TUTORIAL 2

EXPLORING ENVIRONMENTAL DATA USING WEB-BASED TOOLS

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The use of remote sensing data in demographic and social sciences research often implies a steeper learning curve than other types of spatial data (Balk and Grace 2019). AppEEARS (Application for Extracting and Exploring Analysis Ready Samples) offers an efficient way to access and transform geospatial data from a variety of data archives, aiming to reduce the amount of data the users of remote sensing information (particularly those that are new to it) need to download and process; to enable the discovery and comparison of similar datasets; to provide a way to more efficiently explore results; and to facilitate subsetting geospatial datasets using spatial, temporal, and band/layer parameters. AppEEARS focuses mostly on remote sensing data of moderate spatial resolution (30 m to 1 km) and varied temporal resolution (e.g., daily time steps, monthly composites, or year averages)[1].

In this tutorial, we use AppEEARS to integrate point and polygon sociodemographic data (vector data in shapefile format) with vegetation indices and land cover data (raster data in tiff format). You can use the data included in the exercises, or follow the instructions using your own data.

The tutorial includes two exercises:

- Exercise 1: Working with point data

- Exercise 2: Working with area data

Please note: the video "Overview of the Tutorials" mentions the use of DHS (Demographic and Health Survey) clusters points in exercise 1. However, due to its confidentiality and privacy obligations, the DHS program needs to keep a record of who accessed/ downloaded DHS data, and all users must register and sign the "Conditions of Use for The DHS Program datasets". Because of this, exercise 1 now uses a point sample from a difference data source. Those interested in using DHS data (including cluster points) could request access here: https://dhsprogram.com/data/Access-Instructions.cfm

[1] A list of resources is available at https://lpdaac.usgs.gov/tools/appeears/, clicking the "Using the tool" icon. A brief introduction to AppEEARS and other online tools and platforms is available from http://sedac.ciesin.columbia.edu/binaries/web/sedac/thematic-guides/remote-sensing-tools-for-social-scientists.pdf

Exercise 1: Working with POINT DATA

For this exercise, we will add information about vegetation indices[2], vegetation coverage and land cover classifications derived from remote sensing products, to GRUMP (Global Rural Urban Mapping Project[3]) settlement points located in the Kheda district of the Gujarat state, India (Figure 1), a moderately urban district in one of the fastest urbanizing states of the country (Shah and Joshi 2015; Nair et al. 2013). The rapid expansion of urban settlements has been linked to the reduction of green areas and the consequent loss of the beneficial effects that vegetation exerts on quality of life, for example by decreasing urban heat island effects and pollution (e.g., Bajirao 2015; Imam and Banerjee 2016).

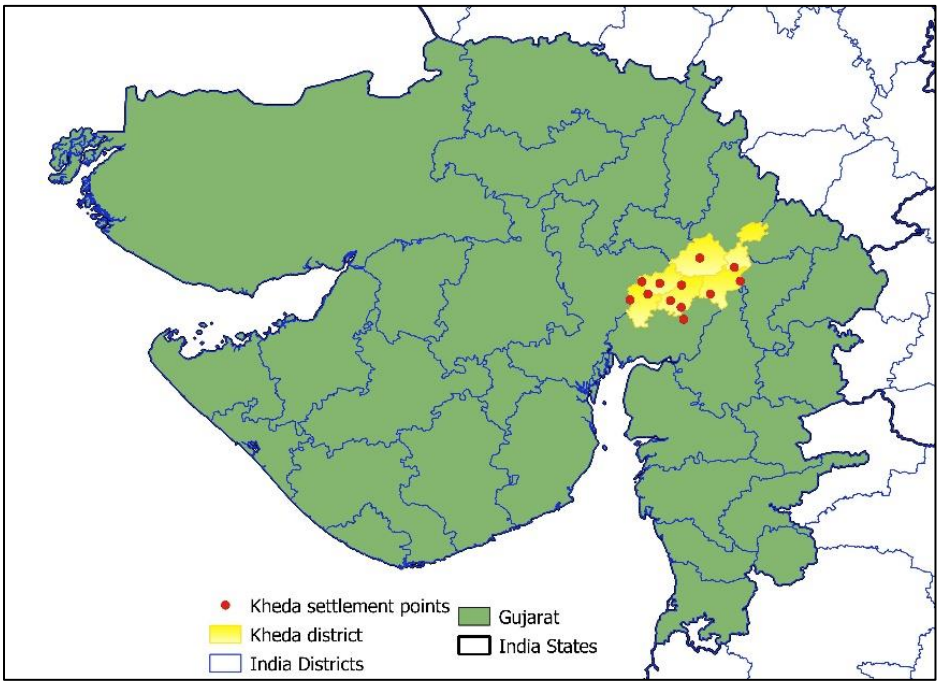


Figure 1: The map displays Gujarat state and its districts, indicating the location of the GRUMP settlement points within the Kheda district. All the administrative boundaries were downloaded from GADM (https://gadm.org/download_country_v3.html). Boundaries were not included in the point sample submitted to AppEEARS. The settlement points were downloaded from https://sedac.ciesin.columbia.edu/data/set/grump-v1-settlement-points-rev01. Map elaborated with QGIS 3.4-Madeira

[2] A Vegetation Index is an indicator that describes the greenness — the relative density and health of vegetation— for each pixel in a satellite image (USGS 2018). Vegetation indices are used for global monitoring of vegetation conditions and are used in products displaying land cover and land cover changes. These data may be used as input for modeling global biogeochemical and hydrologic processes as well as global and regional climate; and for characterizing land surface biophysical properties and processes, such as primary production and land cover conversion (transition from one land cover or use type to another, for example from forest to agriculture) (https://lpdaac.usgs.gov/products/myd13a3v006/).

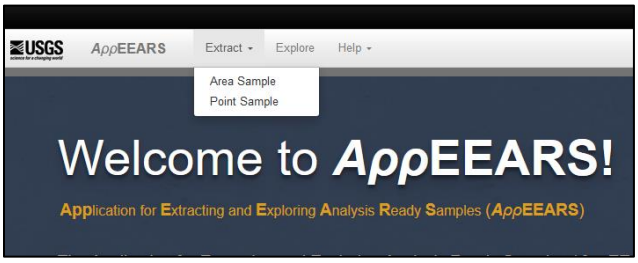
[3] https://sedac.ciesin.columbia.edu/data/collection/grump-v1

Steps:

1. Create and Submit an Extract Point Sample

1.a. Go to: https://lpdaacsvc.cr.usgs.gov/appeears/. You need to register to use AppEEARS, if you are already registered just log in.

1.b. From the "Extract Tab", select "Point Sample" (figure 2, left)



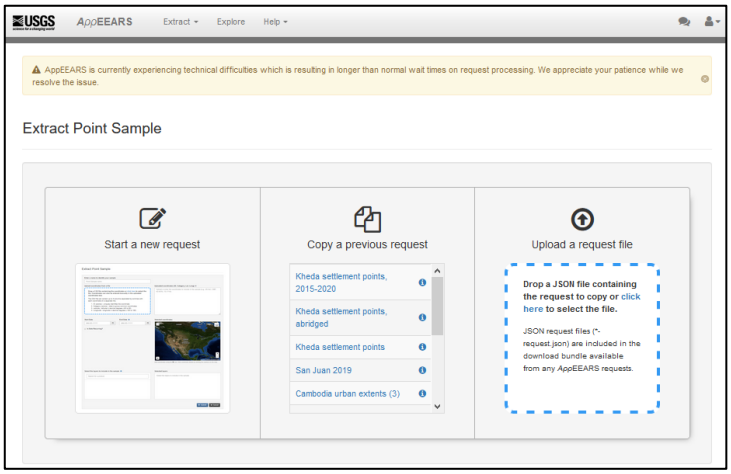


Figure 2. Extract Tab options (left) and Extract Point Sample options (right)

1.c. In the "Extract Point Sample" page, select **"Start a new request"** (figure 2, right)

1.d. Upload the file *online_training_tutorial2_exercise1_point_sample_Kheda_settlements.csv.* You can also use your own data.

Table 1. Point sample: Kheda settlements

ID	Category	Latitude	Longitude
CHAKLASI	U	22.65	72.93
NADIAD	U	22.7	72.85
NAIKA	NU	22.7059	72.5465
DAKOR	U	22.75	73.15
KHEDA	U	22.75	72.68
MAHUDHA	U	22.8167	72.9333
MAHEMDAVAD	U	22.83	72.77
BALASINOR	U	22.95	73.33
KAPADWANJ	U	23.02	73.07
JETALPUR	NU	22.8425	72.6358
TIMBA	NU	22.8473	73.3742
ANAND	U	22.56	72.95

Following the instructions, the csv file should have up to four columns (fields or variables) separated by commas with each point coordinate on a separate line (table 1). The columns are: ID *(optional)* -

uniquely identifies the coordinate; Category *(optional)* - label to group common coordinates; Latitude - latitude in decimal degrees (-90 to 90); Longitude - longitude in decimal degrees (-180 to 180)

For this exercise, the ID is the name of the settlement, while 'Category' has two values: U (urban) and NU (not urban). Latitude and Longitude are the geographic coordinates.

The temporal dimension:

1.e. Check the "Is data recurring?" box. The year range bar is now visible, and the data extract will be by year.

1.f. Slide the Year Range to: 2015-2020. This is the temporal coverage of our data extract.

1.g. Enter start date: 01-01; and end date: 12-31. The data extract will now be also by month, when available. Note that the options are for day and month. If the "Is data recurring" box is not checked, the options would also include year.

The data layers:

1.h. Select all the layers from the following products (because we are ***exploring*** the data, it is relevant to know what information is available for each product):

- S-NPP NASA VIIRS Vegetation Indices: VNP13A3.001, 1000m, Monthly, (2012-01-19 to present)

- Aqua MODIS Vegetation Indices (NDVI & EVI): MYD13A3.006, 1000m, Monthly, (2002-07-01 to Present)

- Terra MODIS Vegetation Continuous Field (VCF): MOD44B.066, 250m, Yearly, (2000-03-05 to 2018-12-31)

- Combined MODIS Land cover type: MCD12Q1.006, 500m, Yearly, (2001-01-01 to 2017-12-31)

The links are from AppEEARS Help, "available products" option (https://lpdaacsvc.cr.usgs.gov/appeears/products). A brief description of each product is available in **Annex 1** of this document.

