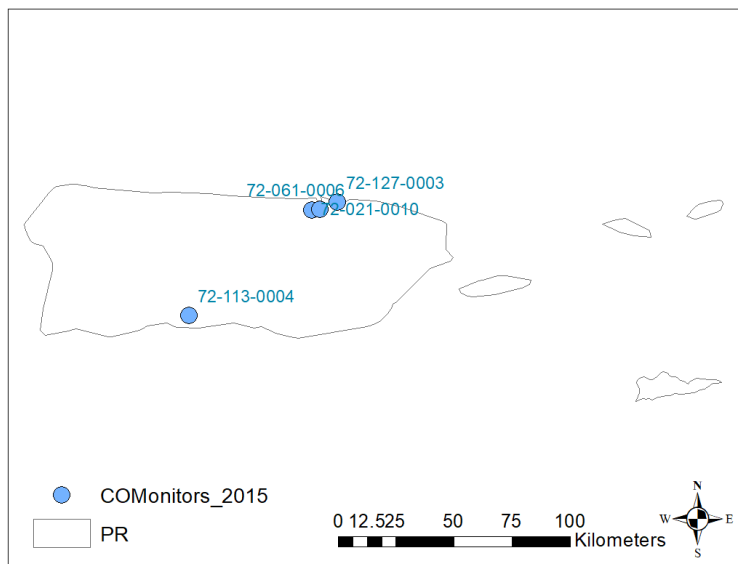


Figure 8 CO monitors

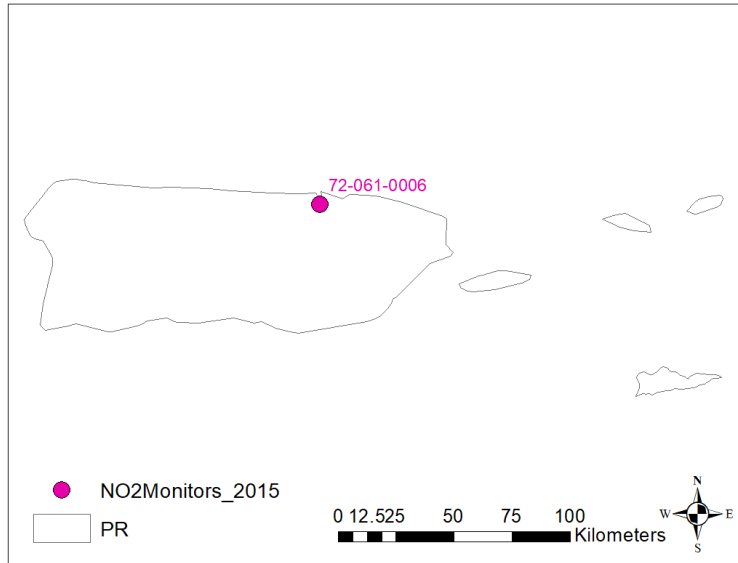


Figure 9 NO<sub>2</sub> monitors

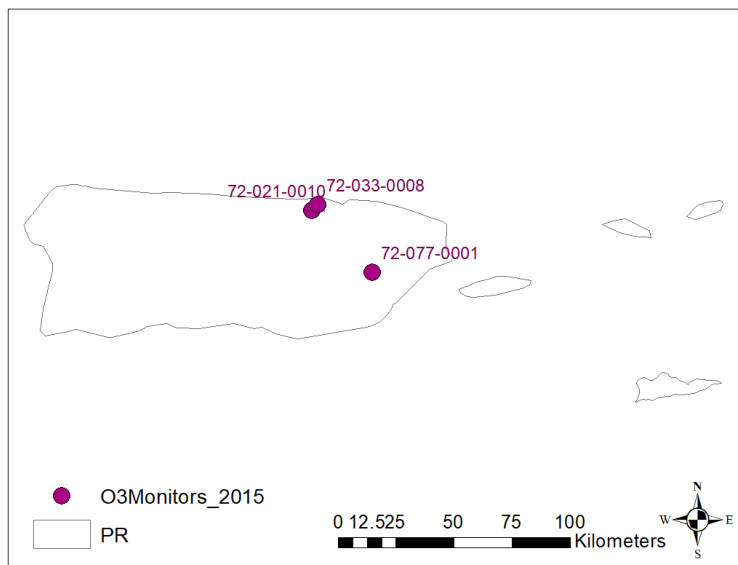


Figure 10 O<sub>3</sub> monitors



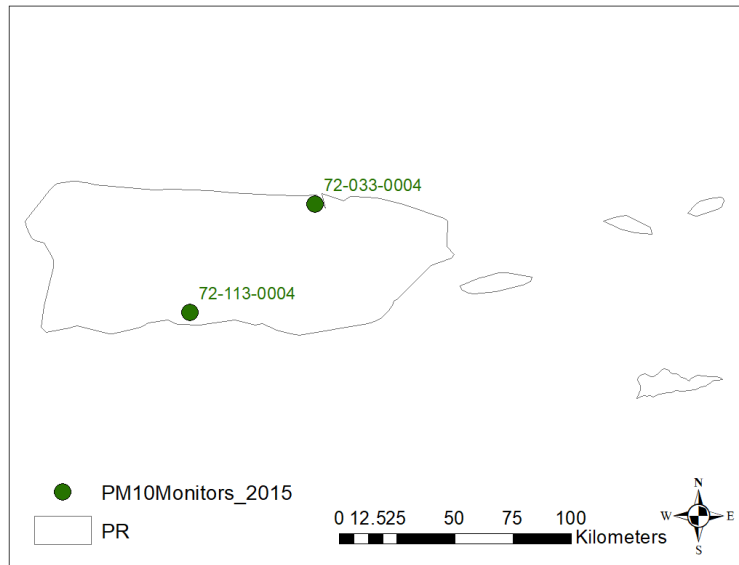


Figure 11 PM<sub>10</sub> monitors

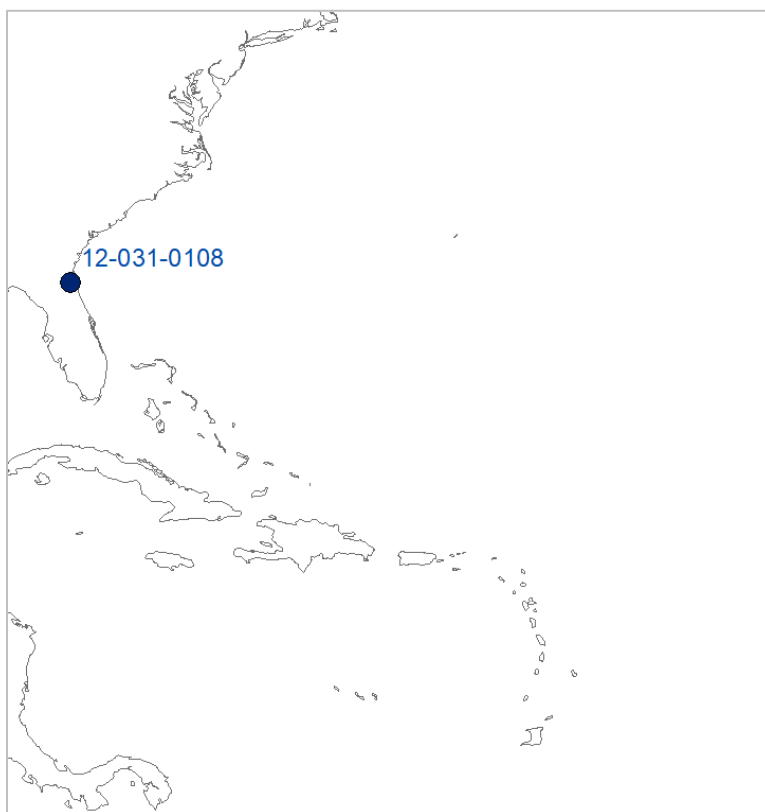


Figure 12 PM<sub>2.5</sub> monitors

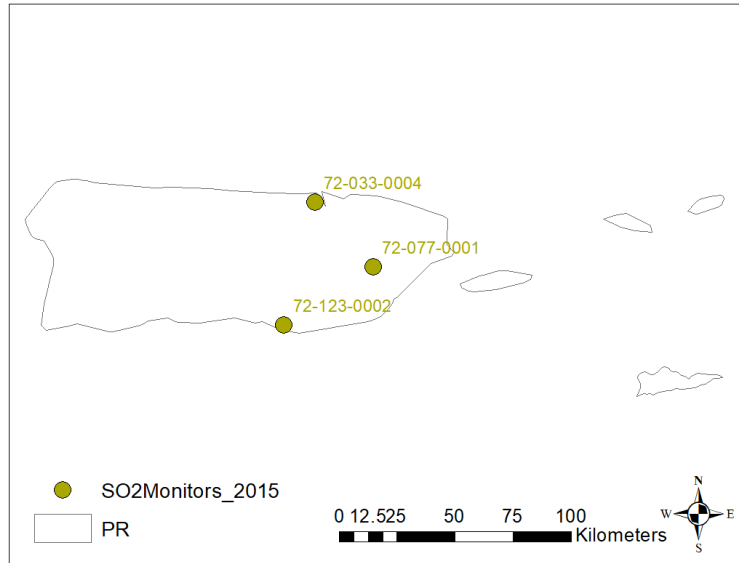


Figure 13 SO<sub>2</sub> monitors

### 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)
72	Puerto Rico	001	Adjuntas	CO	66526.2	43.7	43.7	43.7
72	Puerto Rico	001	Adjuntas	NO2	15692.5	262.2	76.2	295.8
72	Puerto Rico	001	Adjuntas	O3	183091.1	451.8	98.8	544.3
72	Puerto Rico	001	Adjuntas	PM10*	4645119.7	649.7	253.8	1015.2
