i-Tree Eco Batch Run for Hawaii 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_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 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 2010 and 2011 Hawaii National Land Cover Database (NLCD) (Multi-Resolution Land Characteristics Consortium 2022) 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. 1). Evergreen percent was calculated based on the area ratio between "Evergreen Forest" and "Evergreen Forest" + "Deciduous Forest" for the secondary partitions (Fig. 2).
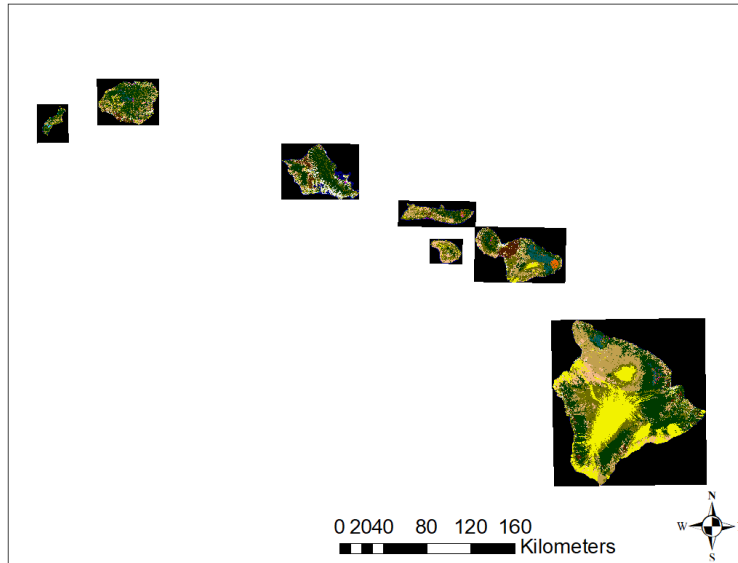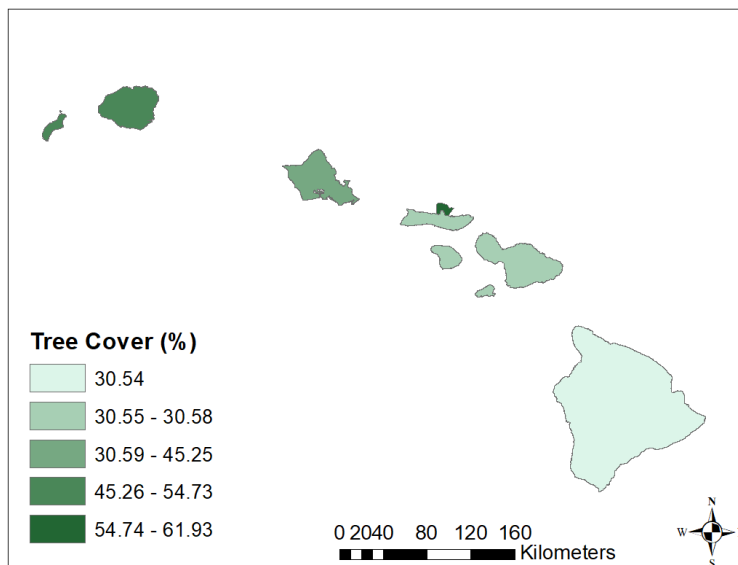
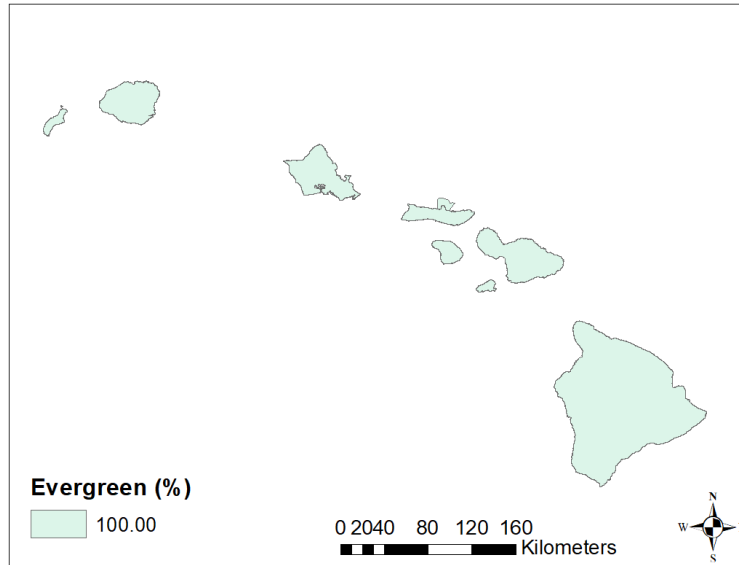Figure 1 2010 and 2011 land cover