Ready to submit:

1.i. Enter a name to identify your sample!!!

1.j. SUBMIT your request.

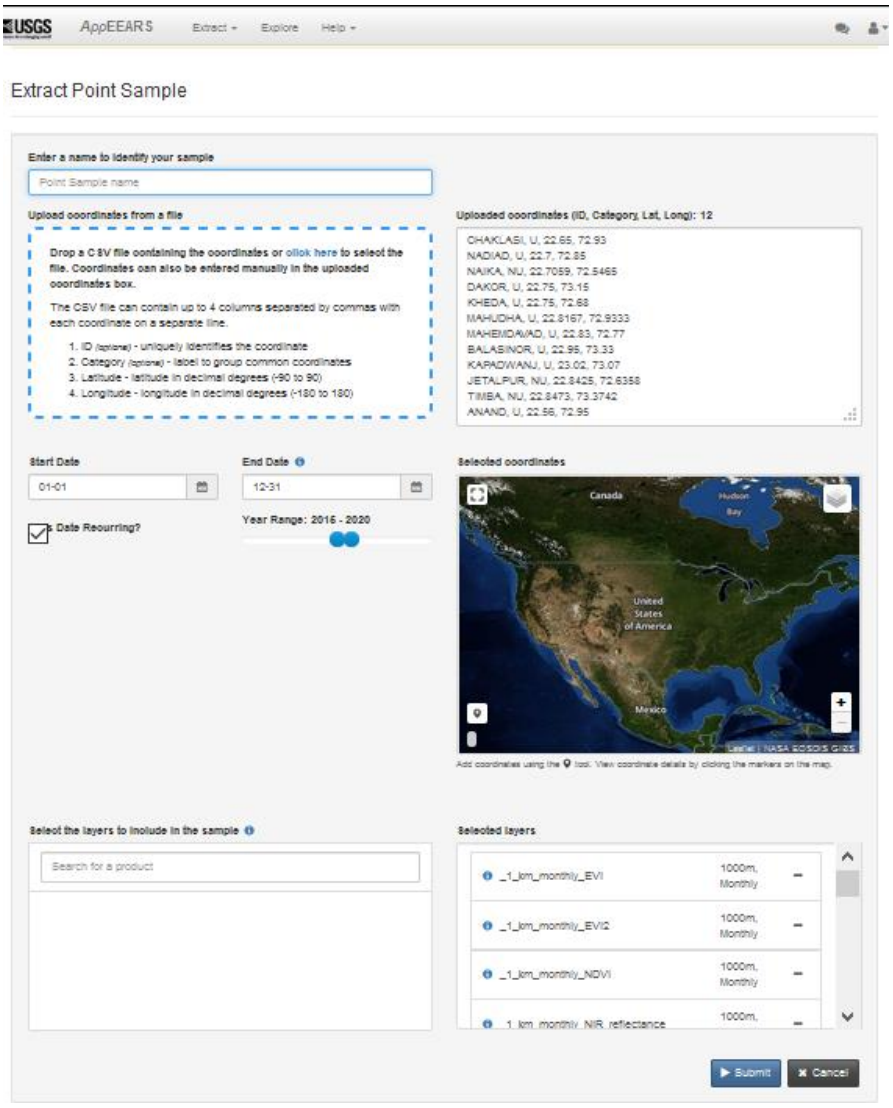


Figure 3. The data request is almost ready to submit; it just needs a name.

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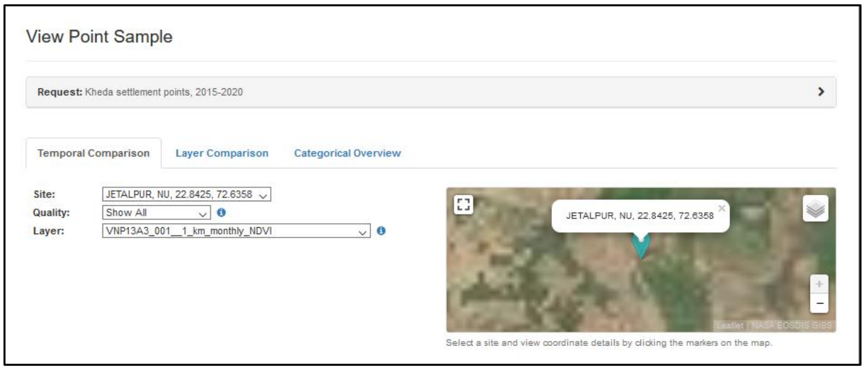
2. Explore the output online

2.a. One of the advantages of AppEEARS is that it is not necessary to download the output of the request to explore the results. For this exercise, we will examine and compare the NDVI and EVI[4] layers from VPN13A3 and MYD13A3, and look at the quality of the categorical vegetation continued field and land cover layers. Go to the **Explore tab**, and click in your sample name to open the View Point Sample page. There are three options: Temporal Comparison, Layer Comparison, and Categorical Overview. For the Temporal and Layer Comparisons, we will use selected settlements (points), while we will use all the settlements (points) for the Categorical Overview option.

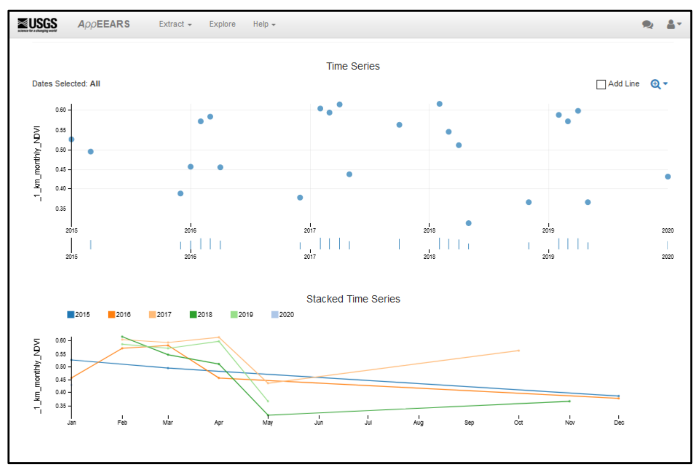
[4] A brief description is available in Annex 1.

2.b. Viewer example: Temporal comparison (images captured with Print Screen)



The figure on the left shows the upper panel of the View Point Sample-Temporal Comparison tab. It shows the location of the selected settlement point, its ID, and information about quality and the visible layer. More information is available by clicking in the little blue circle.

The graphs below[5] display the temporal comparison of VPN NDVI (upper panel) and MODIS NDVI (lower panel), for quality = show all (left) and quality = show good quality (right), for the selected settlement of Jetalpur.

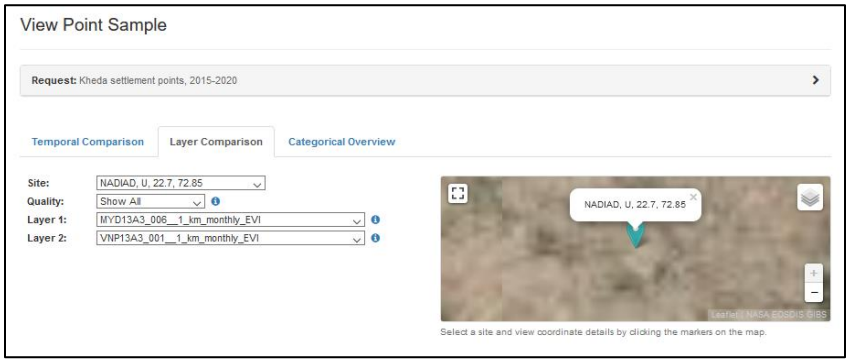


In each graph, the upper section displays the time series for all the available points to test for completeness, while the lower panel shows the stacked annual series to highlight seasonal variations.

[5] The image files are included in the exercise package.

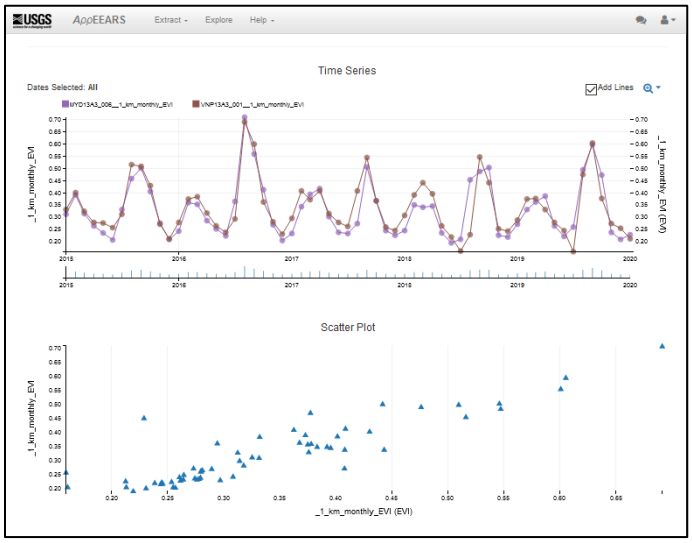
Introducing the “quality” option (graphs on the left) substantially reduces the number of data points in both layers, but the reduction is larger in the VPN NDVI layer (upper panel).

