

AppEEARS CASE STUDY - Combining Species Abundance data with Remote Sensing Data-derived Environmental Descriptors

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Research Question:

How can AppEEARS be used to generate remote sensing-derived environmental descriptors for predicting species richness?

Goal:

Access remotely sensed data that can be used to derive environmental descriptors for use in species richness studies without ever (1) downloading the source data for the remote sensing datasets or (2) needing to open remote sensing software.

Data Needed:

Sensor	Product	Layer
Terra Moderate Resolution Imaging Spectroradiometer (MODIS)	Vegetation Indices (MOD13A3.006)	1 km monthly NDVI
Terra Moderate Resolution Imaging Spectroradiometer (MODIS)	Net Primary Production (MOD17A3.055)	1 km annual Gross Primary Productivity
Terra and Aqua Combined Moderate Resolution Imaging Spectroradiometer (MODIS)	Land Cover Type (MCD12Q1.006)	Land Cover Type 2: Annual University of Maryland Classification
Shuttle Radar Topography Mission (SRTM)	Digital Elevation Model (SRTMGL1.003)	Elevation

Software/Tools Needed:

AppEEARS: <https://lpdaacsvc.cr.usgs.gov/appeears/>

Microsoft Excel

Estimated Time: 30-45 minutes

Instructions

Step 1: Download Data

Go to

https://git.earthdata.nasa.gov/projects/LPDUR/repos/naccb/browse/SQUARE_ID17QK09.zip

and download the zipped shapefile. The zipped shapefile contains one of the 10x10 km grid tiles from the Ontario Breeding Bird Atlas study area. The tiles were used to gather and aggregate statistics for the Ontario Breeding Bird Atlas (OBBA) project that is the source of species richness data used in this use case.

Source Data containing all of the 10x10 km grid tiles used in the study:

http://birdsonario.org/atlas/download/onatlas_squares_shape.zip

Step 2: Extract Area Sample in AppEEARS

- Go to the AppEEARS homepage <https://lpdaacsvc.cr.usgs.gov/appeears/> and sign-in using your NASA Earthdata Login.
- From the top panel, select “Extract” → “Area Sample”
- Start a new request
- Provide a name for your sample (ESA 2019 Use Case)
- Upload SQUARE_ID17QK09.zip
- Set Start Date to 01-01-2001 and End Date to 12-31-2005
- “Is Date Recurring” is unchecked
- Under “Select the layers to include in the sample,” choose the following layers from these products (find products by typing in the product name in the search and selecting the appropriate data product. Click on the layer to select.)

Data Product	Layer
Vegetation Indices (MOD13A3.006)	_1_km_monthly_NDVI
Net Primary Production (MOD17A3.055)	Npp_1km
Land Cover Type (MCD12Q1.006)	LC_Type2
Digital Elevation Model (SRTMGL1.003)	Band1

- Review the data product layers in the “Selected Layers” that you have chosen and use the “-“ symbol to remove any unwanted layers.
- File Format: GeoTiff
- Projection: Geographic
- Submit the request. Click on the “Explore” tab to view submission progress.