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.
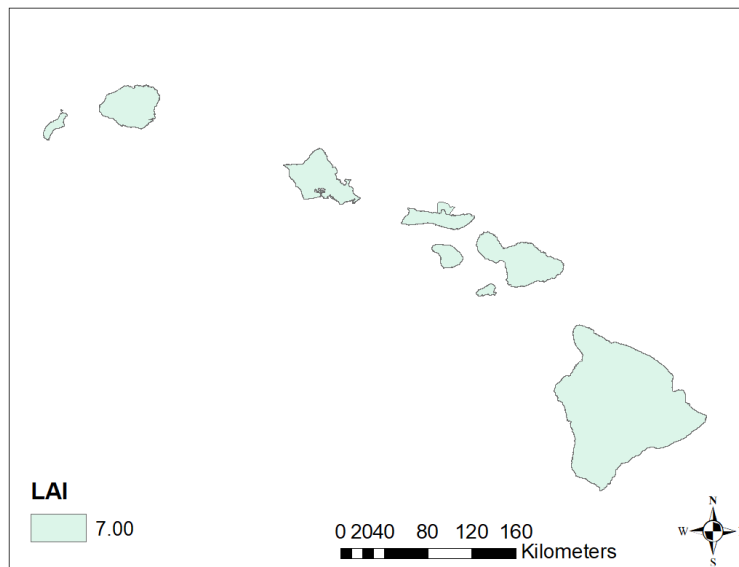

Figure 4 Leaf Area Index

"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).
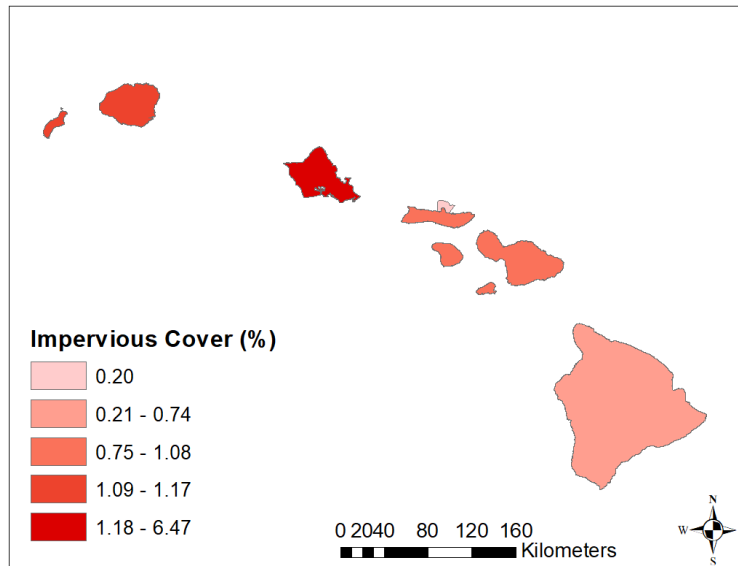

