ATLASX USER GUIDE

Remote Sensing Toolkit

Version 1.0.0

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1 SOFTWARE SUMMARY

Atlasx (**https://airwrx.com/atlasx**) is a server-side ecosystem-scale mapping platform for drone professionals with little technical background in remote sensing. We developed Atlasx to enable you to quickly map and report the status of ecosystems, contributing to a global effort to assess the state of our ecosystems.

Atlasx uses the power of the Google Earth Engine, allowing you to directly access vast satellite data archives and state-of-the-art remote sensing method Atlasx handles the technical details of remote sensing so that you can focus on training, classifying and improving your maps.

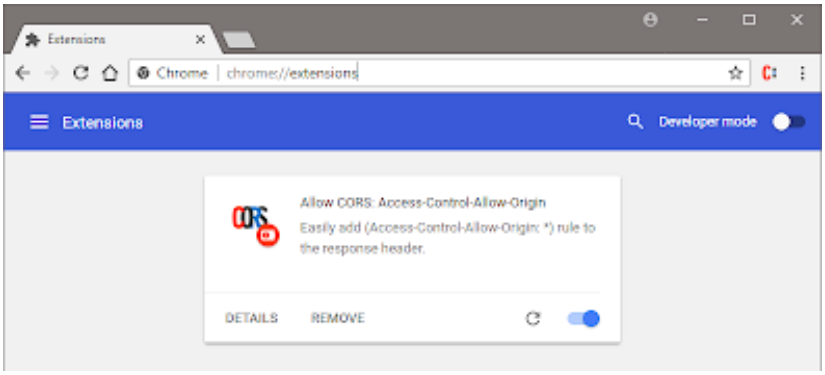
2 SETUP

Required: Chrome Browser -> https://www.google.ca/chrome/
Once the browser has been downloaded, Sign-in to your Gmail user account and continue to the following steps:

1. Migrate to: airwrx.com
2. Type the Email and Password of the pre-registered account.
3. Read the End-User License Agreement, select "I accept the terms in the License Agreement" and click Next.
4. Click “Login”.

Connect the automated Report extension.

1. In a new window, migrate to the chrome web store.
https://chrome.google.com/webstore/category/extensions?hl=en
2. Add the CORS extension
https://chrome.google.com/webstore/detail/allow-cors-access-control/lhobafahddgcelffkeicbaginigeejlf?hl=en



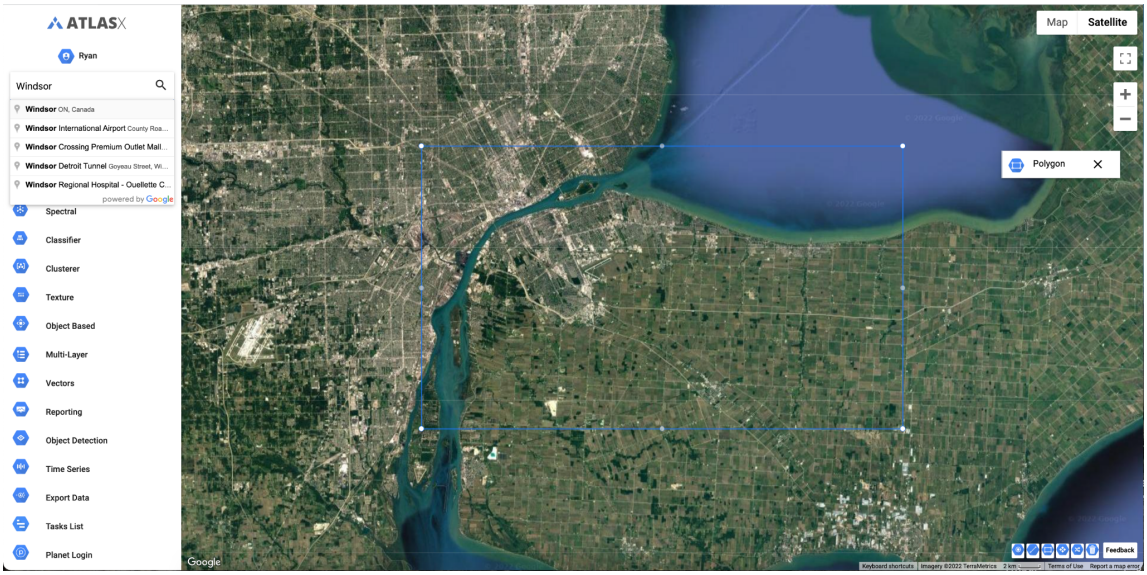
Atlasx is now ready for analysis and reporting!

