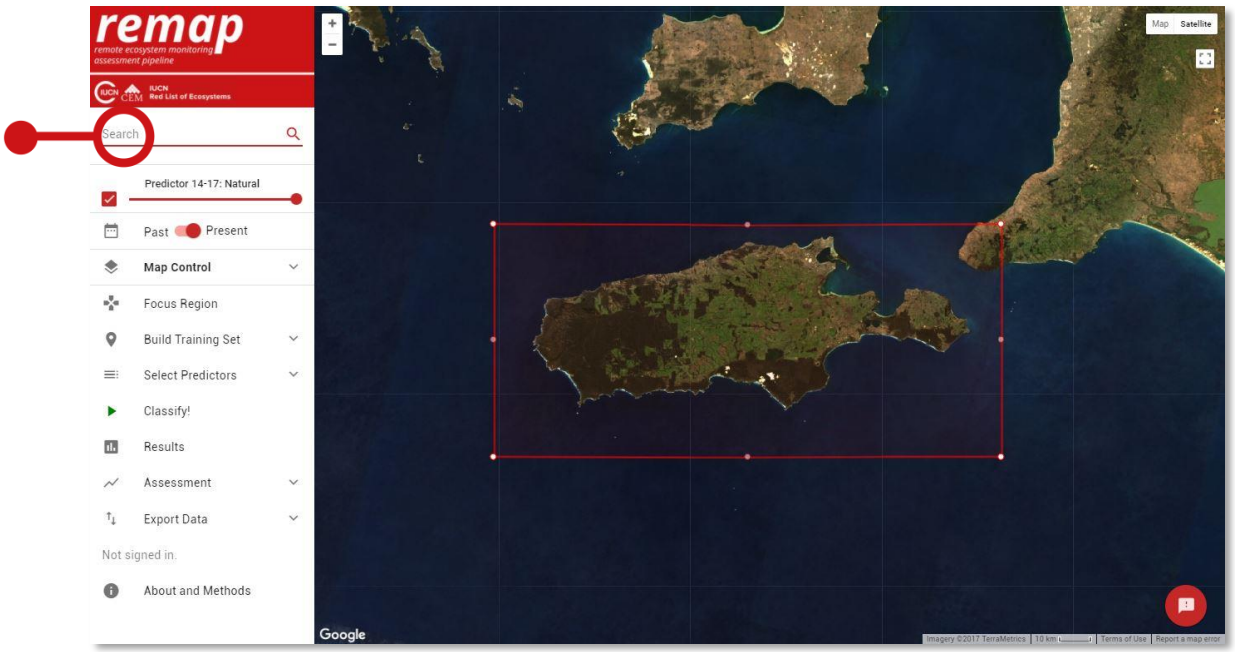
Remap (https://remap-app.org) is an online mapping platform for people with little technical background in remote sensing. We developed remap to enable you to quickly map and report the status of ecosystems, contributing to a global effort to assess all ecosystems on Earth under the IUCN Red List of Ecosystems.

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

Location search

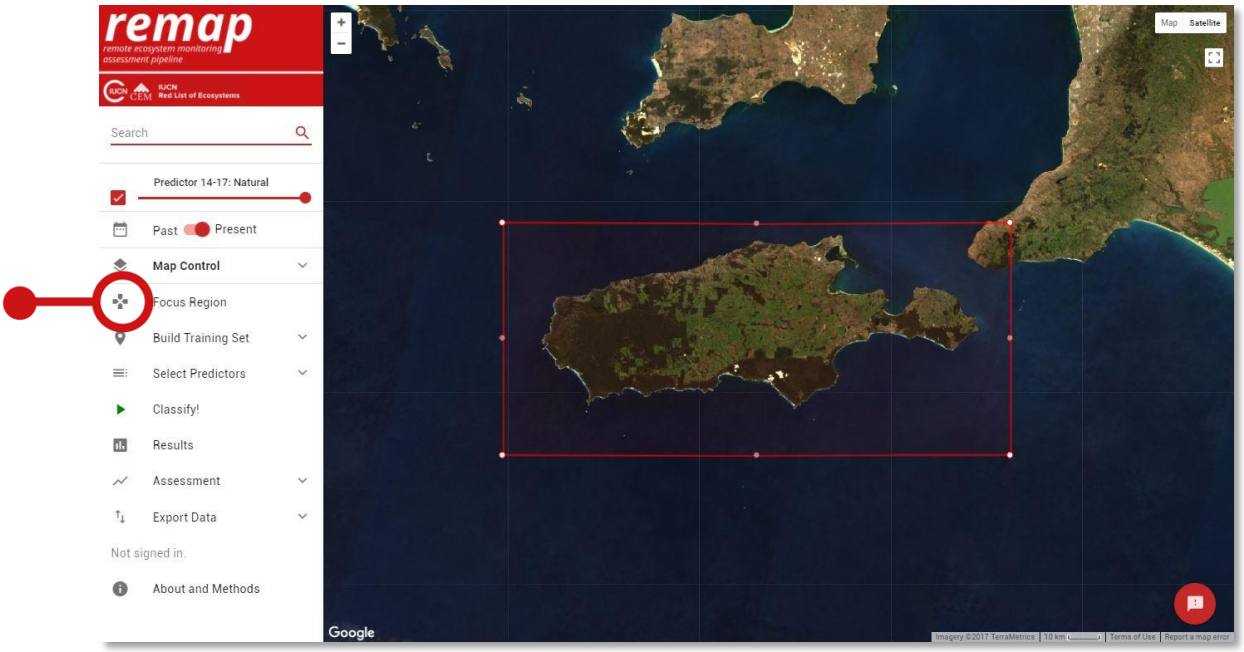
Search for a location using the location search bar:



Focus region

Focus Region defines the boundaries of the analysis and ensures analysis remain within the computational limits applied to remap by the Google Earth Engine. Change the shape of your region of interest by modifying the polygon boundaries, or upload your own study region via the .kml upload feature in Build Training Set. In general, smaller regions of interest will run faster in remap.