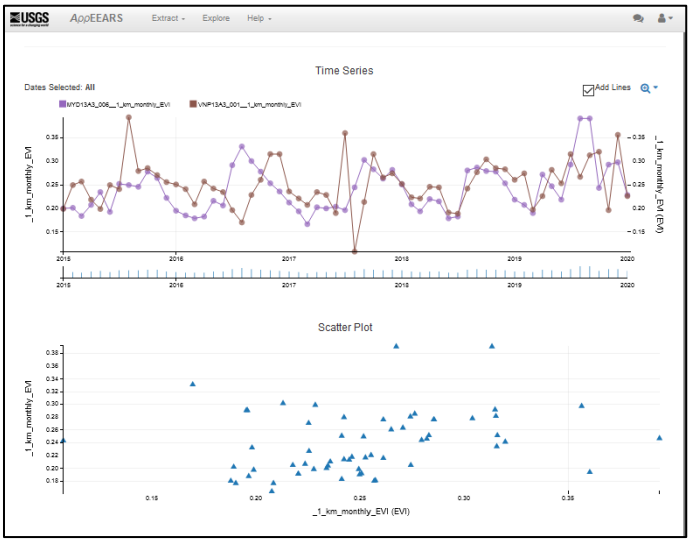
2.c. Viewer example: Layer comparison

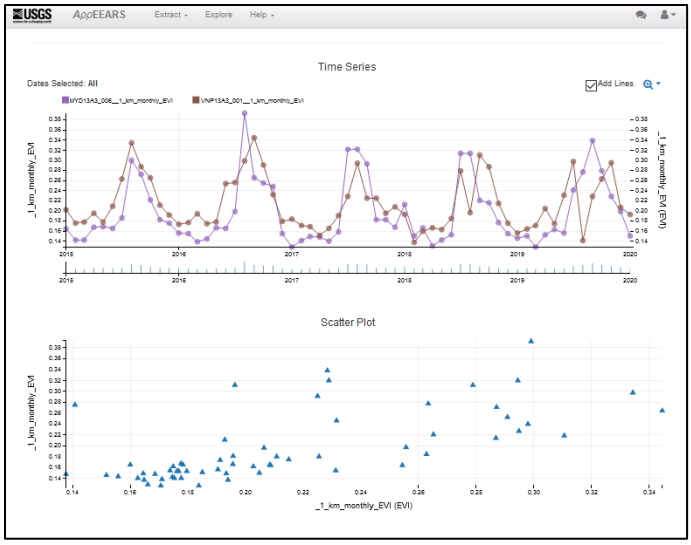


On the left is the image of the upper panel of the View Point Sample-Layer Comparison tab. It shows the location of a selected settlement point, its ID, the quality options, and identifies the two layers being compared. More information is available by clicking in the little blue circle.

The graphs below display the layer comparison of EVI (enhanced vegetation index) from MODIS (lilac) and VPN (brown), for selected settlement points: Jetalpur (upper left), Timba (upper right), Kapadwanj (lower left) and Nadiad (lower right).

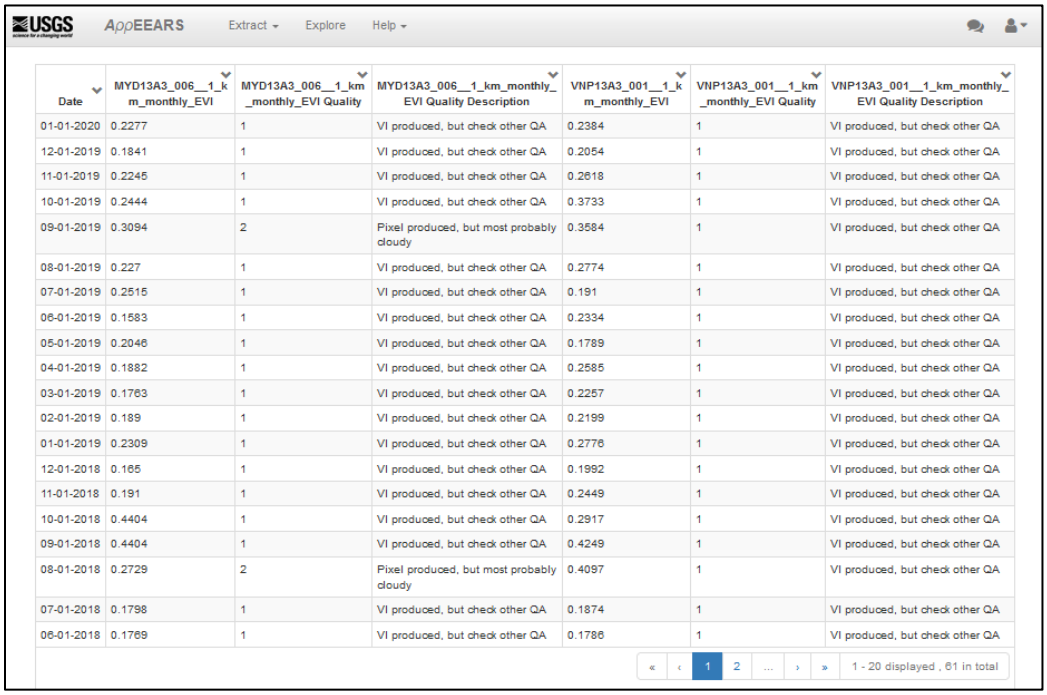






For each location, the upper graph displays the data points of the two EVI layers chronologically, while the lower panel shows the scatter plot of the MODIS and VPN points. This information could be help to select the appropriate EVI for a particular analysis. For example, while the EVIs from MODIS and VPN look quite similar for Jetalpur, the scatter plot for Kapadwanj suggests large differences between the two options.

A third panel in the layer comparison tab is a comparison table, similar to the one displayed below. For each time slice –in this case it is month/year—the table provides information on the value and the quality of the indicator, for each layer included in the comparison.

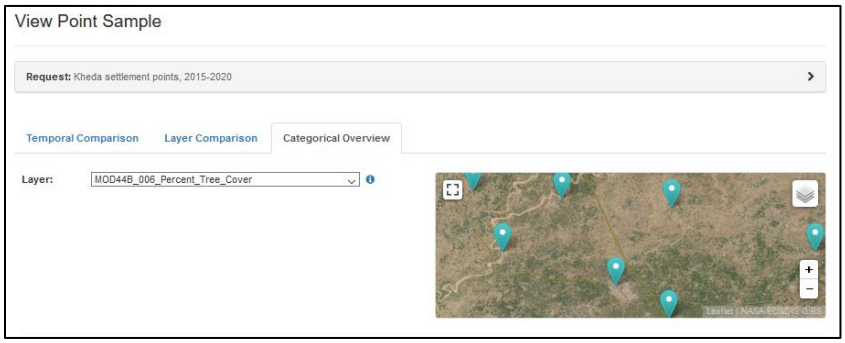


Date	MYD13A3_006__1_km_monthly_EVI	MYD13A3_006__1_km_monthly_EVI Quality	MYD13A3_006__1_km_monthly_EVI Quality Description	VNP13A3_001__1_km_monthly_EVI	VNP13A3_001__1_km_monthly_EVI Quality	VNP13A3_001__1_km_monthly_EVI Quality Description
01-01-2020	0.2277	1	VI produced, but check other QA	0.2384	1	VI produced, but check other QA
12-01-2019	0.1841	1	VI produced, but check other QA	0.2054	1	VI produced, but check other QA
11-01-2019	0.2245	1	VI produced, but check other QA	0.2618	1	VI produced, but check other QA
10-01-2019	0.2444	1	VI produced, but check other QA	0.3733	1	VI produced, but check other QA
09-01-2019	0.3094	2	Pixel produced, but most probably cloudy	0.3584	1	VI produced, but check other QA
08-01-2019	0.227	1	VI produced, but check other QA	0.2774	1	VI produced, but check other QA
07-01-2019	0.2515	1	VI produced, but check other QA	0.191	1	VI produced, but check other QA
06-01-2019	0.1583	1	VI produced, but check other QA	0.2334	1	VI produced, but check other QA
05-01-2019	0.2046	1	VI produced, but check other QA	0.1789	1	VI produced, but check other QA
04-01-2019	0.1882	1	VI produced, but check other QA	0.2585	1	VI produced, but check other QA
03-01-2019	0.1763	1	VI produced, but check other QA	0.2257	1	VI produced, but check other QA
02-01-2019	0.189	1	VI produced, but check other QA	0.2199	1	VI produced, but check other QA
01-01-2019	0.2309	1	VI produced, but check other QA	0.2776	1	VI produced, but check other QA
12-01-2018	0.165	1	VI produced, but check other QA	0.1992	1	VI produced, but check other QA
11-01-2018	0.191	1	VI produced, but check other QA	0.2449	1	VI produced, but check other QA
10-01-2018	0.4404	1	VI produced, but check other QA	0.2917	1	VI produced, but check other QA
09-01-2018	0.4404	1	VI produced, but check other QA	0.4249	1	VI produced, but check other QA
08-01-2018	0.2729	2	Pixel produced, but most probably cloudy	0.4097	1	VI produced, but check other QA
07-01-2018	0.1798	1	VI produced, but check other QA	0.1874	1	VI produced, but check other QA
06-01-2018	0.1769	1	VI produced, but check other QA	0.1786	1	VI produced, but check other QA

« ‹ 1 2 ... › » 1 - 20 displayed , 61 in total

2.d. Viewer example: Categorical overview

The categorical view displays the distribution of all the settlement points by category (user-defined or quality categories) and by site. As an example, the graph below (Figure 4) displays the percent of tree cover from 2015 to 2018. There are four data points for each settlement for a total of 48 data points. Most of these points (36) are included in the urban category, and the rest is in the non-urban category (upper panel: Categories). The percentage of tree cover is higher but also more variable among non-urban settlements. The second panel (Sites) displays the same indicator for each settlement point (4 observations each). The percent of tree cover varies widely among settlement points, and some of them also display internal variability over the four years under observation.