Note: When a new version of Atlasx is available, the update will automatically appear during the next session.

Warning: A dataset of insufficient quality will lead to poor results or may even lead to processing failure. This requires taking a new dataset on the field.

3 LOCATION SEARCH

Atlasx uses the power of the Google Earth Engine, allowing you to directly access vast satellite data archives, personal UAV image assets, and state-of-the-art remote sensing methods. DroneEarth handles the technical details of remote sensing so that you can focus on training, classifying and improving your maps.

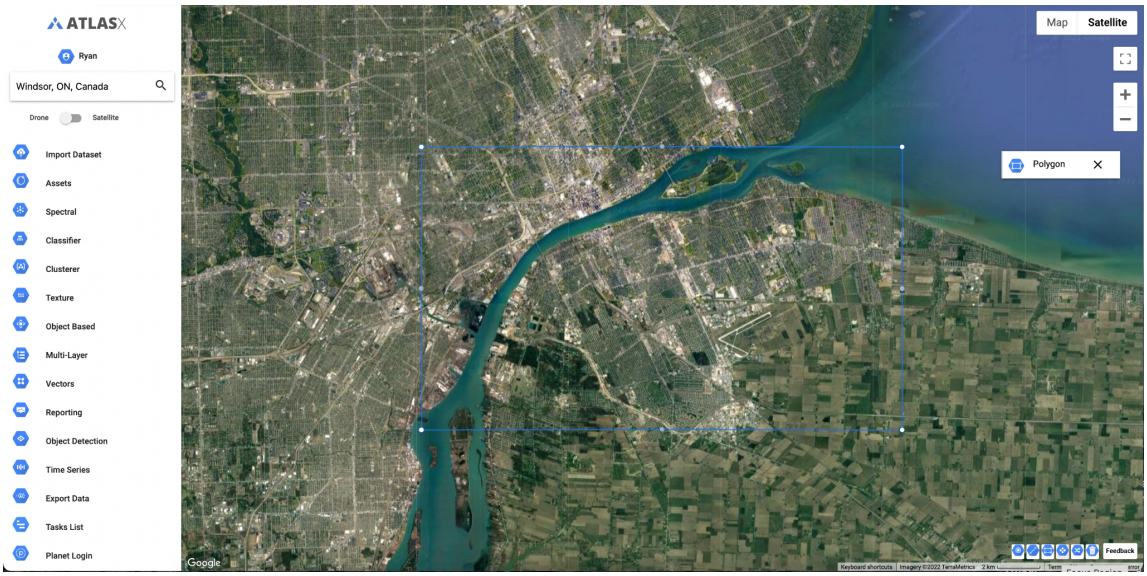


4 FOCUS REGION

Focus Region defines the boundaries of the analysis and ensures analysis remain within the computational limits applied to Atlasx. Change the shape of your region of interest by modifying the polygon boundaries, or upload your own study region via the .kml upload feature termed “Upload Focus Region”.

In general, smaller regions of interest will run faster in Atlasx. Therefore, the larger the focus region, the more pixels that must be computed and undergo transformation. However, these mathematical procedures are conducted by super computers and will be displayed in a matter of seconds-minutes.

Use focus region to define the boundaries



5 UPLOAD GEOTIFF

Key Objectives:

Search for a GeoTIFF using the location search bar: Find the GeoTIFF you want to upload to the asset manager. It will take a couple of minutes to complete the upload, which varies depending on the size of the file. The GeoTIFF must be less than 10GB. If you have a project that is larger than 10GB, separate the project into smaller batches. We recommend processing less than 1000 images to ensure the file remains less than 10GB.

Key Challenges:
The current software only works with GeoTIFF. It is advised to upload assets <10GB unless users have a strong internet connection.. EnviroDrone is working on a process to stitch JPG and TIFF imagery. In version 2, users will be able to upload imagery, which will be processing and uploaded as a GeoTIFF for further analysis in DroneEarth.