Use focus region to define the boundaries



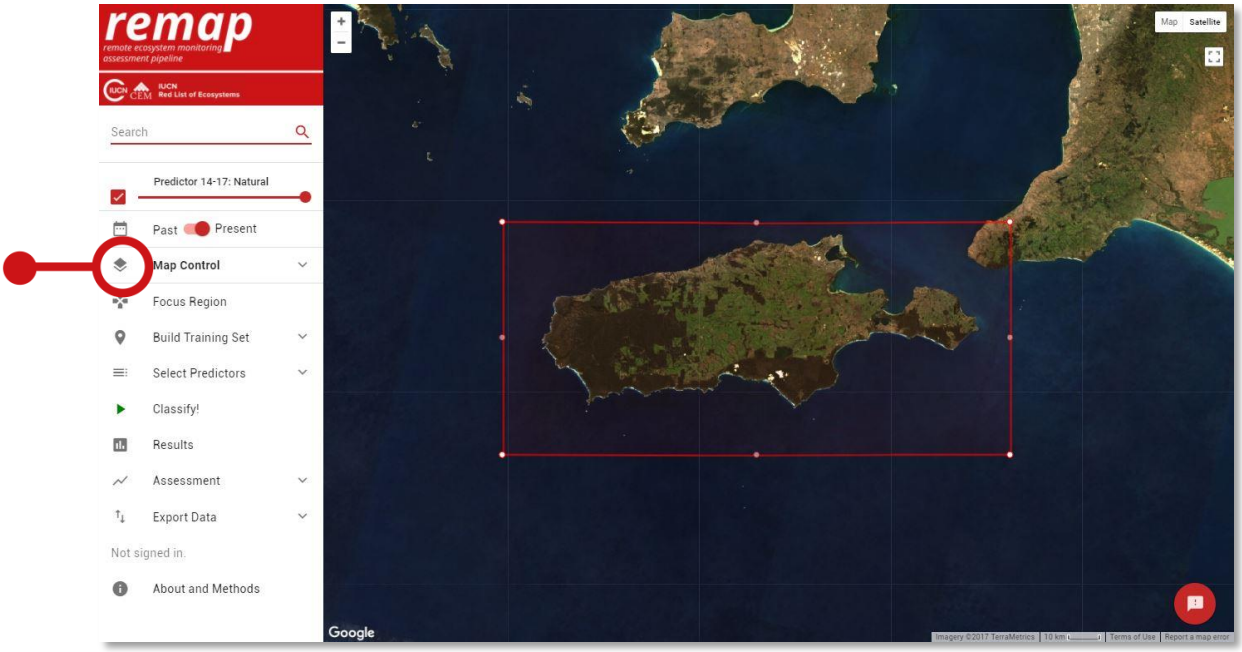
Map control

Map control allows you to visualise different base layers (predictors), toggle marker points on and off and change the way colours of the base layers are rendered. It is particularly useful for visualising the different predictors that the classifier will use to classify each pixel.

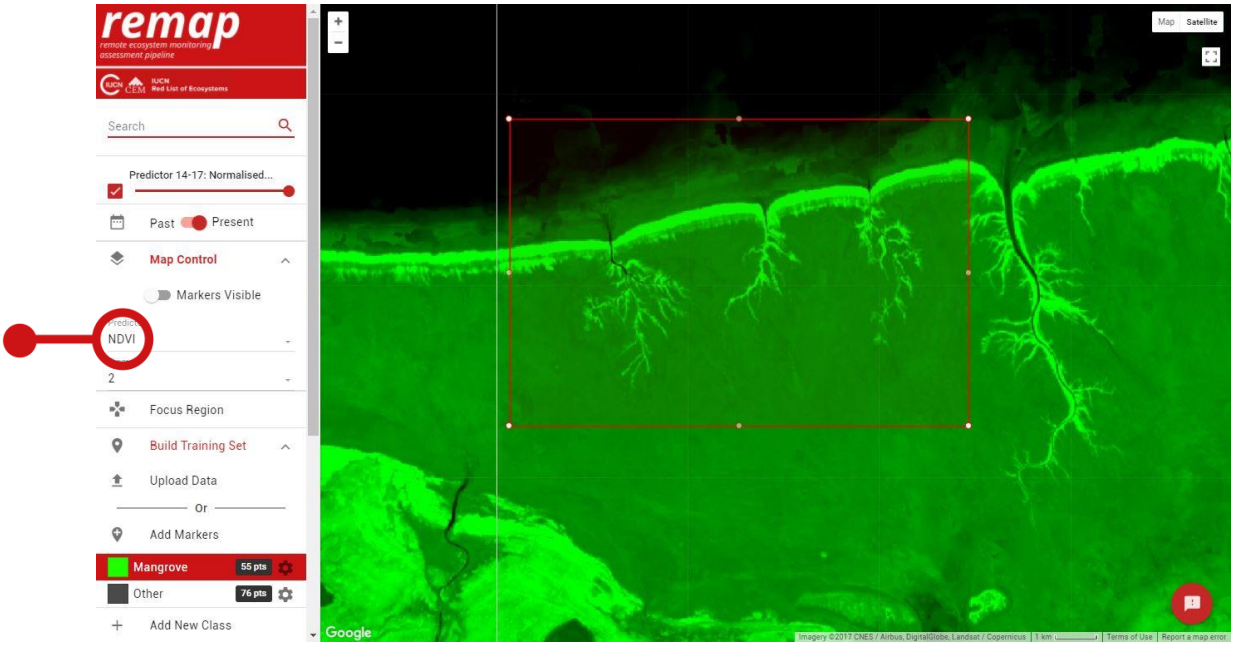
Predictors that can be visualised in remap include the Normalized Differenced Vegetation Index (NDVI), Normalized Differenced Water Index (NDWI), the Near Infrared band of Landsat 8, Slope, Elevation, Mean Annual Temperature, and Mean Annual Precipitation.