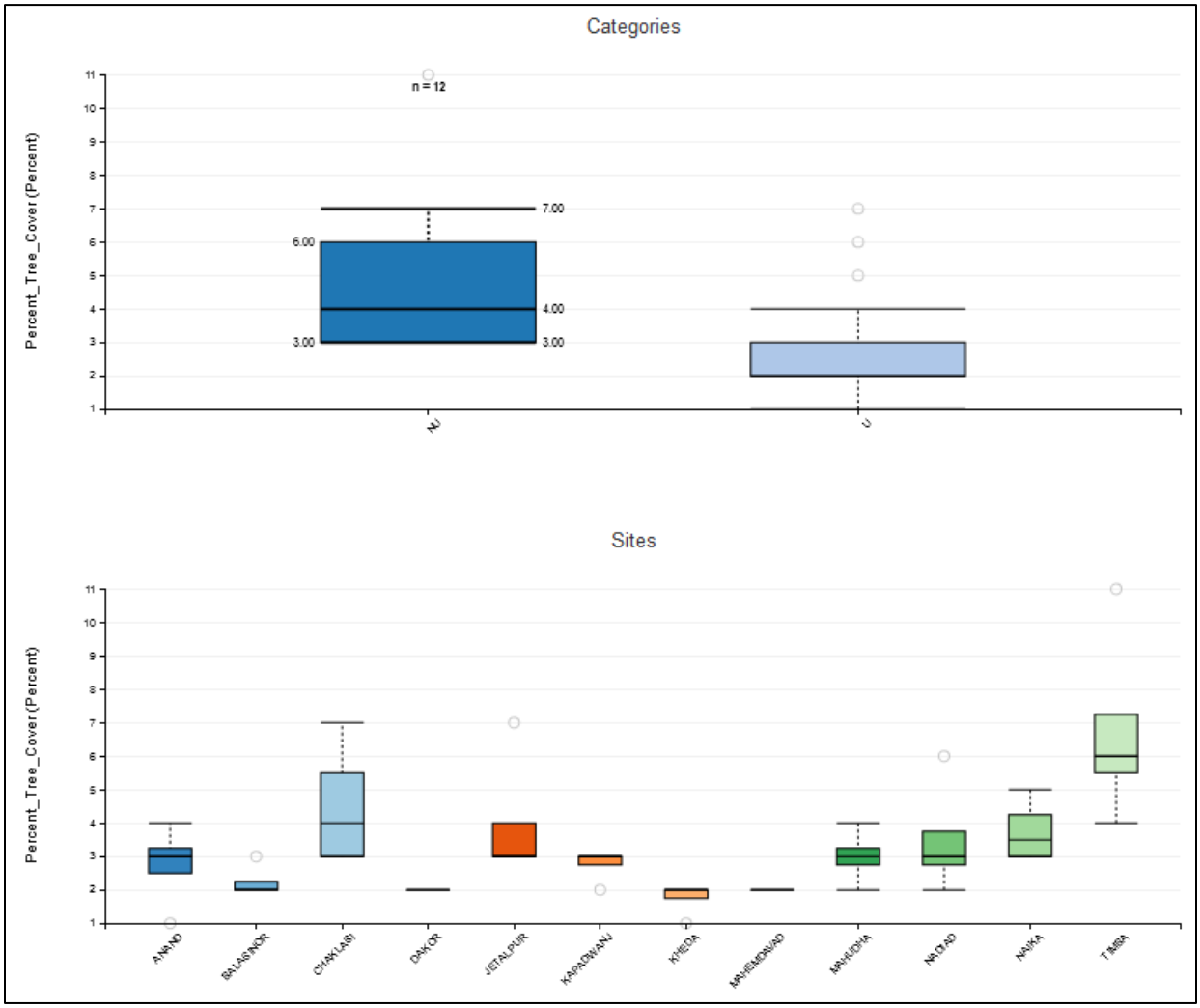
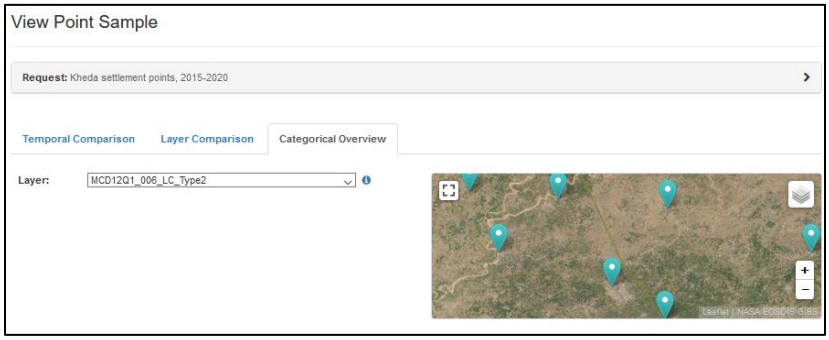


Figure 4: Categorical Overview output example: tree cover (percentage), 2015-2018

The following example (figure 5) displays land cover classification, 2015 to 2018, using the University of Maryland scheme[6], for the urban/non-urban categories (upper panel) and for each site (lower panel).



Darker orange represents 'croplands', green is 'cropland/natural vegetation mosaics', and lighter orange is 'urban and built up lands'. As mentioned above, there are four data points for each settlement point. Almost all the settlements display the same land cover category each year, except for Kheda, which displays two. It is interesting to observe that the overall modal category is croplands. This could seem obvious for non-urban settlements, but it is also predominant among urban settlements.

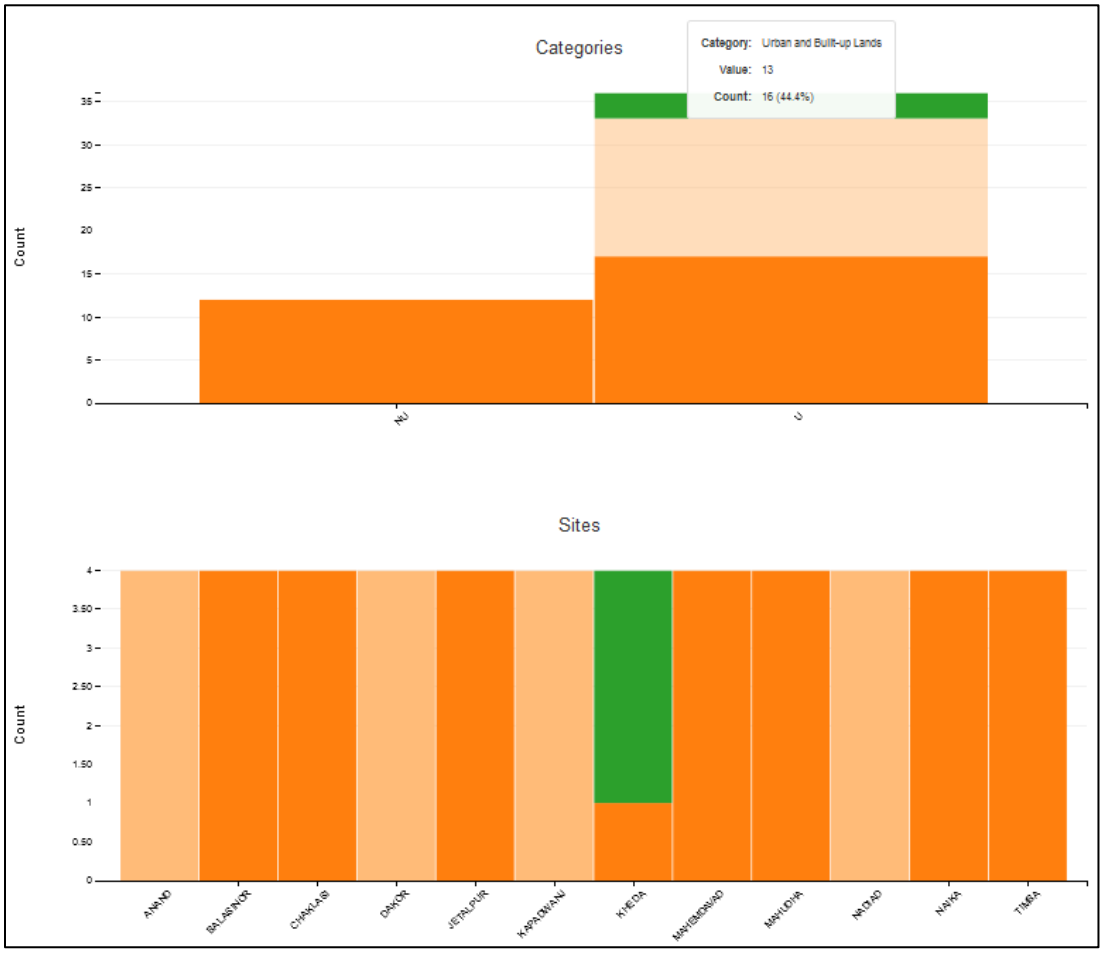


Figure 5: Categorical Overview output example: Land cover type, University of Maryland scheme (Land cover type 2)

[6] For an explanation of the land cover classifications included in MCD12Q1_006_LC, see: https://yceo.yale.edu/modis-land-cover-product-mcd12q1

3. Download and examine the output

3.a. In the *"Explore requests"* page, locate your request and click the "download" icon to go to the *"Download Point Sample"* page (Figure 6). There are two options: to download all the results as a .zip file, or to download each file separately. For this exercise, select the "Download Zip" option, then download and save the output.

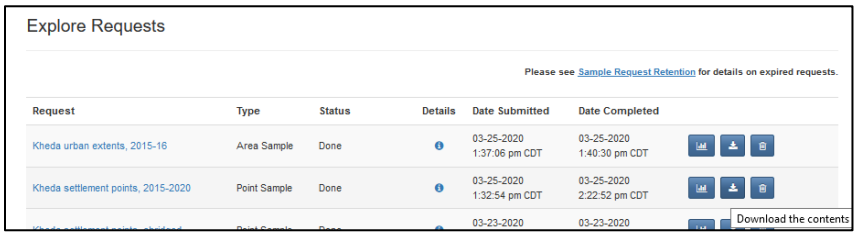


Figure 6: Downloading the output

3.b. Extract the output files from the zip file.