6 MAP CONTROL

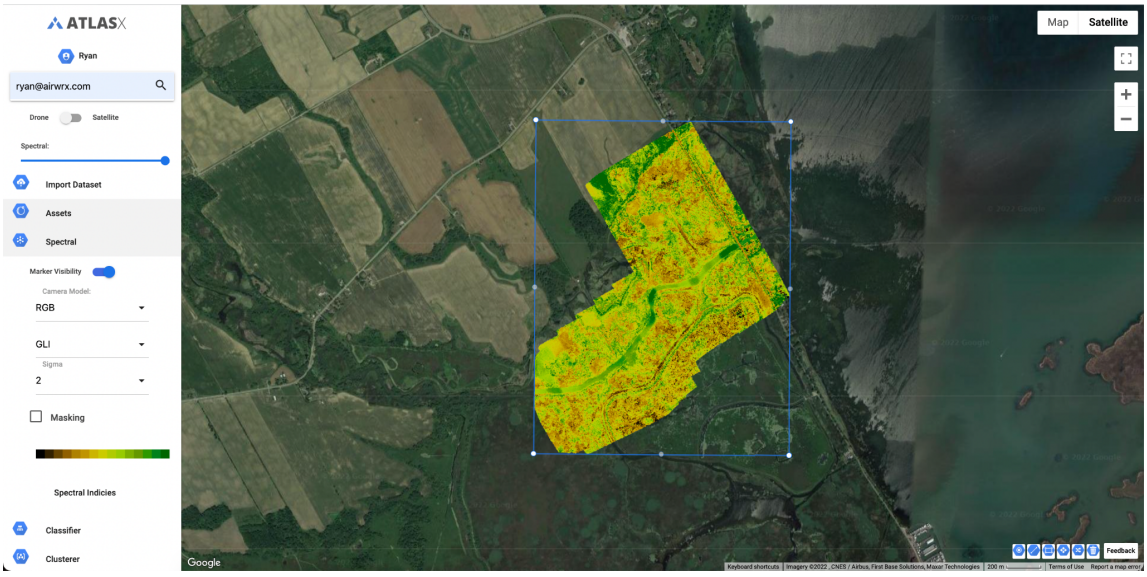
Map control allows you to visualize different base layers (predictors), toggle marker points ON and OFF and change the way colours of the base layers are rendered using sigma. It is particularly useful for visualizing the different predictors that the classifier will use to classify each pixel.

Predictors that can be visualized in Atlasx include the Normalized Differenced Vegetation Index (NDVI), Normalized Differenced Water Index (NDWI), the Near Infrared band of Landsat 8, Slope, Elevation, Mean Annual Temperature, and Mean Annual Precipitation.

6.1 Predictors

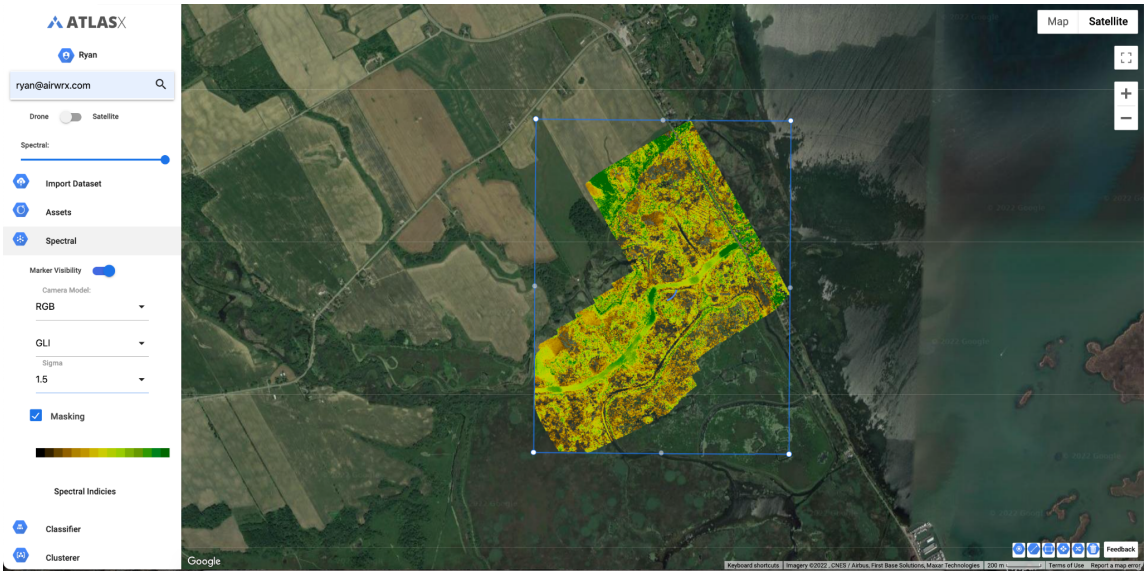
Predictors are combinations of spectral reflectance from two or more wavelengths that indicate the relative abundance of features of interest. Vegetation indices are the most popular type, but other indices are available for burned areas, man-made (built-up) features, water, and geologic features. The following topics provide definitions and equations for each spectral index, grouped by feature type:

Use map control to visualize the Greenness Leaf Index (GLI) for a study region:



6.2 Progress Reports

Use map control to visualize the Green Leaf Index (GLI) for a study region and mask only the areas to are interested in assessing:



7 SELECT PREDICTORS

The Atlasx default predictor layers were selected to achieve good accuracy across a wide range of land cover types. However, in some cases you may be able to achieve higher accuracies by selecting a custom predictor set. For example, if you are mapping the distribution of alpine ecosystems you may wish to include temperature as well as elevation to distinguish from surrounding ecosystem types. Use the Map Control to view the predictor layers available and select the ones you want to include in your classification. Selecting the predictors that DroneEarth will use to generate a classified map:

8 SUPV. CLASSIFIER

The Classify package handles supervised classification in Atlasx. The general workflow for classification is:

1. Collect training data. Assemble features which have a property that stores the known class label and properties storing numeric values for the predictors. Place the “Markers” above these localities to build a training set.
2. Instantiate a classifier. Set its parameters if necessary.
3. Alternatively you can train the classifier using a pre-developed training set. Upload a CSV file for the class-of-interest.
4. “Classify” an image or feature collection. Select “Classify”. This operation requires a minimum of two classes.
5. Estimate classification error with independent validation data. “Results” display the total area for each class. “Assessment” displays the polygon information (Build Training Set) for the classify procedure.

8.1 Training Dataset

To make your map, you will need to provide a set of training data ('the training set') to train, or teach, the classifier what you would like to map. Each map class is an entity you want to distinguish, which are most often ecosystem types (e.g. mangroves), land use types (e.g. rice field) or land cover types (e.g. water, non-water).
This can be achieved in two ways:

- Upload a .csv file of a training set, perhaps from field data or herbarium records (Upload Data)

OR

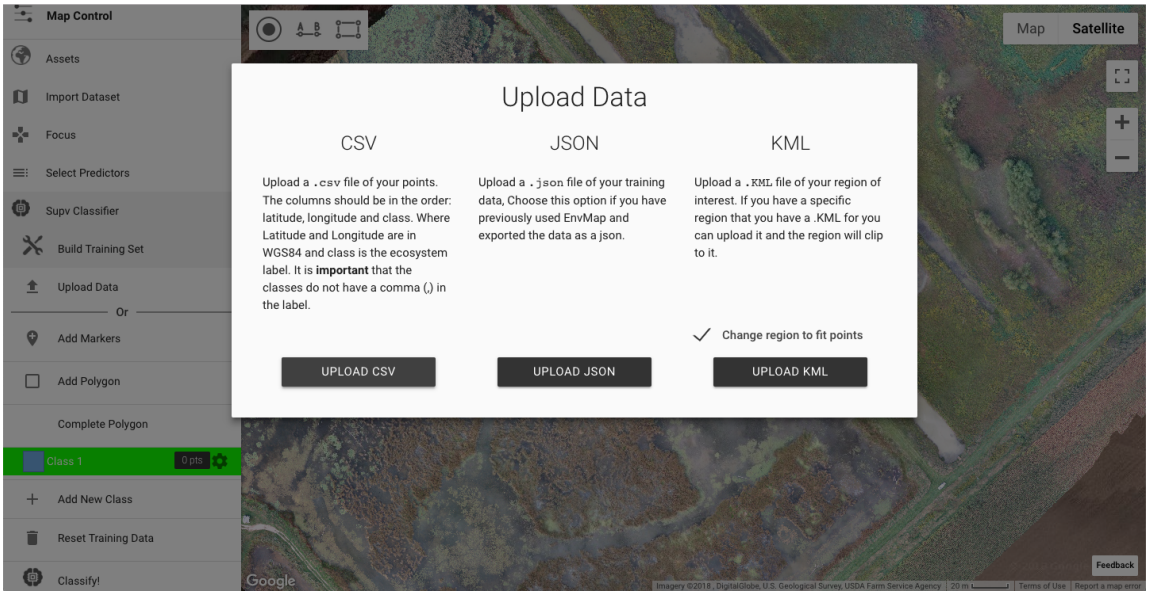
- Train the classifier interactively (Add Markers)

To achieve the highest classification accuracy, ensure your training points are accurate. In general, a larger number of points will achieve the greatest classification accuracy.