Map control also allows you to view or hide your training points and adjust the visualisation parameters of the predictor layers (sigma setting).

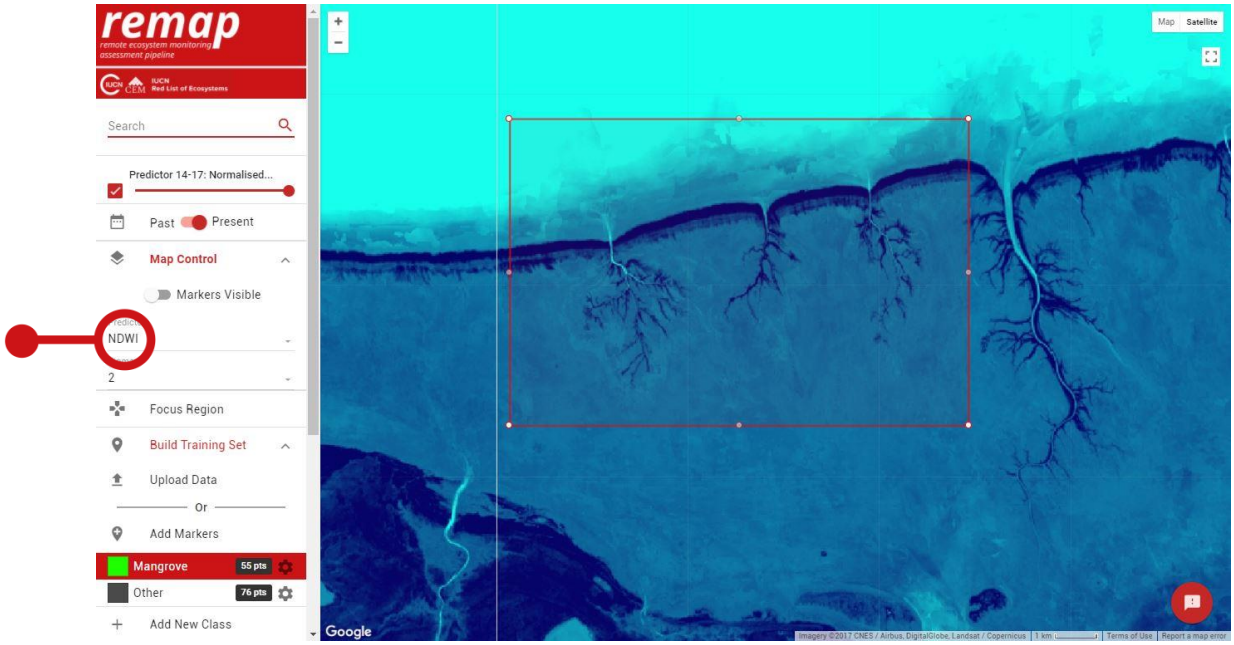
Expand map control to access controls:



Use map control to visualise the Normalized Differenced Vegetation Index (NDVI) for a study region:



Use map control to visualise the Normalized Differenced Water Index (NDWI) for a study region:



Build training set

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).