3.c. The output include two groups of files: supporting files –metada and readme files for the selected layers—and results files in csv format. Explore the README file, paying particular attention to quality statements as the one in text box below.

```
4. Data Quality: When available, AppEEARS extracts and returns quality
assurance (QA) data for each data file returned regardless of whether the
user requests it. This is done to ensure that the user possesses the
information needed to determine the usability and usefulness of the data they
get from AppEEARS. Most data products available through AppEEARS have an
associated QA data layer. Some products have more than one QA data layer to
consult.
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3.d. Explore the results files. As mentioned, these are are csv tables, one for each product in the sample, where values for each variable and point in time are attached to the settlement points in the requested sample. Tables 2 and 3 below are examples of two of the results tables.

Table 2 displays selected results for Terra MODIS vegetation continous field. The first four columns correspond to the variables included in point requesT. The 'Date' column indicate that this is annual data, with one value for year for a total of four observations for each settlement point , from 2015 to 2018. The columns in yellow are the three vegetation cover variables, and the grey ones are quality indicators. These results suggest that percent of tree cover is quite low in the three sites included in the example (Jetalpur, Naika and Timba), while the non-tree vegetation cover (usually crops) is higher and increrasing over time to the expense of proportion not-vegetated. Quality indicators display a large variation across settlements and years.

Table 2: Exploring the output: selected results for Terra MODIS vegetation continous field

Category	ID	Latitude	Longitude	Date (MM/DD/YYYY)	MOD44B_006_Percent_NonTree_Vegetation	MOD44B_006_Percent_NonVegetated	MOD44B_006_Percent_Tree_Cover	MOD44B_006_Cloud	MOD44B_006_Quality
NU	JETALPUR	22.8425	72.6358	3/6/2015	59	38	3	0	12
NU	JETALPUR	22.8425	72.6358	3/5/2016	63	34	3	4	12

NU	JETALPUR	22.8425	72.6358	3/6/2017	61	32	7	0	4
NU	JETALPUR	22.8425	72.6358	3/6/2018	78	19	3	0	0
NU	NAIKA	22.7059	72.5465	3/6/2015	82	15	3	4	4
NU	NAIKA	22.7059	72.5465	3/5/2016	84	11	5	0	12
NU	NAIKA	22.7059	72.5465	3/6/2017	77	20	3	0	8
NU	NAIKA	22.7059	72.5465	3/6/2018	81	15	4	0	8
NU	TIMBA	22.8473	73.3742	3/6/2015	75	21	4	4	12
NU	TIMBA	22.8473	73.3742	3/5/2016	76	18	6	8	12
NU	TIMBA	22.8473	73.3742	3/6/2017	73	16	11	8	12
NU	TIMBA	22.8473	73.3742	3/6/2018	76	18	6	8	8

Note: data dictionaries for this layer are available from https://lpdaac.usgs.gov/products/mod44bv006/ "Layers"; https://ladsweb.modaps.eosdis.nasa.gov/filespec/MODIS/6/MOD44B; https://developers.google.com/earth-engine/datasets/catalog/MODIS_006_MOD44B

The table below displays the results for the MODIS Normalized Difference Vegetation Index (NDVI) (MYD13A3_006__1_km_monthly) layers. These are monthly data, from January 2015 to January 2020 (61 data points for each settlement). The table below includes the first year and a half for Jetalpur. In addition to the variables included in the point sample request, the table include the date, the values of the enhanced vegetation index values (EVI) and the normalized difference vegetation index (NDVI) and one of the quality indicators.

Table 3: Exploring the output: selected results for the MODIS NDVI

Category	ID	Latitude	Longitude	Date	MYD13A3_006__1_km_monthly_EVI	MYD13A3_006__1_km_monthly_NDVI	MYD13A3_006__1_km_monthly_pixel_reliability_MODLAND_Description
NU	JETALPUR	22.8425	72.6358	1/1/2015	0.3129	0.5262	Good data, use with confidence
NU	JETALPUR	22.8425	72.6358	2/1/2015	0.3909	0.6213	Marginal data, Useful, but look at other QA information
NU	JETALPUR	22.8425	72.6358	3/1/2015	0.3143	0.4948	Good data, use with confidence
NU	JETALPUR	22.8425	72.6358	4/1/2015	0.2659	0.4041	Marginal data, Useful, but look at other QA information
NU	JETALPUR	22.8425	72.6358	5/1/2015	0.2355	0.3629	Marginal data, Useful, but look at other QA information
NU	JETALPUR	22.8425	72.6358	6/1/2015	0.2063	0.3222	Marginal data, Useful, but look at other QA information
NU	JETALPUR	22.8425	72.6358	7/1/2015	0.3313	0.423	Cloudy data, Target not visible, covered with cloud
NU	JETALPUR	22.8425	72.6358	8/1/2015	0.4578	0.7138	Marginal data, Useful, but look at other QA information