Step 3: Reviewing Results in AppEEARS Test Location

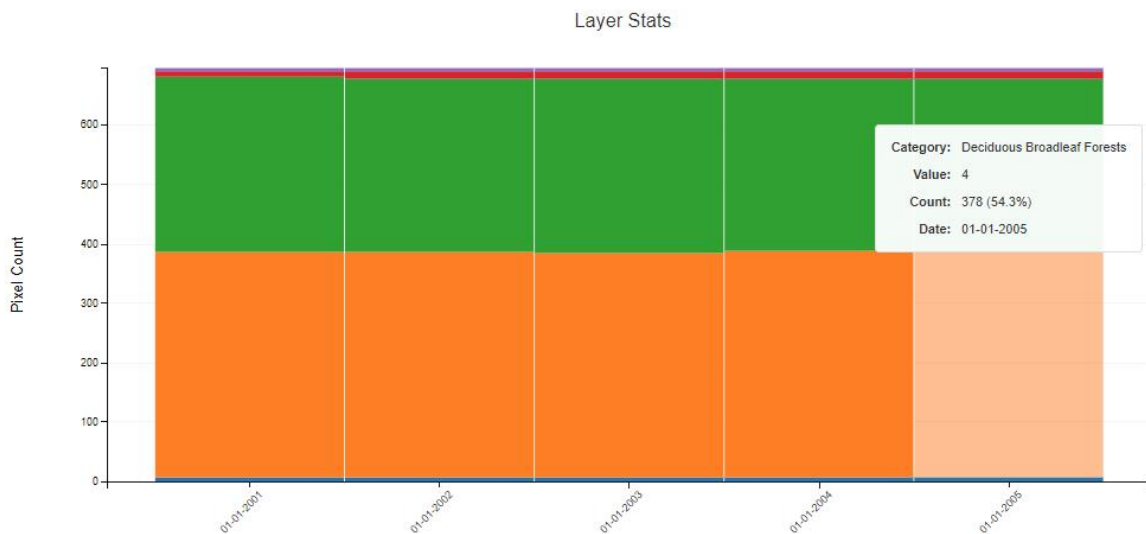
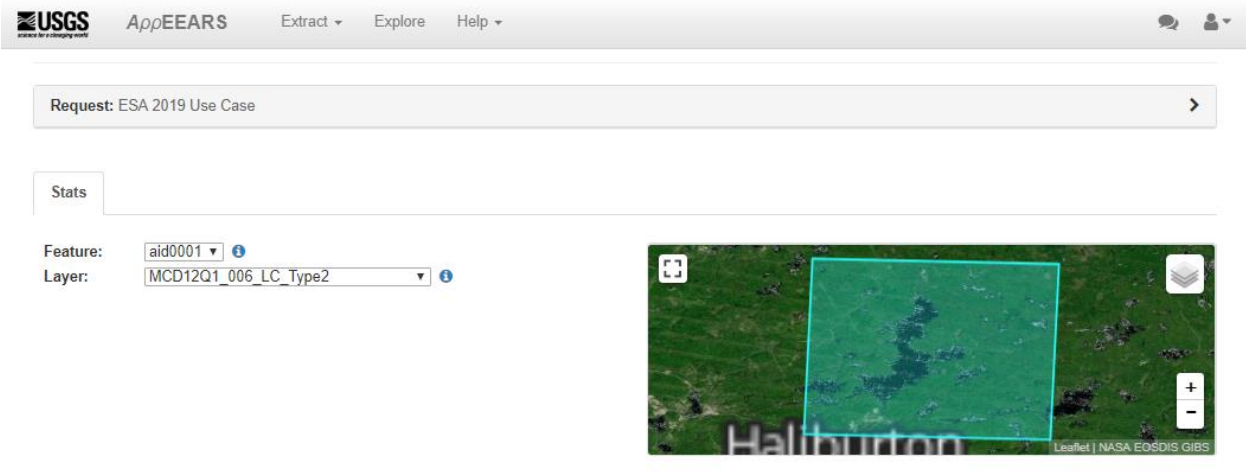
- The length of time for an AppEEARS request to process is dependent upon a number of factors including size of request and server traffic. In the meantime, you can log-on to an AppEEARS Demo account to view the outputs for the above request:
- Go to <https://urs.earthdata.nasa.gov> and sign out of your personal account. Next, sign in using the username and password provided. From there, return to AppEEARS.
 - Username: AppEEARSTesting

- Password: NASApixels2017
- Once you are logged in, from the top panel, select “Explore” → “ESA 2019 Use Case”