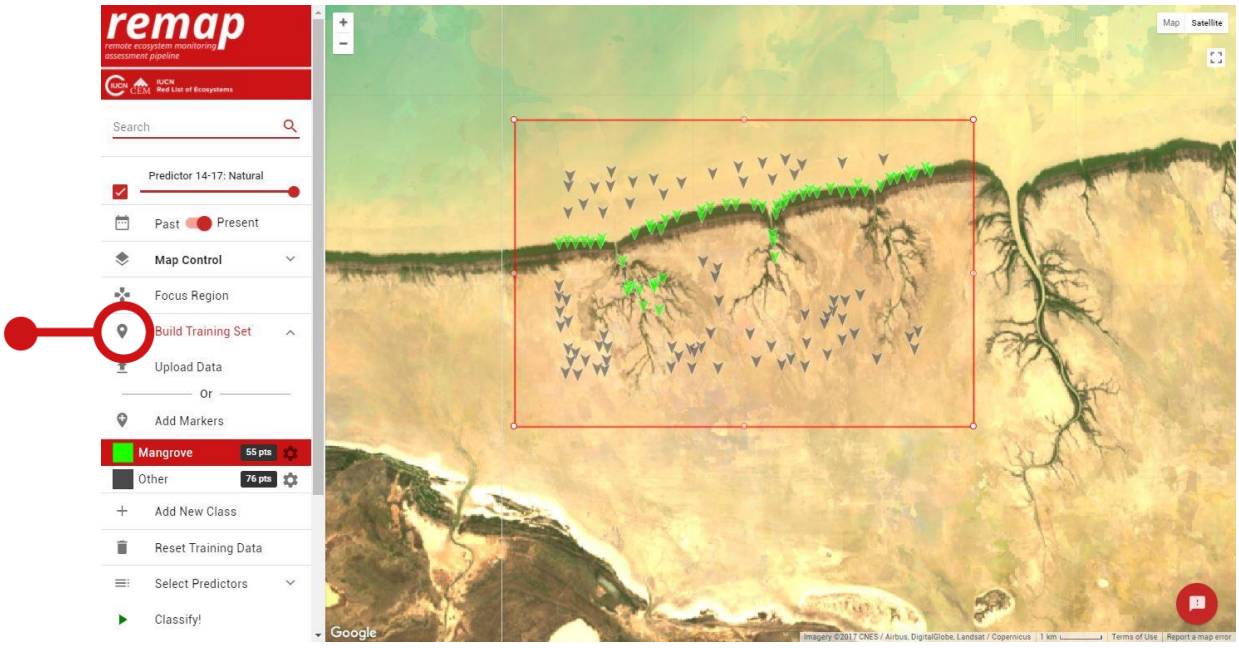
This can be achieved in two ways:

- 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.



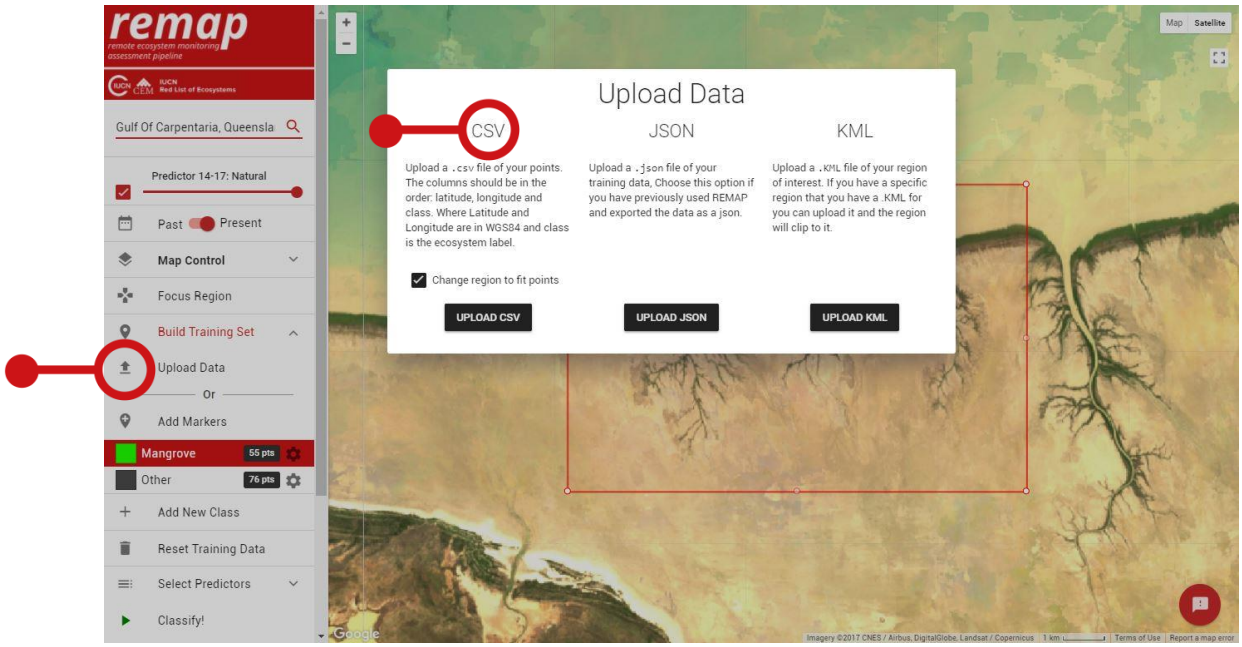
Build training set (.csv upload)

Remap 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 remap 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 remap:

lat	lng	Label
1.039524	-59.425	Forest
1.152114	-59.4827	Forest
1.158979	-59.6983	Non-forest