NU	JETALPUR	22.8425	72.6358	9/1/2015	0.5019	0.6867	Marginal data, Useful, but look at other QA information
NU	JETALPUR	22.8425	72.6358	10/1/2015	0.406	0.6161	Marginal data, Useful, but look at other QA information
NU	JETALPUR	22.8425	72.6358	11/1/2015	0.2759	0.4457	Marginal data, Useful, but look at other QA information

NU	JETALPUR	22.8425	72.6358	12/1/2015	0.2093	0.3882	Good data, use with confidence
NU	JETALPUR	22.8425	72.6358	1/1/2016	0.2422	0.4564	Good data, use with confidence
NU	JETALPUR	22.8425	72.6358	2/1/2016	0.36	0.5719	Good data, use with confidence
NU	JETALPUR	22.8425	72.6358	3/1/2016	0.3527	0.5836	Good data, use with confidence
NU	JETALPUR	22.8425	72.6358	4/1/2016	0.2865	0.456	Good data, use with confidence
NU	JETALPUR	22.8425	72.6358	5/1/2016	0.2522	0.4074	Marginal data, Useful, but look at other QA information
NU	JETALPUR	22.8425	72.6358	6/1/2016	0.2243	0.3404	Marginal data, Useful, but look at other QA information

Note: MODLAN = MODIS Land

Exercise 2: Working with AREA DATA

The objective of this exercise is to add information on vegetation indices and population size and distribution to GRUMP's urban extent polygons (ca 1995) located in the Kheda district of the Gujarat state. You can use the data included in the exercise, or use your own data.

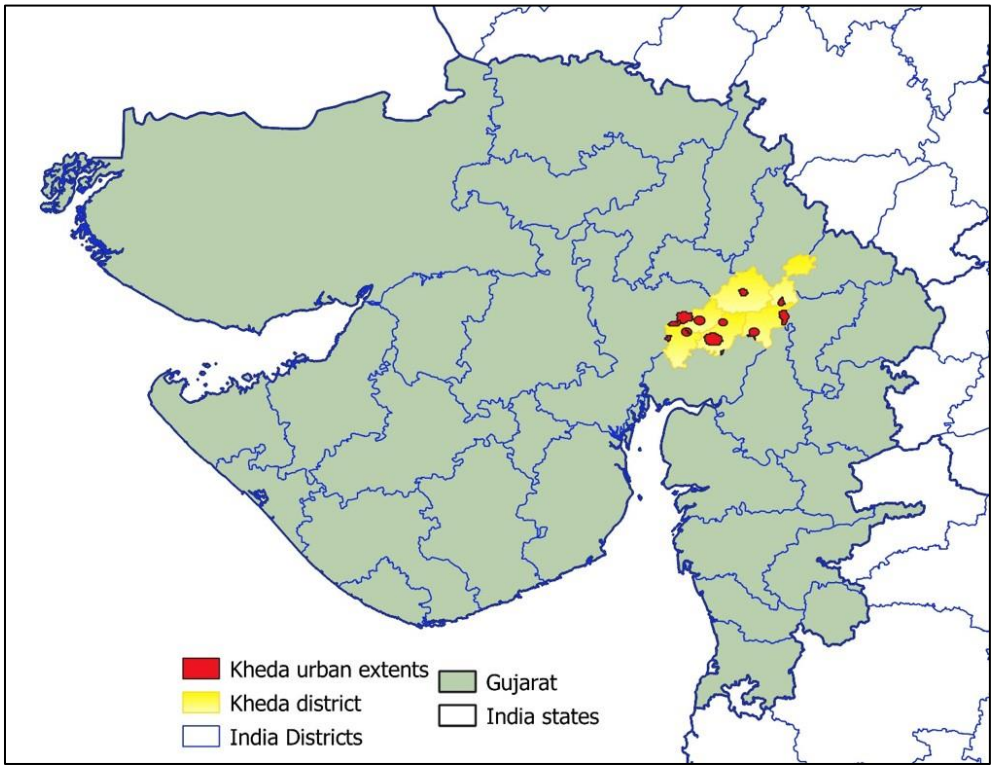

Figure 6: The map displays the same administrative units as Figure 1, from the same source, GADM. The urban extent polygons (in red) were extracted from GRUMP Urban Extents Polygons, downloaded from https://sedac.ciesin.columbia.edu/data/set/grump-v1-urban-ext-polygons-rev01

Steps

1. Create and Submit an Extract Area Sample

1.a. Open AppEEARS and log in.

1.b. From the Extract Tab (figure 2), select "Area Sample"

1.c. Select "Start a new request"

1.d. Upload the file *online_training_tutorial2_exercise2_area_sample_kheda3.zip*. This zip file contains a modified shapefile with the four (4) files required for an Area Sample request.

1.e. Check "Is data recurring?"

1.f. Enter start date: 01-01; and end date: 12-31

1.g. Slide the Year Range to: 2015-2016

1.h. Select the following layers from the specified products:

Product	Layer
S-NPP NASA VIIRS Vegetation Indices: VNP13A3.001, 1000m, Monthly, (2012-01-19 to present)	_1_km_monyhly_NDVI
Aqua MODIS Vegetation Indices: MYD13A3.006, 1000m, Monthly, (2002-07-01 to Present)	_1_km_monyhly_NDVI
Gridded Population of the World (GPW) : GPW_UN_Adj_PopCount.004, 1000, Quinquennial, (2000-01-01 to 2020-12-31)	population-count

1.i. Select "GeoTiff" for File Format, and "Geographic" for Projection.

1.j. Enter a name to identify your sample!!!

1.k. SUBMIT your request.

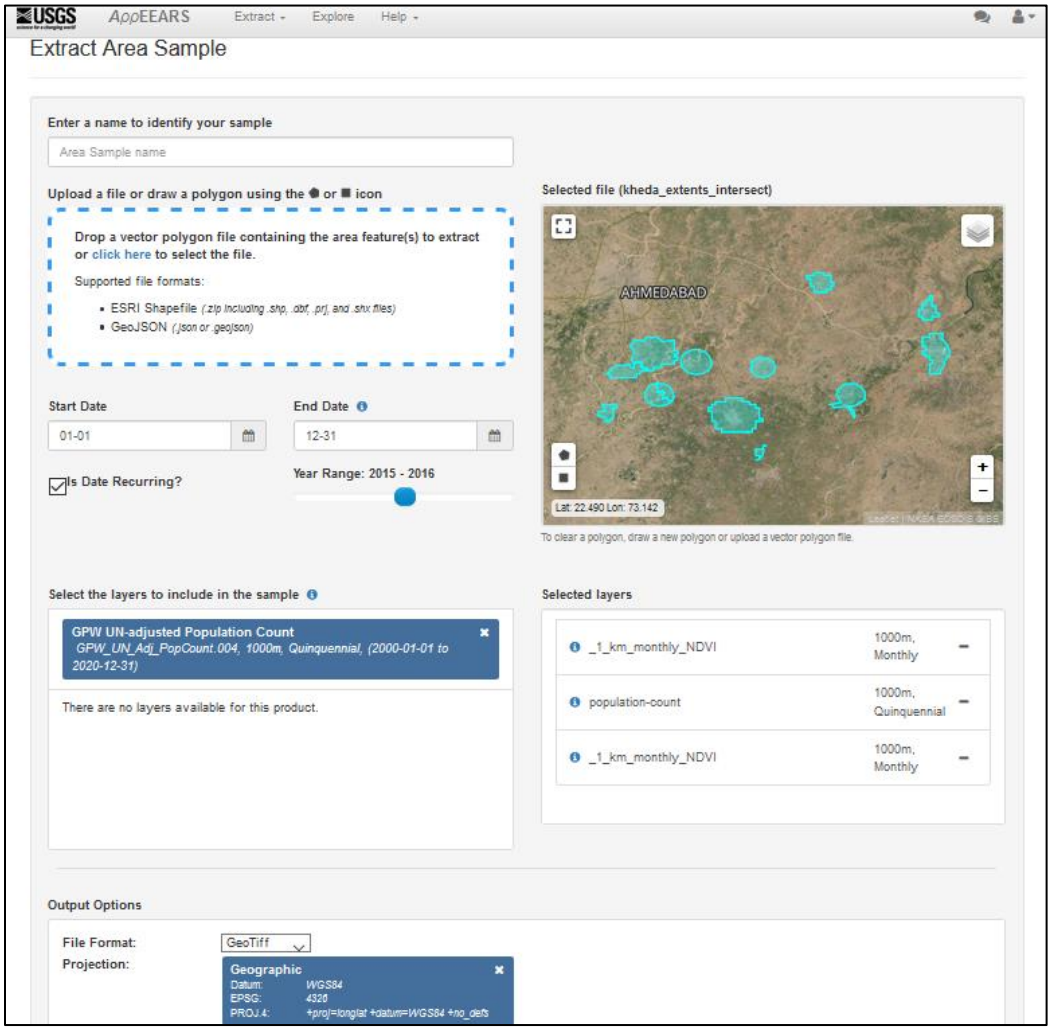

Figure 7. The area sample request menu

2. Explore the output online

2.a. Go to the *"Explore"* tab, and click in your sample name to open the *"View Area Sample"* page. Select a feature (i.e. an urban extent), and a layer. For this exercise, we will use urban extent AID0009-Nadiad, and AID0015=Balasinor, and will select the NDVI layers from MODIS and VPN (Figures 8 and 9 below).

The output graphs suggest that the MODIS and VPN layer stats (upper panel) are quite similar in Nadiad while more differences are visible in Balasinor, and the same could be said of the quality stats (lower panel).

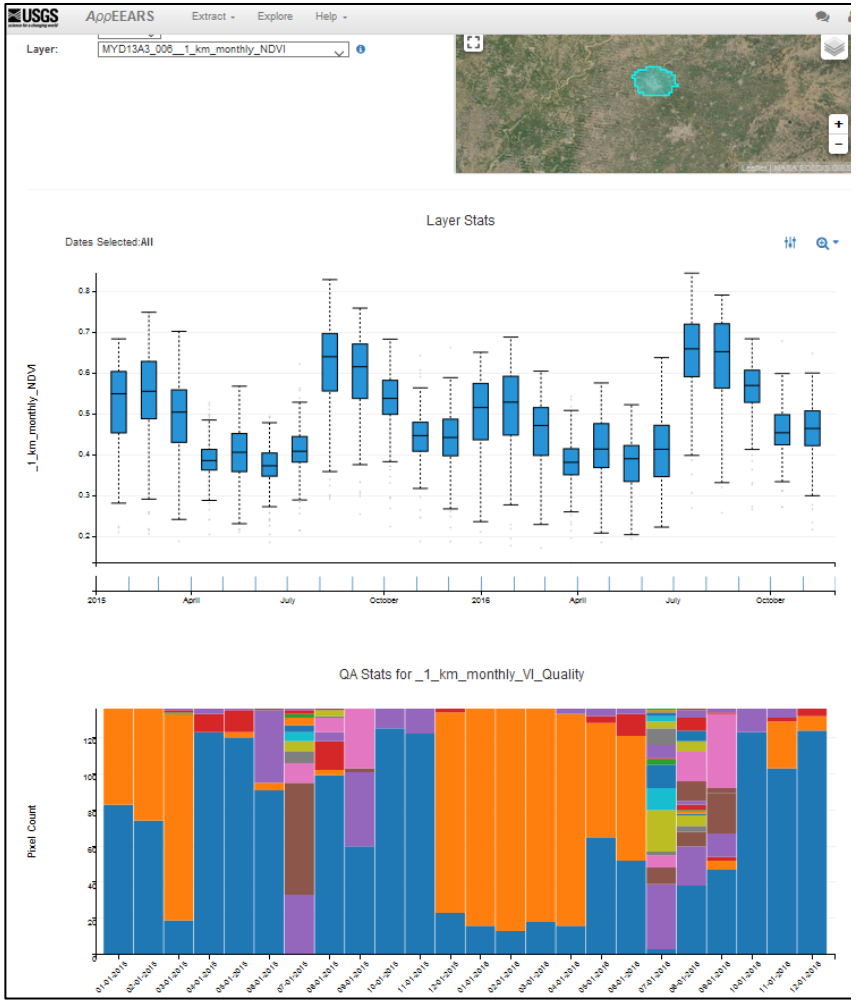

Figure 8a: Viewer example: Nadiad (AID0009), MODIS NDVI

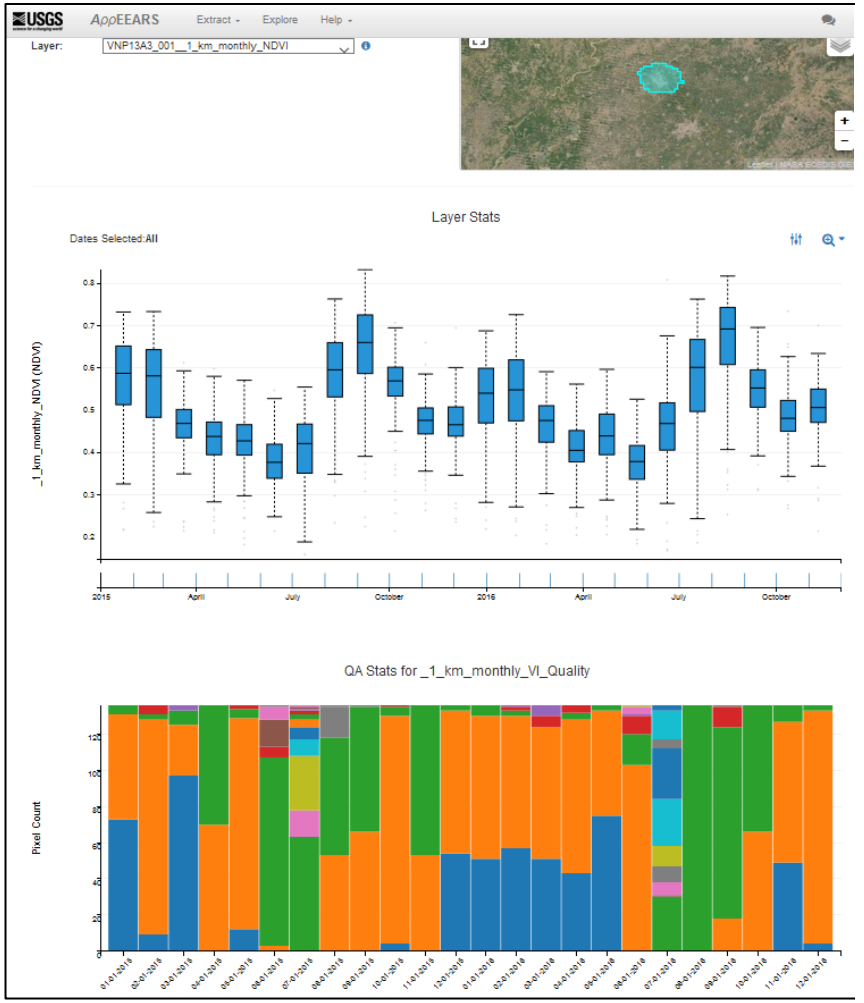

Figure 8b: Viewer example: Nadiad (AID0009), VPN NDVI

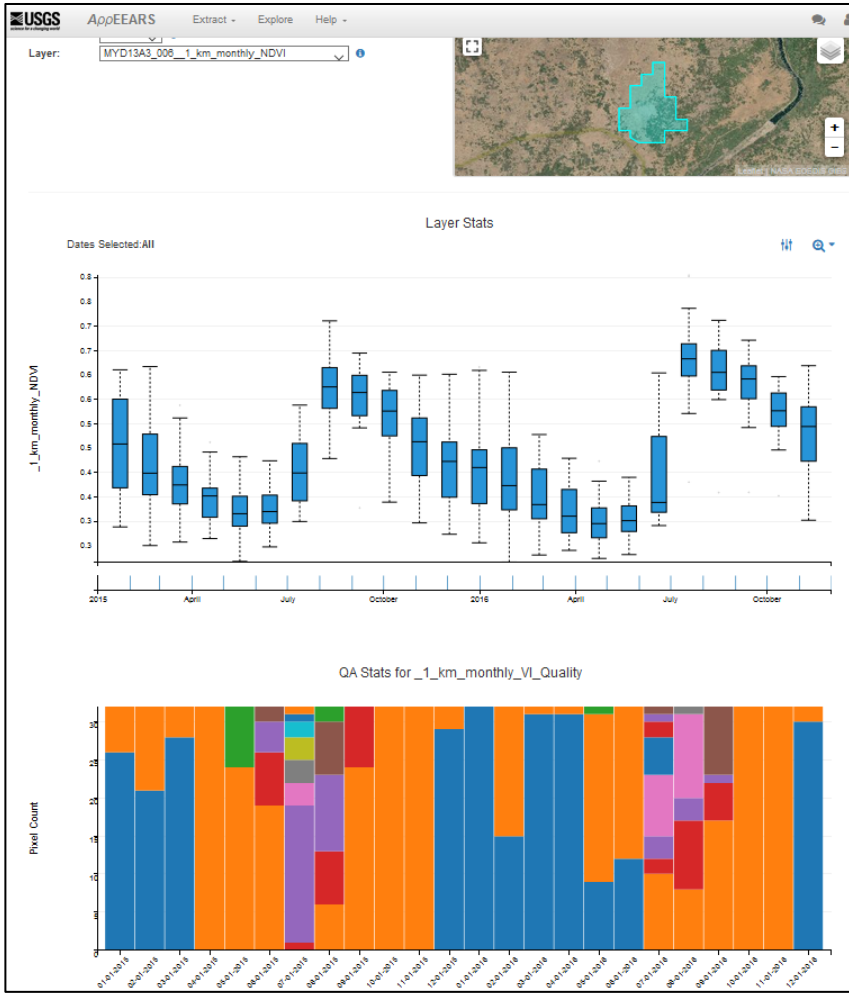

Figure 9a: Viewer example: Balasinor (AID0015), MODIS NDVI

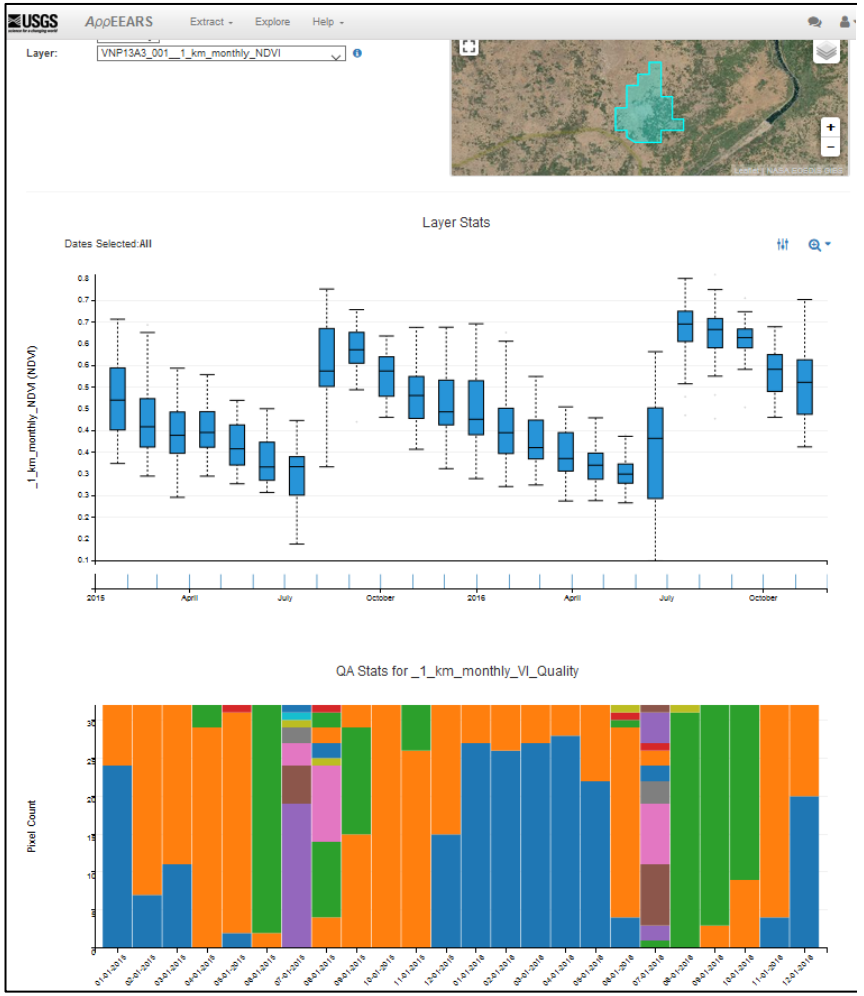

Figure 9b: Viewer example: Balasinor (AID0015), VPN NDVI

3. Download and examine the output

3.a. In the "Explore requests" page, click the download icon to go to the "Download Area Sample" page. There is not a .zip option for downloading area sample results and metadata. Metadata files can be dowonlaoded one at a time, while there is a "download all" option for the results files.

It is important to consider that results are in raster format (tiff), one raster file for each combination of urban extent, layer and year. There are 1470 files for this exercise request, and because of this the examples will include only the two urban extents mentioned in the online exploration, above, Nadiad and Balasinor.

3.b. Select the metadata and results files you would like to download and save them. The README file has to be included.

3.c. Explore the README file, in particular the quality statements as the one below.