8.2 Upload .csv

Atlasx allows you to upload spatial data of the map classes you wish to map. Use the Upload Data to upload a .csv file with column headers 'lat', 'lng', 'label' and rows that represent training points. This format allows Atlasx to map the point locations of each map observation and use it to train the classifier.

Example format of the .csv file required to upload training data to Atlasx:



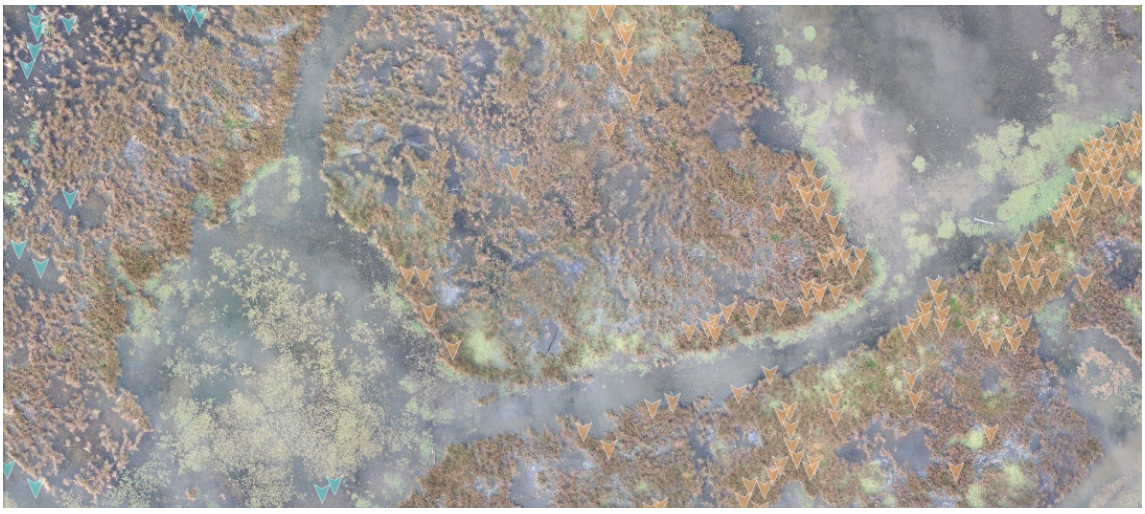
Uploading a .csv file of training data to DroneEarth:

LATITUDE	LONGITUDE	LABEL
1.039524	-59.425	Forest
1.152114	-59.4827	Forest
1.158979	-59.6983	Non-forest

8.3 Interactive markers

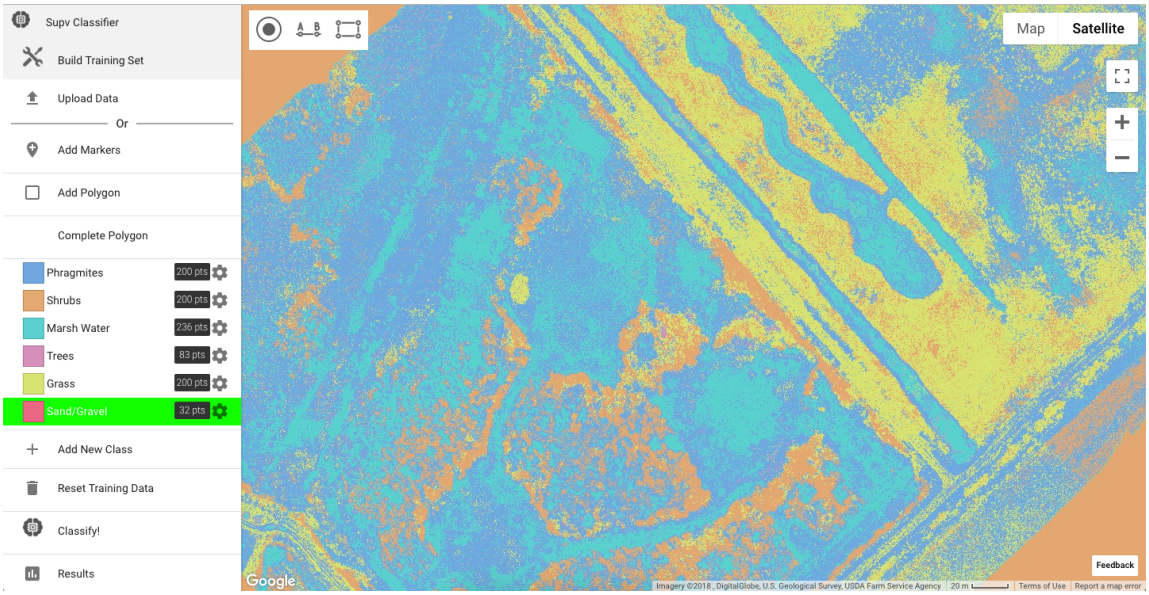
Use the Add Markers and Add New Class functions to interactively train Atlasx. First, use Add New Class to identify all of the classes you want the Atlasx to map. Modify the class name or colour, or delete the class, using the gear icon located next to each class label.
Changing the colour and name of a class in Atlasx:

You are now ready to interactively develop your training set. Select the class you want to add training data for, and use the Add Markers button to click on the map where that class occurs. Continue to add markers for each class until a full training set for all classes is achieved.
In the example above, we have added 55 points that correspond with Mangroves and 76 points that correspond with the Other class. Note that it may be possible to achieve higher accuracies by distinguishing 3 classes, Mangrove, Salt pan and Water, rather than a single Other class.



8.4 Classify!

Click Classify to run the classification. Atlasx will implement the classification in the Google Earth Engine and return the result to the browser. When clicking Classify, Atlasx implements the classification on the Google Earth Engine and returns a classified map to the browser:

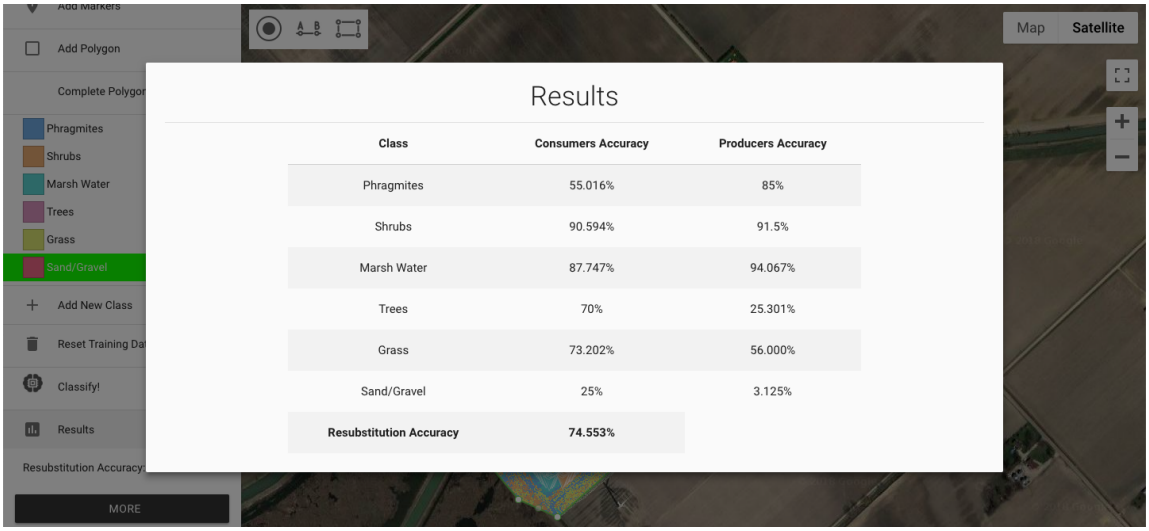


Hide the markers (Map Control) or change the classified map transparency in the side bar.

8.5 Results

The results function allows you to assess the accuracy of your classified map. Most of the time we aim for >85% overall accuracy, so consider adding more training data, adding or removing classes, and rerunning the model to achieve a higher accuracy. Also reported is an estimate of the area of each map class. Note, the areas reported in results are optimized for speed and are estimates only. For more accurate area results, use the assessment function.

Atlasx reports the overall accuracy of the map and the area per class:

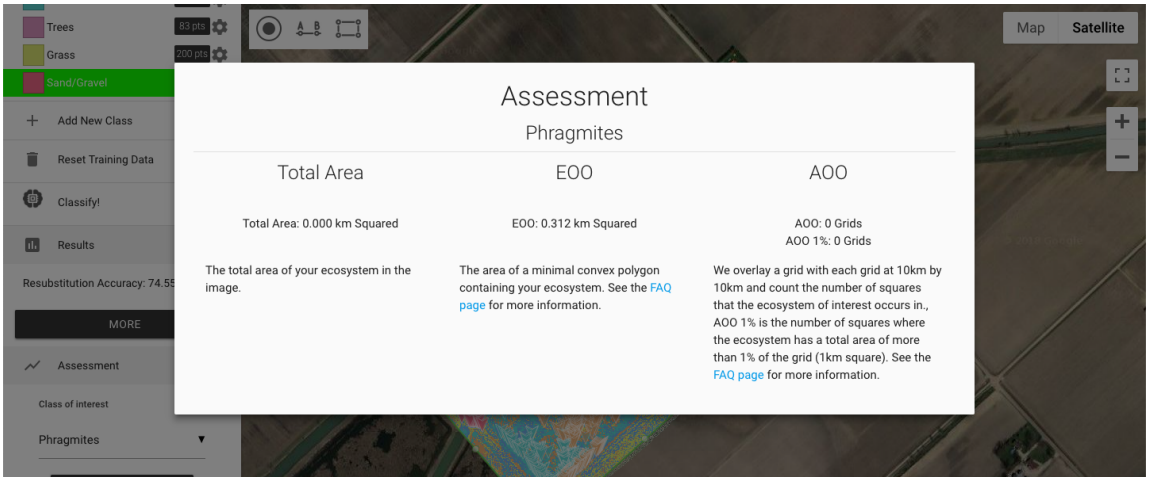


8.6 Assessment

The Assessment tab in Atlasx calculates the spatial metrics required for assessments under the IUCN Red List of Ecosystems (https://iucnrle.org). Atlasx reports the total area (km^2), the Extent of Occurrence (EOO) and the Area of Occupancy (AOO).

Area is calculated by counting the number of pixels per class and multiplying by the pixel area. EOO reports the area of a minimum convex polygon surrounding the map class, and AOO reports the number of 10 × 10 km cells occupied by the ecosystem. For further information see the IUCN Red List of Ecosystems Guidelines (https://iucnrle.org/resources/key-documents).

Atlasx assessments report total area (km^2), the Area of Occupancy (AOO) and the Extent of Occurrence (EOO):



9 UNSUPV. CLASSIFIER

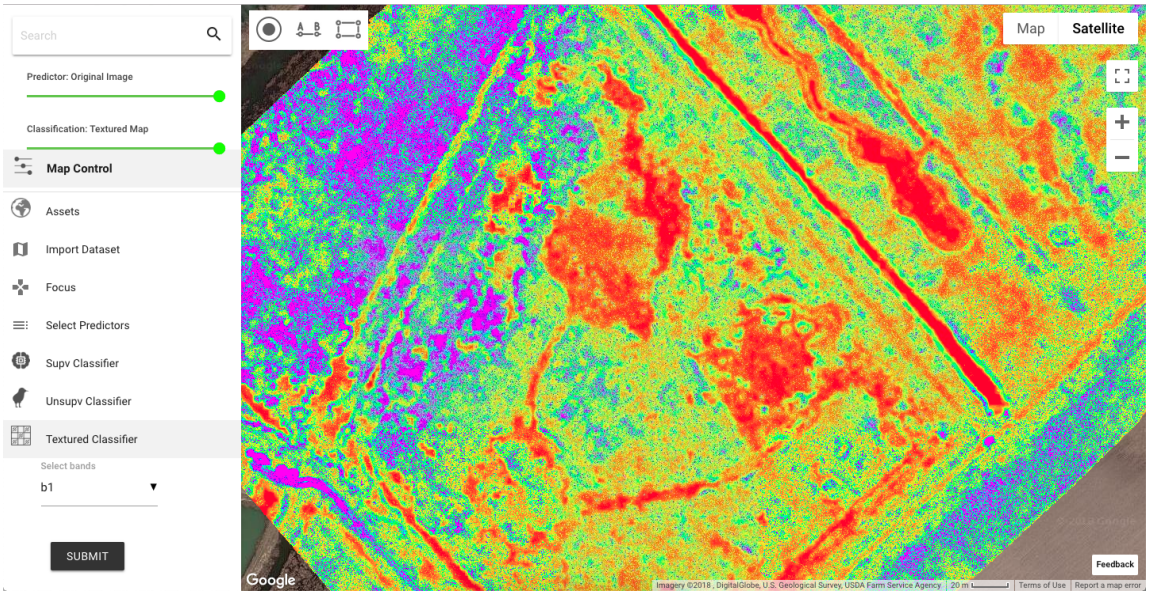
The WEKA package handles unsupervised classification (or clustering) in Atlasx. These algorithms are currently based on the algorithms with the same name in Weka. More details about each Clusterer are available in the display.

Clusterers are used the same manner as classifiers. The general workflow for clustering is:

1. Assemble features with numeric properties in which to find clusters.
2. Instantiate a clusterer and set its parameters if necessary.
3. Train the clusterer using the training data (if required).
4. Apply the clusterer to an image or feature collection.
5. Label the clusters (post-classification).