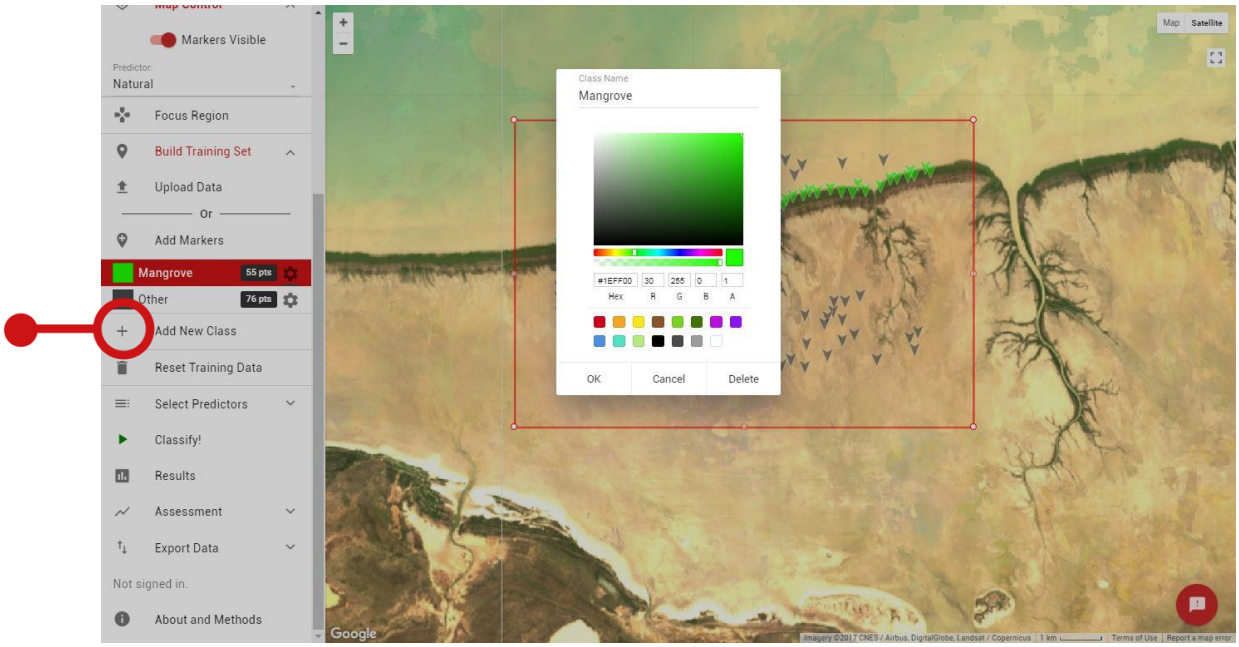
Uploading a .csv file of training data to remap:



Build training set (interactive)

Use the Add Markers and Add New Class functions to interactively train remap. First, use Add New Class to identify all of the classes you want the remap 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 remap:



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.

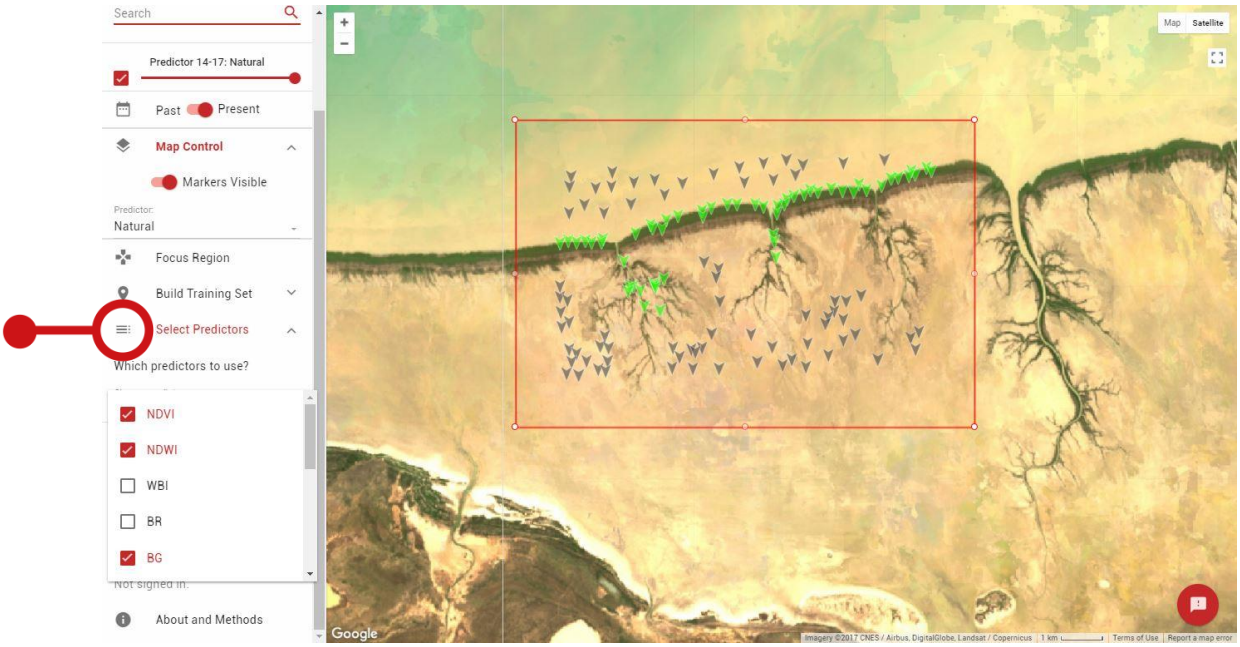
In the example above, we have added 55 points that correspond with Mangroves and 76 points that correspond with the Other class. Note that it may be possible to achieve higher accuracies by distinguishing 3 classes, Mangrove, Salt pan and Water, rather than a single Other class.

Select predictors

The remap 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.