```
4. Data Quality: When available, AppEEARS extracts and returns quality
assurance (QA) data for each data file returned regardless of whether the
user requests it. This is done to ensure that the user possesses the
information needed to determine the usability and usefulness of the data they
get from AppEEARS. Most data products available through AppEEARS have an
associated QA data layer. Some products have more than one QA data layer to
consult.
```

3.d. Explore the results files.

As mentioned before, the results files are .tiff rasters. The maps below (Figures 10 and 11) illustrate the results for selected variables (MODIS and VPN NDVI in July 2015, and their quality layers) and urban extents (Nadiad and Balasinor).

The results indicate that both layers could be used to explore the NDVI spatial patterns in the selected urban extents, although these patterns show some differences in terms of, for example, the location of the highest and lowest values. The examination of the quality layeers, on the other hand, suggests that the VPN layer for Nadiam includes a larger number of low quality pizels than the MODIS layer, while the opposite is observed for Balasinor.

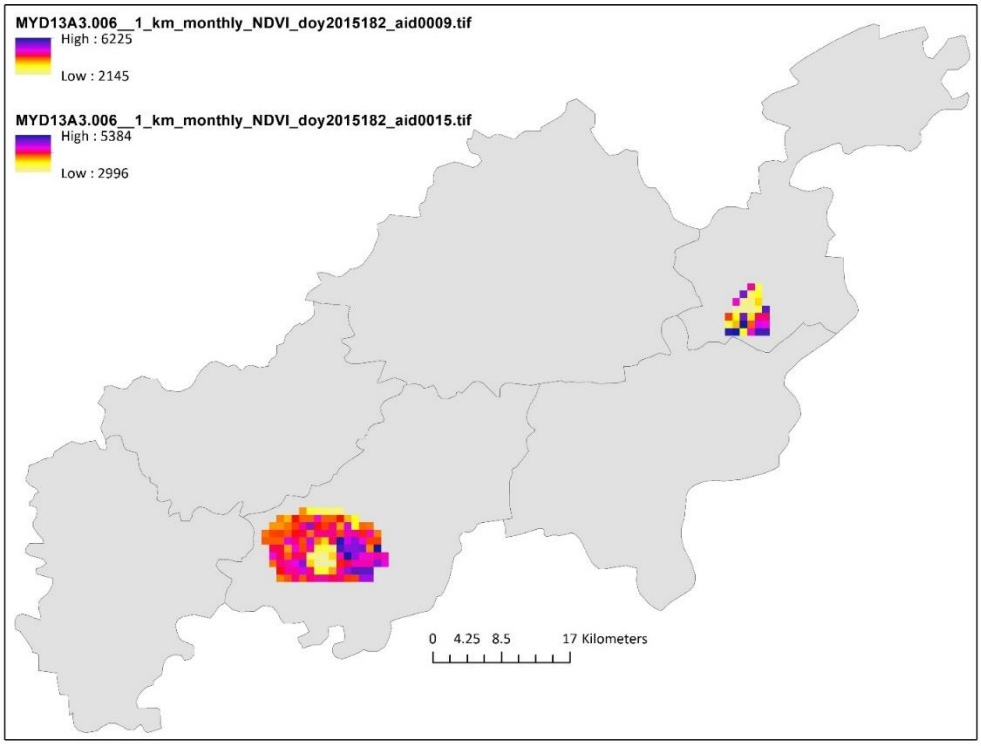

Figure 10a. MODIS Mid-year monthly NDVI, 2015, selected urban extents: Nadiad (AID0009, southwest) and Balasinor (AID0015, northeast)

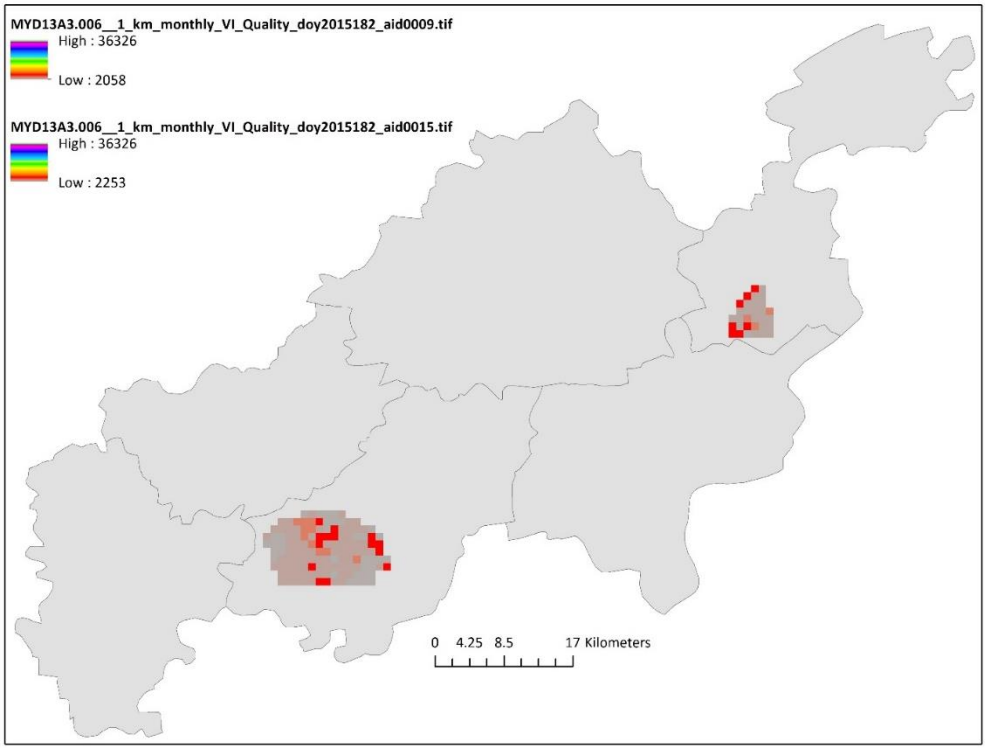

Figure 10b. MODIS Mid-year monthly NDVI, 2015, quality layer, selected urban extents

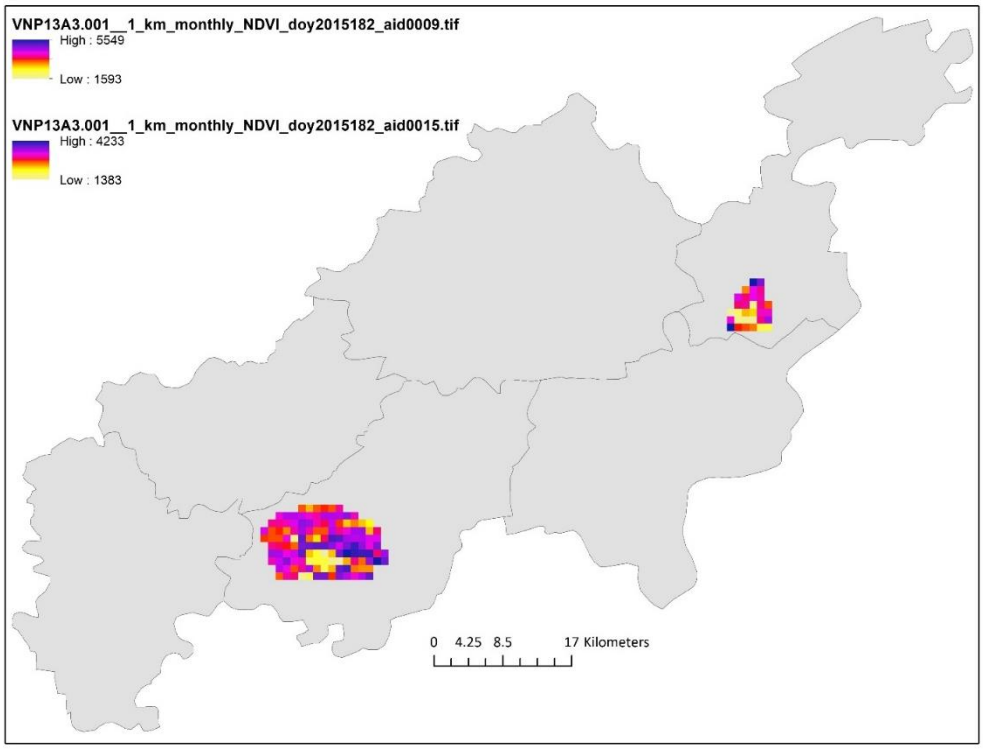

Figure 11a.VPN Mid-year monthly NDVI, 2015, selected urban extents: Nadiad (AID0009, southwest) and Balasinor (AID0015, northeast)

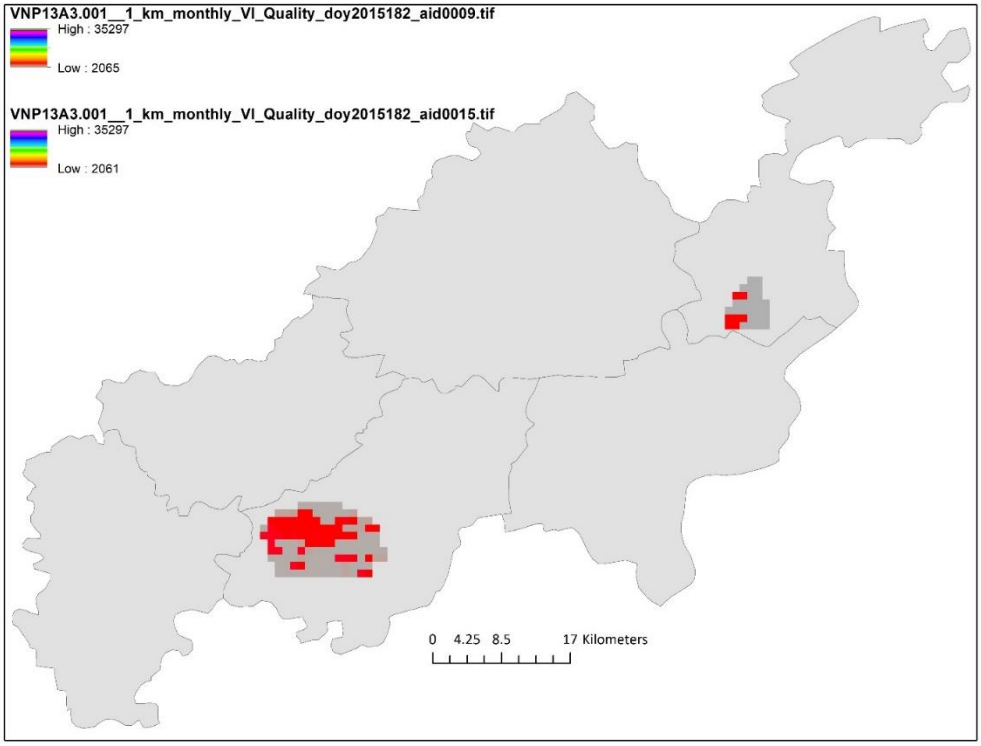

Figure 11b. VPN Mid-year monthly NDVI, 2015, quality layer, selected urban extents.

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Supplementary information

- *About AppEEARS*

An Introduction to the NASA AppEEARS Area Sampler. https://www.youtube.com/watch?v=Gb9E4TkTdrc

An Introduction to the NASA AppEEARS Point Sampler. https://www.youtube.com/watch?v=z6DIldM9l8A

Beck, J. 2020. Mapping Deforestation. Using Land Cover and Vegetation Continuous Fields to highlight land cover changes. https://storymaps.arcgis.com/stories/8b89a1df0db647bbb1d479d172be55aa

- *About Vegetation Indices*

Dutta, R. (2017). Introduction to satellite derived vegetation indices. https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwj4qNqkie3xAhU7QjABHYPoAU4QFjABegQIBBAD&url=https%3A%2F%2Fwww.unescap.org%2Fsites%2Fdefault%2Ffiles%2FPresentation_MOD%2520A3_S1_ESCAP.pdf&usg=AOvVaw0HiPypFAUzI0utLcszV2Pa

Topics: Vegetation Index https://www.sciencedirect.com/topics/earth-and-planetary-sciences/vegetation-index

- *About MODIS Vegetation Indices:*

NCAR/UCAR. NDVI and EVI: Vegetation Indices (MODIS) https://climatedataguide.ucar.edu/climate-data/ndvi-and-evi-vegetation-indices-modis

- *Selected literature on vegetation indices in population research:*

Brown, M. E., et al. (2014). Using satellite remote sensing and household survey data to assess human health and nutrition response to environmental change. *Population and Environment*, 36(1): 48-72. https://link.springer.com/article/10.1007/s11111-013-0201-0

Rhew, I. C., et al. (2011). Validation of the Normalized Difference Vegetation Index as a Measure of Neighborhood Greenness. *Annals of Epidemiology*, 21(12): 946-952. https://www.sciencedirect.com/science/article/pii/S104727971100250X