Figure 5 Impervious cover percent

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.
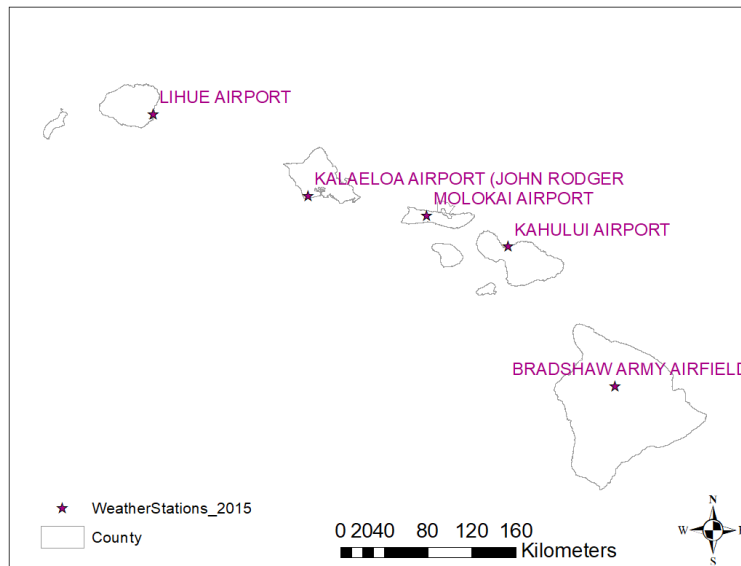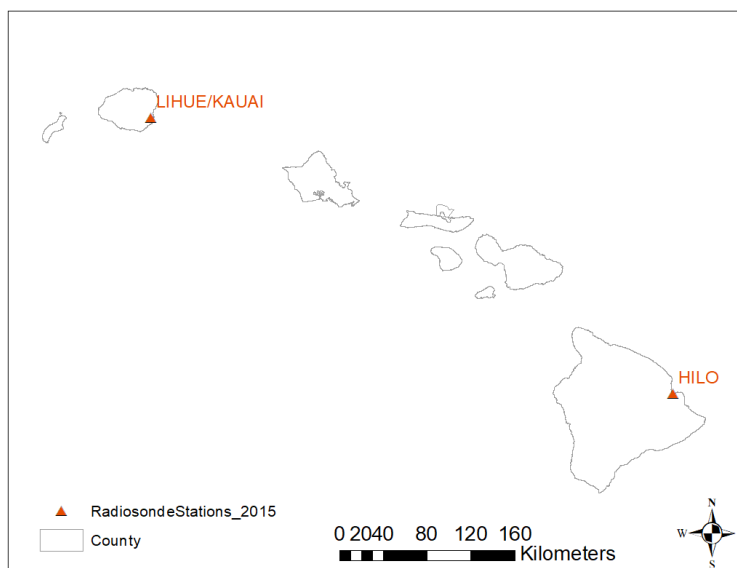

Figure 7 Radiosonde stations

1.1.3. Air pollutant monitors

CO, NO_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.
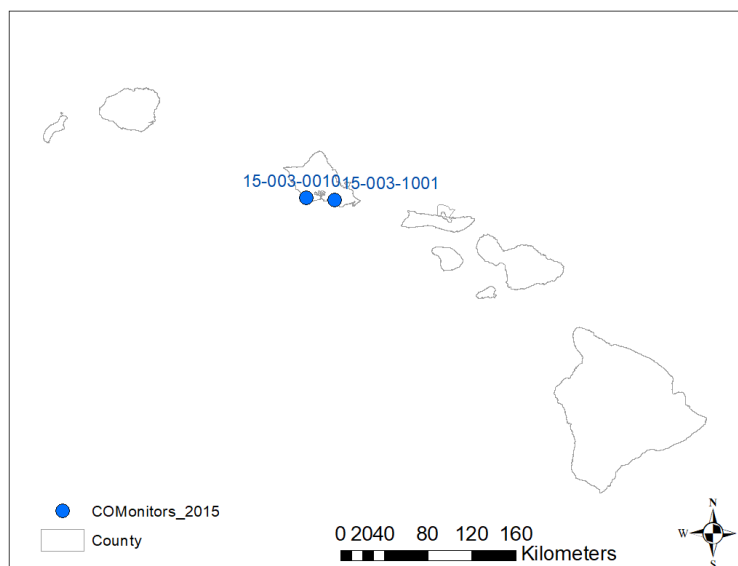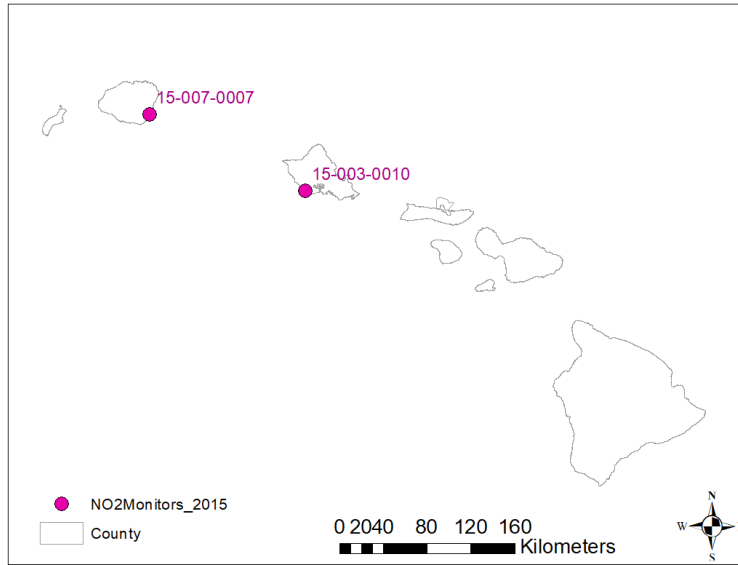