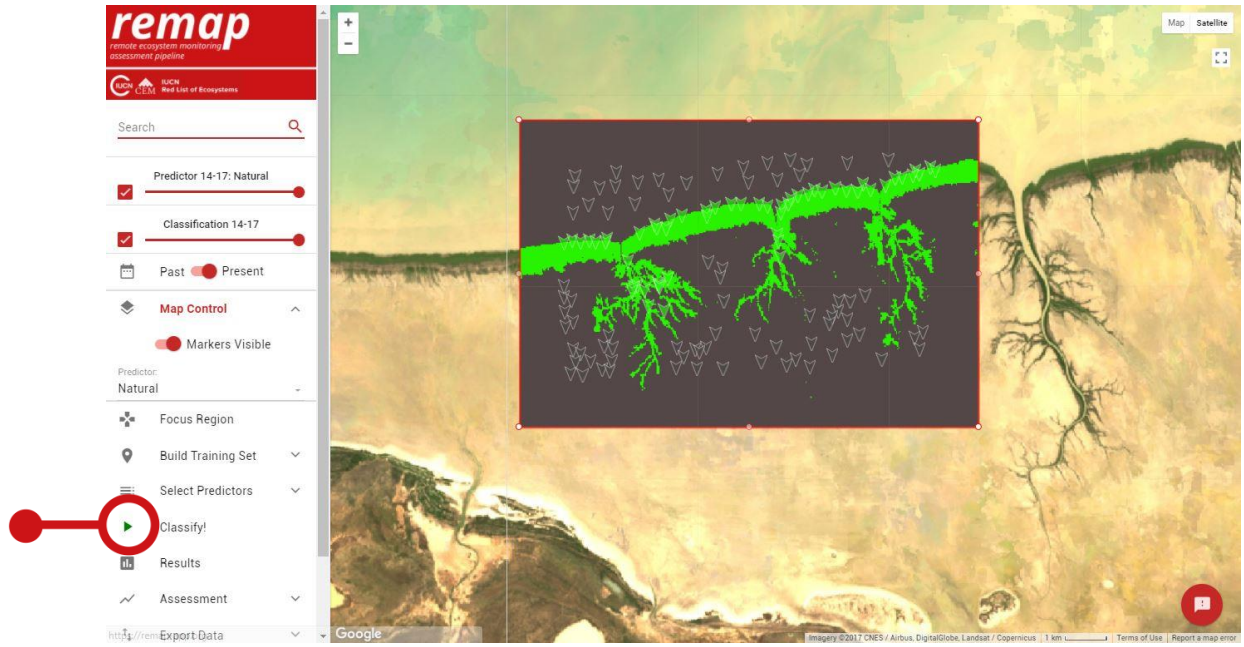
Use the Map Control to view the predictor layers available and select the ones you want to include in your classification.

Selecting the predictors that remap will use to generate a classified map:

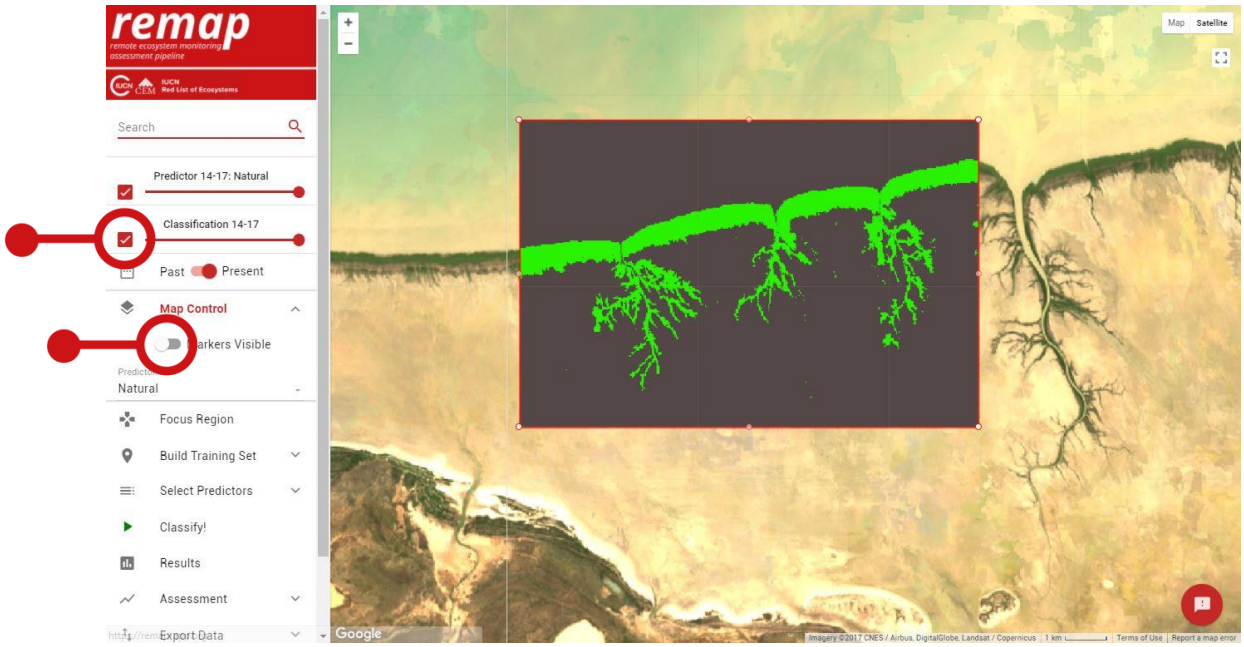


Click Classify to run the classification. Remap will implement the classification in the Google Earth Engine and return the result to the browser.