72	Puerto Rico	001	Adjuntas	PM2.5	1481561.2	104.6	13.2	267.8
72	Puerto Rico	001	Adjuntas	SO2	530.3	24.4	7.9	31.6

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)
72	Puerto Rico	001	Adjuntas	32.0	27354475.9	27523851.5	221371.4
72	Puerto Rico	003	Aguada	7.2	6180701.4	6218948.4	216847.3
72	Puerto Rico	005	Aguadilla	5.4	4647595.6	4676374.5	195570.2
72	Puerto Rico	007	Aguas Buenas	6.3	3266844.4	3266844.4	58977.3
72	Puerto Rico	009	Aibonito	6.6	3417940.3	3417940.3	88629.3

### 4. References

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

Multi-Resolution Land Characteristics Consortium. 2022. *NLCD 2001 Land Cover (PUERTO RICO)*. Accessed 7 8, 2022. <https://www.mrlc.gov/data/nlcd-2001-land-cover-puerto-rico>.

NASA. 2022. *MODIS - MODERATE RESOLUTION IMAGING SPECTRORADIOMETER* -. Accessed 7 7, 2022. [https://modis.gsfc.nasa.gov/data/dataproduct/mod15.php#:~:text=MODIS%20Leaf%20Area%20Index%2FFPAR,-Overview&text=LAI%20is%20defined%20as%20the,nm\)%20absorbed%20by%20green%20vegetation](https://modis.gsfc.nasa.gov/data/dataproduct/mod15.php#:~:text=MODIS%20Leaf%20Area%20Index%2FFPAR,-Overview&text=LAI%20is%20defined%20as%20the,nm)%20absorbed%20by%20green%20vegetation).

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United States Environmental Protection Agency. 2022. *Hourly Data*. Accessed 7 7, 2022.  
[https://aqs.epa.gov/aqsweb/airdata/download\\_files.html#Raw](https://aqs.epa.gov/aqsweb/airdata/download_files.html#Raw).