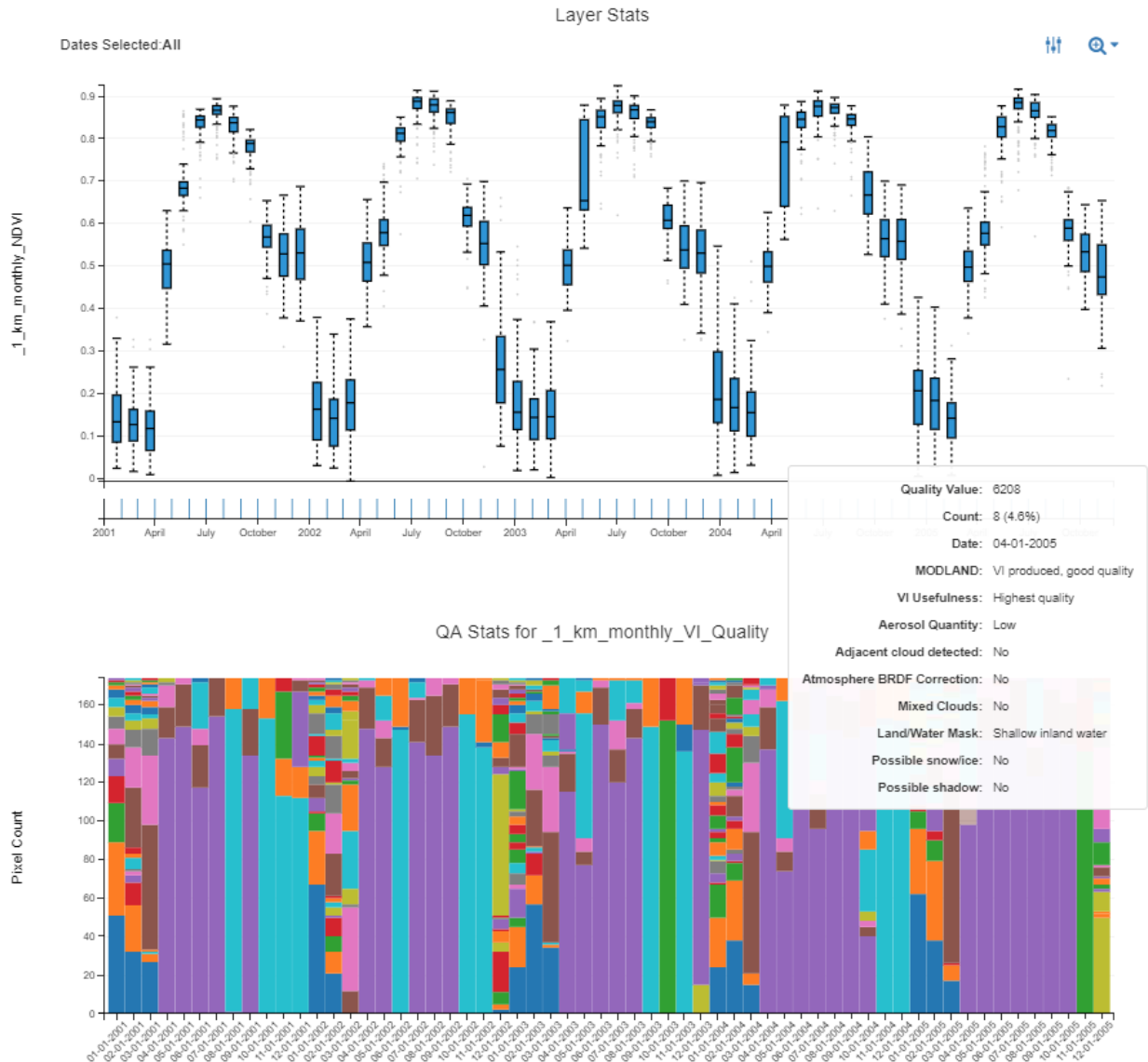
Step 4: Exploring Results of an Area Sample Request

Layer Stats

- Figure 1 shows the land cover type distribution for this grid tile north of Haliburton, ON. For this OBBA tile, the dominant land cover type is ‘Deciduous Broadleaf Forests’.



- Under the Layer Dropdown, select “MOD13A3_006__1_km_monthly_NDVI”
 - Figure 2 shows the distribution of NDVI over the five-year time period for the selected tile. AppEEARS also shows the associated quality values in the stacked bar charts below, which can be used to interpret the quality of your data by hovering over each section in the bar chart.



Step 5: Downloading the Contents of an AppEEARS Request

- Under the Explore Tab, select “Download the contents of the request” (Figure 3).

Explore Requests

One or more of your requests have expired. Please see [Sample Request Retention](#) for details.

Request	Type	Status	Details	Date Submitted	Date Completed	
ESA 2019 Use Case	Area Sample	Done		08-09-2019 8:53:47 am CDT	08-09-2019 8:54:28 am CDT	

Here, you will find a list of the supporting files used to generate the output of your request.

- Begin by downloading the following statistics files:
 - MCD12Q1-006-LC-Type2-Statistics.csv
 - MOD13A3-006-Statistics.csv
 - MOD17A3-055-Statistics.csv

- SRTMGL1-003-Statistics.csv
- The files above contain statistics associated with the request including minimum/maximum, mean, standard deviation, and variance of the data values from each region of interest for each observation available.
 - For categorical layers like Land Cover Type, frequency distributions are returned in the statistics files.