When clicking Classify, remap implements the classification on the Google Earth Engine and returns a classified map to the browser:



Hide the markers or change the classified map transparency in the side bar:

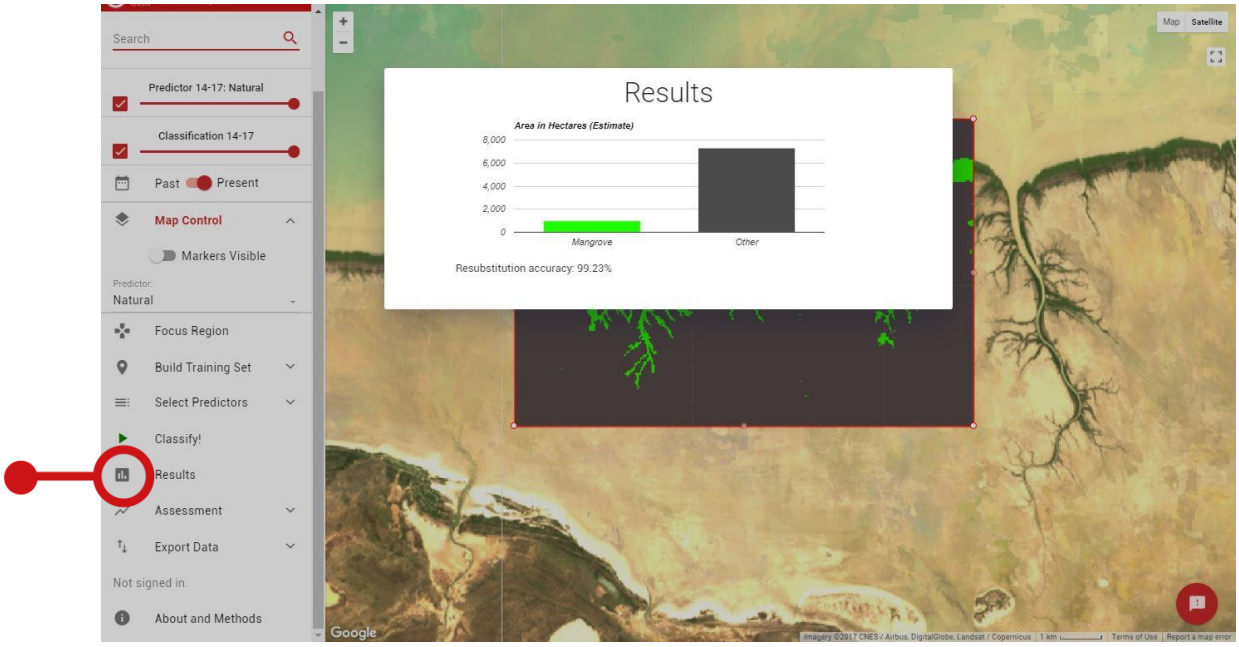


Results

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 optimised for speed and are estimates only. For more accurate area results, use the assessment function.

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

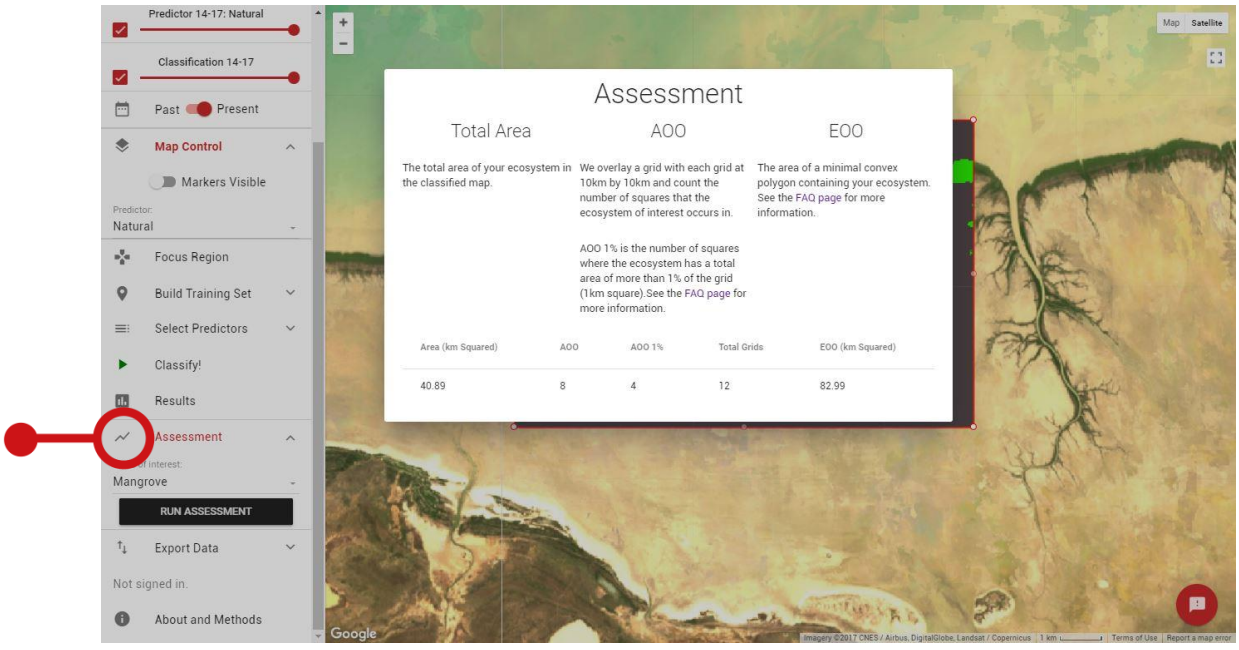


Assessment

The assessment tab in remap calculates the spatial metrics required for assessments under the IUCN Red List of Ecosystems (https://iucnrle.org). Remap 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).