10 TEXTURED CLASSIFIER

Texture has several special methods for estimating spatial texture. The primary method is a gray-level co-occurrence matrix (GLCM). Using the image and non-zero elements in the kernel used to specify the neighbour-hood, the GLCM-based contrast calculates neighborhood standard deviation to compute image texture



11 OBJ-BASED CLASSIFIER

For treating landscape elements as objects, Atlasx contains several methods. Specifically, when an image has distinct patches identified by unique pixel values, the number of pixels in each patch are used to label each patch with a unique identifier. The unique identifiers can then be

used to enumerate the patches and analyze the distribution of size or some other quality of interest.

An example of a object-based classification can be processed to computed the size and unique identifiers of hot patches (min:750um; max: 1350um; band centre 1200um) in a thermal image. In the previous example, the maximum patch size is set to 256 pixels by the arguments to the connected pixels method. The connectivity is also specified by the arguments, in the former method by a boolean and in the latter method by an Kernel. In this example, only four neighbors are considered for each pixel.

12 MULIT-LAYERED CLASSIFIER

A multi-layered classification method can define multiple objects with a high level-of-precision and accuracy. The classification values are reduced into a unique image. The class delineation includes proprietary algorithms, which separates the object(s) with a higher level of certainty compared to traditional classification methods.

All the users must do is select the type of ecosystem, and let DroneEarth do all the heavy lifting. The output will provide details about the various training classes. Please review the methods first to ensure you have the correct imager to complete the algorithm properly (airwrx.com/methods).

The classification has only been deployed for only a few applications, but more will be coming down the pipeline. The multi-layered classification method has been developed to make assessments easy, accurate, and faster than ever before. If you have an application in-mind, feel free to reach-out to our team for service support.

13 EXPORT DATA

Atlasx allows you to export the data used to develop your map:

- Download a .csv file of your training set to your local drive (Download CSV).
- Download a Atlasx'workspace' file (.JSON), which saves your training set, focal region, map classes and class options (Download JSON). This option is very useful if you want to return to working on your classification with minimal fuss.

Both the .csv file and the Atlasx 'workspace' file (.JSON) can be uploaded again via the Build Training Set, Data Upload function. Data can be quickly and easily exported from Atlasx to allow users to return to their classification at a later date:

13.1 Export as GeoTIFF

Atlasx also allows you to download a spatially rectified GeoTIFF file for use in third party software such as R, ArcGIS and QGIS (Drive export GeoTIFF).

- Atlasx only allows GeoTIFF file downloads to Google Drive, so you will need to first login to your Google account.

- To begin the map download, select Drive export GeoTIFF. Atlasx will now run the classification again on the Google Earth Engine at the finest spatial resolution possible and deliver it to the root folder of your Google Drive account. This may take some time.
- The download will also include a metadata file that reports the date of the classification, pixel values, scale, time-frame and citation. Export the GeoTIFF of your map to Google Drive to allow further analysis in software such as R, QGIS and ArcGIS.

14 HISTORICAL/CHANGE MAPPING

The default classifications in Atlasx are implemented on drone imagery in the form of a georectified orthomosaic (ie. GeoTIFF). The application allows users to identify change within a time-frame collected by the user. To support long-term ecosystem monitoring and reporting against global conservation targets and development goals, Atlasx also hosts Landsat composites

To assess change between two orthomosaics (ex. summer 18' (past) and fall 18' (present)), develop maps for both periods using the Past-Present toggle. It is important to develop a training set for each period to account for land use change over time.
Use the past-present toggle to implement a classification on Landsat data for the years Fall-2017 (past) or Spring-2018 (present).

15 FEEDBACK

Please provide feedback or get in touch with us by submitting your comments, questions or concerns to ryan@airwrx.com

Alternatively, use the contact button at airwrx.com to provide feedback. Useful feedback allows us to further improve Atlasx.

16 ABOUT ATLASX

Atlasx was developed by AirWrx with the aim of increasing the utility of remote sensing for the drone industry and ecosystem-scale environmental conservation. We thank the Google Earth Engine team for developing such a ground-breaking geospatial analysis tool.

If you use Atlasx for any purpose, please acknowledge it by citing our paper and software:

Cant, R., & Veeramallu, V. (2018) Atlasx: UAS remote sensing application for land-cover classification and environmental monitoring. **https://airwrx.com/methods**

This user guide can be identified as:

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