Sasson, I. and A. Weinreb (2017). Land cover change and fertility in West-Central Africa: rural livelihoods and the vicious circle model. *Population and Environment*, 38(4): 345-368. https://link.springer.com/article/10.1007/s11111-017-0279-x

Annex 1: Point Sample: Description of the data layers

Layer	Description	Spatial resolution	Temporal resolution	Period covered
S-NPP NASA VIIRS Vegetation Indices Suomi National Polar-Orbiting Partnership (S-NPP) NASA Visible Infrared Imaging Radiometer Suite (VIIRS) Vegetation Indices (VNP13A3) Version 1	This data product provides vegetation indices by a process of selecting the best available pixel over a monthly acquisition period at 1 kilometer (km) resolution. The VNP13 algorithm process produces three vegetation indices: The Normalized Difference Vegetation Index (NDVI), the Enhanced Vegetation Index (EVI), and the Enhanced Vegetation Index-2 (EVI2). NDVI is one of the longest continual remotely sensed time series observations, using both the red and near-infrared (NIR) bands. EVI is a slightly different vegetation index that is more sensitive to canopy cover, while NDVI is more sensitive to chlorophyll. EVI2 is a reformation of the standard 3-band EVI, using the red band and NIR band. This reformation addresses arising issues when comparing VIIRS EVI to other EVI models that do not include a blue band. EVI2 will eventually become the standard EVI.	1000 m	Monthly	2012-01-19 to present
Aqua MODIS Vegetation Indices Aqua Moderate Resolution Imaging Spectroradiometer (MODIS) Vegetation Indices (MYD13A3) Version 6	The MODIS Normalized Difference Vegetation Index (NDVI) complements NOAA's Advanced Very High Resolution Radiometer (AVHRR) NDVI products and provides continuity for time series historical applications. MODIS also includes an Enhanced Vegetation Index (EVI) that minimizes canopy background variations and maintains sensitivity over dense vegetation conditions. The EVI uses the blue band to remove residual atmosphere contamination caused by smoke and sub-pixel thin clouds.	1000 m	Monthly	2002-07-01 to Present
Terra MODIS Vegetation Continuous Field (VCF) MOD44B Version 6 Vegetation	This yearly product is a global representation of surface vegetation cover as gradations of three ground cover components: percent tree cover, percent non-tree cover, and percent non-vegetated (bare).	250 m	Yearly	2000-03-05 to 2018-12-31

Continuous Fields (VCF)	VCF products provide a continuous, quantitative portrayal of land surface cover at 250 meter (m) pixel resolution, with a sub-pixel depiction of percent cover in reference to the three ground cover components. The sub-pixel mixture of ground cover estimates represents a revolutionary approach to the characterization of vegetative land cover that can be used to enhance inputs to environmental modeling and monitoring applications.			
Combined MODIS Land cover type Terra and Aqua combined Moderate Resolution Imaging Spectroradiometer (MODIS) Land Cover Type (MCD12Q1) Version 6	This data product provides global land cover types at yearly intervals (2001-2018), derived from six different classification schemes: listed in the User Guide. It is derived using supervised classifications of MODIS Terra and Aqua reflectance data. The supervised classifications then undergo additional post-processing that incorporate prior knowledge and ancillary information to further refine specific classes.	500 m	Yearly	2001-01-01 to 2017-12-31