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



Export data

Remap 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 remap '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 remap 'workspace' file (.JSON) can be uploaded again via the Build Training Set, Data Upload function.

Data can be quickly and easily exported from remap to allow users to return to their classification at a later date:

Export map as GeoTIFF

Remap 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).

- Remap 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. Remap will now run the classification again on the Google Earth Engine at the finest spatial resolution possible (100m) 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.

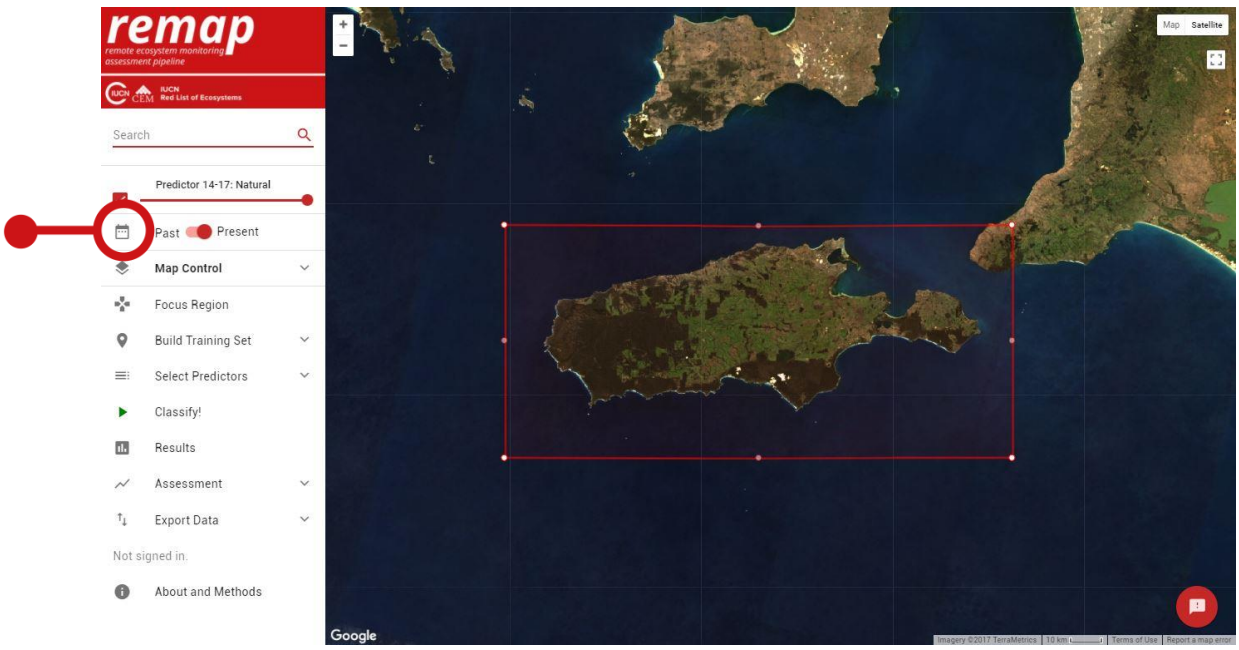
Export the GeoTIFF of your map to Google Drive to allow further analysis in software such as R, QGIS and ArcGIS.

Historical mapping

The default classifications in remap are implemented on Landsat images acquired in the years 2014-17. This 4-year time-frame enabled our Landsat composites to be near cloud-free with a global extent, and required the processing of >350,000 Landsat images. To support long-term ecosystem monitoring and reporting against global conservation targets and development goals, Remap also hosts Landsat composites produced with data between 1999-03.

To assess change over the ~15 year period between 1999-03 (past) and 2014-17 (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 1999-03 (past) or 2014-17 (present).



Feedback

Please provide feedback or get in touch with us by submitting a form that can be accessed by the feedback button.

Use the feedback button to provide feedback. Useful feedback allows us to further improve remap.

About remap

Remap was developed with funding from a Google Earth Engine Research Award with aim of increasing the utility of remote sensing for global environmental conservation. We thank the Google Earth Engine team for developing such a ground-breaking geospatial analysis tool.

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

> Murray, N.J., Keith, D.A., Simpson, D., Wilshire, J.H. & Lucas, R.M. (2017) REMAP: An online remote sensing application for land cover classification and monitoring. *bioRxiv*. DOI: 10.1101/212464
>
> Murray, N.J., Keith, D.A., Simpson, D., Wilshire, J.H., Lucas, R.M. (2017) REMAP: The remote sensing ecosystem monitoring and assessment pipeline. https://remap-app.org

The data used to prepare this tutorial are available at:

> https://figshare.com/s/7125654aded6d9235f08

This user guide can be identified as:

> Murray, N.J., Wilshire, J.H. and Simpson, D (2017) *Remap user guide Version 1.0.0.* Centre for Ecosystem Science, University of New South Wales. DOI: xxx.xxx.xxx

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