Step 6: Deriving Environmental Descriptors from Remote Sensing Data in Excel

- Open up a new excel workbook

Below, use the 'Statistics.csv' files to calculate the following Environmental Descriptors for each tile:

- **Dominant Land Cover Class**
 - Open the MCD12Q1-006-LC-Type2-Statistics.csv file
 - Insert a new column after Column C (Date), labeled 'Dominant Land Cover Class'
 - In cell D2, enter the formula:
 =INDEX(\$E\$1:\$I\$1,0,MATCH(MAX(\$E2:\$I2),\$E2:\$I2,0))
 - This will select the dominant land cover type
 - Dominant Land Cover Class for our example: (4) Deciduous Broadleaf Forests for all 5 years
- **Land Cover Dominance**
 - Proportion of the area covered by the dominant class
 - insert a column after column D (Dominant Land Cover Class) and label it 'Land Cover Dominance'
 - in cell E2, type the following formula:
 - =MAX(F2:J2)/SUM(F2:J2)*100
 - Land Cover Dominance for this example is around 54%
- **Richness of Land Cover Classes**
 - Total # of classes within the 10 km cell
 - Insert a column after column E (Land Cover Dominance) and label it 'LCT Richness'
 - in Cell F2, type the following formula
 - =COUNT(G2:K2)
 - There are 5 LCT classes in this grid cell
- In cell B7, type the ID for the grid cell
 - To find the ID, return to the AppEEARS View Area Sample Page and click on the i icon next to the feature dropdown
 - grid cell: SQUARE_ID: 17QK09
- in cell C7, type '2001-2005'
- in cell D7, we can see that the most frequently occurring dominant land cover class is '(4) Deciduous Broadleaf Forests'
- in cell E7, calculate the mean Land Cover Dominance for 2001-2005 for the tile
- in cell F7, calculate the mode for LCT Richness
- Save the csv file
- **Topographic Coefficient of Variation**

- Open the SRTMGL1-003-Statistics.csv file
- in Cell Q1, type ‘Coefficient of Variation’
- in Cell Q2, calculate CV (take the SD divided by the mean multiplied by 100)
 - $=J2/I2*100$
- Save the csv file
- **Total Annual Productivity (NPP)**
 - Open the MOD17A3-055-Statistics.csv file
 - In cell C7, type the ID for this grid cell
 - 17QK09
 - In cell D7, type 2001-2005
 - In cell I7, calculate the 5 year mean net primary productivity (NPP)
- Save the CSV file
- **Minimum Level of Perennial Cover (NDVI)**
 - Open the MOD13A3-006-Statistics csv file
 - in cell R2, type Minimum Annual NDVI
 - in cells S1 - W1, type 2001, 2002, 2003, etc
 - in cells S2 - W2, find the minimum NDVI value for each year
 - in cell X2, calculate the mean annual minimum NDVI for the 5 year period
- **Degree of Vegetation Seasonality (NDVI, CV)**
 - in Cell Q1, label it CV
 - find the Coefficient of Variation for NDVI for each month ($=J2/I2*100$)
 - in Cell R3, type ‘Mean CV’
 - calculate the mean CV by year, and for 2001-2005
- Save the csv file
- Environmental Descriptors for OBBA Tile 17QK09 2001-2005
 - **Dominant Land Cover Class:** (4) Deciduous Broadleaf Forests
 - **Land Cover Dominance:** 54.37%
 - **LCT Richness:** 5 (land cover classes present in tile)
 - **Topographic Coefficient of Variation:** 8.544516163
 - **Total Annual Productivity (NPP):** 0.5552 kg C/m²
 - **Minimum Level of Perennial Cover (NDVI):** 0.00424
 - **Degree of Vegetation Seasonality (CV):** 19.17308619
- To see how these environmental descriptors can be used for species richness modeling, be sure to check out the study that our example was based on:
 - Coops, N. C., Wulder, M. A., and Iwanicka, D., 2009, Exploring the relative importance of satellite-derived descriptors of production, topography and land cover for predicting breeding bird species richness over Ontario, Canada, *Remote Sensing of Environment*, vol. 113(3), p. 668-679. Available online: <https://doi.org/10.1016/j.rse.2008.11.012>.

Step 7: Looking to Add Quality Considerations? Check out our tutorials:

- Masking, Visualizing, and Plotting AppEEARS Output GeoTIFF Time Series in Python
 - <https://lpdaac.usgs.gov/resources/e-learning/masking-visualizing-and-plotting-apppeears-output-geotiff-time-series-python/>
- Working with AppEEARS NetCDF-4 Output Data in Python
 - <https://lpdaac.usgs.gov/resources/e-learning/working-apppeears-netcdf-4-output-data-python/>
- Working with AppEEARS NetCDF-4 Output Data in R
 - <https://lpdaac.usgs.gov/resources/e-learning/working-apppeears-netcdf-4-output-data-r/>
- Using AppEEARS Quality Service to Extract Information from MODIS Quality Layers
 - <https://lpdaac.usgs.gov/resources/e-learning/using-apppeears-quality-service-extract-information-modis-quality-layers/>