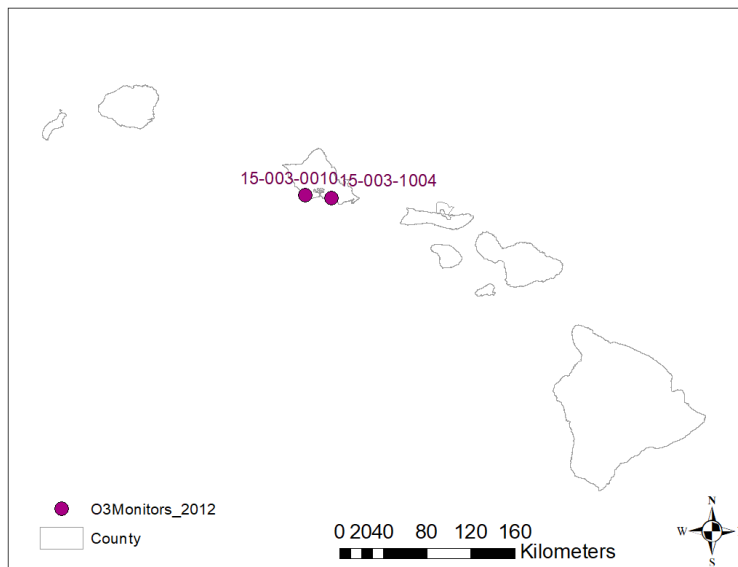Figure 8 CO monitors

Figure 9 NO_2 monitors
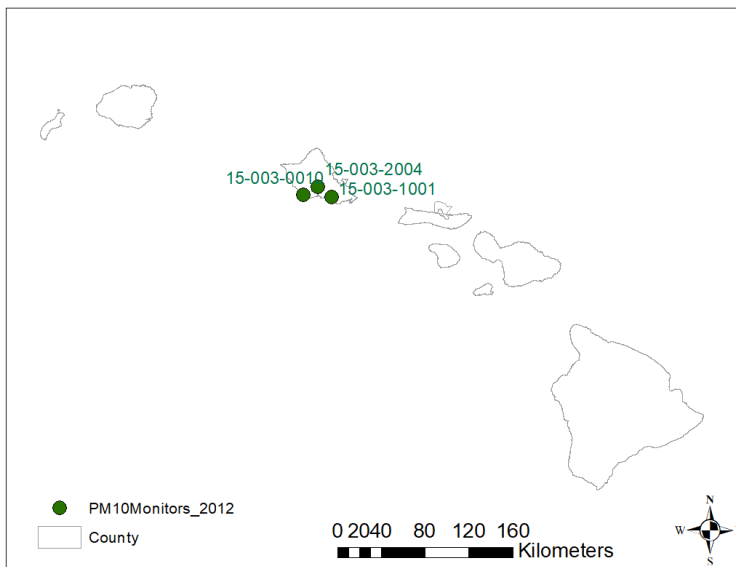

Figure 10 O_3 monitors
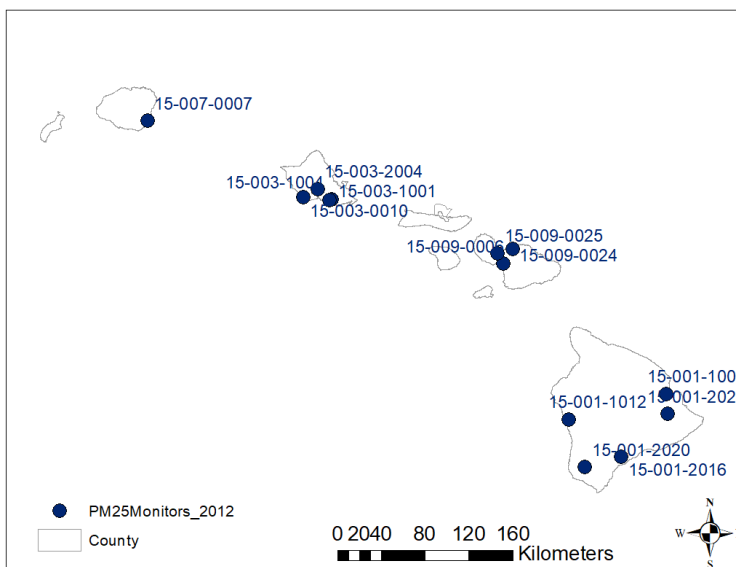
Figure 11 PM$_{10}$ monitors
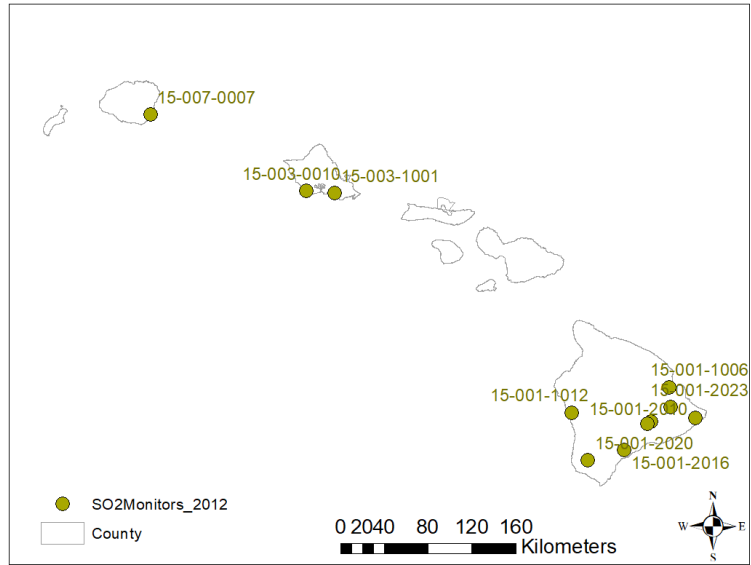

Figure 12 PM$_{2.5}$ monitors

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)
15	Hawaii	001	Hawaii	CO	1876001.6	1233.5	1233.5	1233.5
15	Hawaii	001	Hawaii	NO2	16498.2	1645.1	574.7	1987.5
15	Hawaii	001	Hawaii	O3	1391502.7	19404.6	4587.6	23028.7
15	Hawaii	001	Hawaii	PM10*	15680792.3	2193.4	856.8	3427.1
15	Hawaii	001	Hawaii	PM2.5	1305606.3	504.4	64.8	1125.9
15	Hawaii	001	Hawaii	SO2	37616.7	10649.4	4386.0	16858.0

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)
15	Hawaii	001	Hawaii	2097139531	1828103320	514.4897971	190907440.6
15	Hawaii	003	Honolulu	517920015.1	469834932.2	359.1894717	45146526.39
15	Hawaii	005	Kalawao	13828942.16	12548260.91	4.405842087	2602853.046
15	Hawaii	007	Kauai	682565728.7	634267780.5	197.7650699	148326581.9
15	Hawaii	009	Maui	723877806.9	666873362.2	239.1661839	112876692.7

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. *NOAA 2011 High Resolution Land Cover.* Accessed 7 7, 2022. https://www.mrlc.gov/taxonomy/term/31.

NASA. 2022. *MODIS - MODERATE RESOLUTION IMAGING SPECTRORADIOMETER -.* Accessed 7 7, 2022. 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.

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.