Earth Engine App 'CropMapper'

Overview

Crop type mapping at the field level is necessary for a variety of applications in agricultural monitoring and water resources management. Remote sensing imagery is a powerful input from which crop type maps can be created. Hydrosolutions ltd is currently designing various apps which facilitate users with no or minimal background in remote sensing to access and use such data for their purposes. Here we present a new browser application which we have designed for IWMI Uzbekistan. The purpose of the app is to generate high resolution annual maps of crop types and cropping patterns for three selected study sites in Uzbekistan.

Method

The methodology for crop type mapping that we have implemented in our tool is based on an unsupervised classification technique proposed and evaluated by Wang et al. 2019. It uses harmonic regression in Google Earth Engine to extract features from time series of optical remote sensing data. The features are then used to cluster the pixels, i.e. to group pixels with similar features into different classes. The final step is to label the classes, which means that we must attribute a crop type to every cluster of pixels. This last step is not automatized, and we rely on the expert knowledge of the local users to label the clusters with the main crop types that are growing in his region of interest. To facilitate this task, users can display the characteristic time series of vegetation indices, or they can identify the crop type by looking at the provided high-resolution satellite imagery. The advantage of our method is that it is not constrained by the common lack of field-level crop labels for training and can therefore theoretically be applied anywhere on the planet where optical satellite imagery is available. Clouds and haze are the methods' main adversaries, and it works best in arid or semi-arid regions with distinct seasons and crop growth calendars.

Detailed Instructions

1. Open the following URL in your browser:
   https://hydrosolutions.users.earthengine.app/view/cropmapper-uzb
   For best performance we recommend the browsers Google Chrome or Safari (on Mac).

Initial User Inputs

2.1 Select an **Area of Interest**. Three sites are available in this demonstration app:
- Kuva Urta Buz Anori (25.62 km2); the perimeter of a Water User Association in the Fergana Valley.
- Shakrikhansai (681.30 km2); the catchment of an irrigation canal in eastern Fergana Valley.
- Aksu (3238.01 km2); an area of interest in the Kashkadarya province of Southern Uzbekistan.

2.2 Select a **Sensor**. Three sensors are available:
- *Sentinel-2*; available since the year 2016; output crop maps with a resolution of 20 meters. Best option due to highest spatial and temporal resolution.
- *Landsat 8*; available since the year 2013; output crop maps with a resolution of 30 meters.
- *Landsat 7*; available since the year 1999; output crop maps with a resolution of 30 meters. Imagery of this satellite comes with strips of missing data due to a hardware component failure in 2003.

2.3 Select a **Year** for the Analysis. The drop-down list of available years depends on the chosen sensor and is updated automatically.

2.4 Specify the **number of main crop types** within the area of interest. If the number of main crop types is unknown, choose the automatic option. The automatic option will identify a number of clusters (between 1 and 9) that best reflects the differences in cropping calendars and spectral appearance.

2.5 Tick the box "***Show Douple Crop Planting Area***" if a map of double crop planting area should be produced. The map will of consist of black areas where the algorithm identifies double crop plantations, and will be shown on top of the crop type map. It is also possible to tick this option later on during the analysis.

2.6 Click "**Submit**" to run the analysis.

Crop Map Postprocessing

3.1 Manual Class **Labelling** of the clusters. Select a class label from the drop-down list or type in a label of your choice (by first selecting "User Input…" from the drop-down list).

- Select "*No-Crop Area*" if you think the cluster does not designate cropland. The cluster will be removed from the map in the next step.
- It is possible to attribute the same class label to several clusters. In that case the corresponding clusters will be merged into a single group. Clusters whose associated crop type remains unknown will not be merged.

3.2 Define a **minimum field size** (unit in hectares). Use this option to remove noise from the map. Be aware the using this option implies some additional calculation time and for large area of interests it might not be possible to display the crop map at low zoom levels.

3.3 Click on the second "**Submit**" button to confirm the post-processing settings.

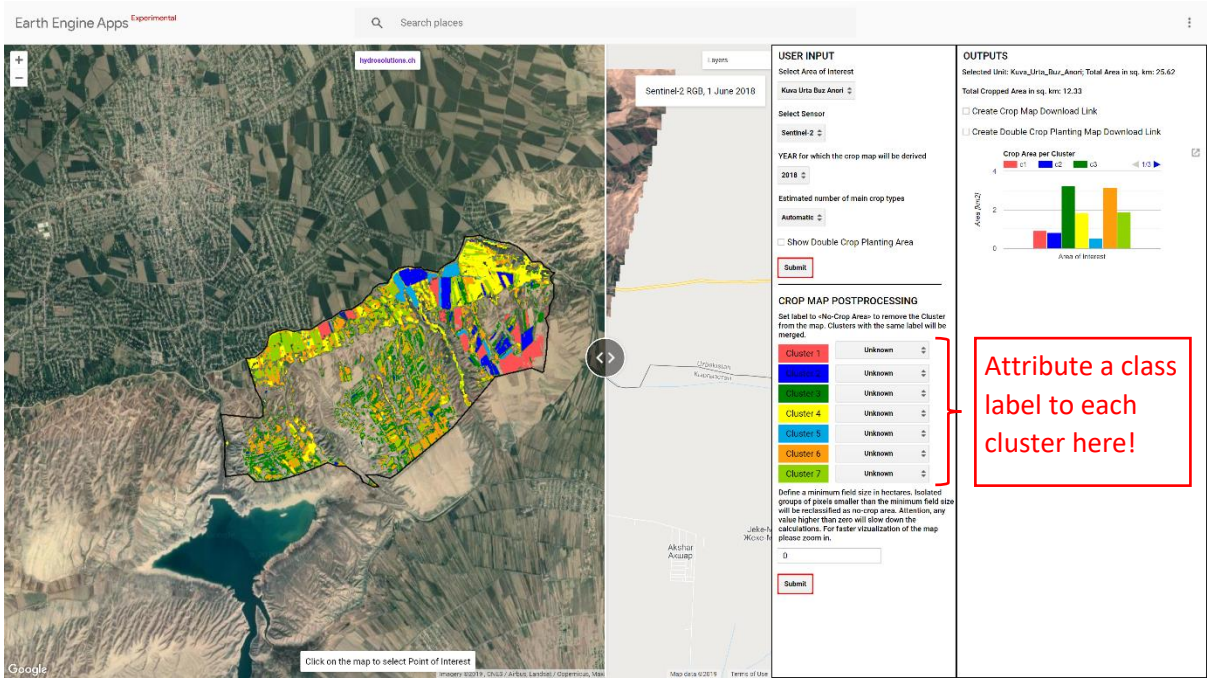

Figure 1: Crop Map Postprocessing

Outputs

4.1 The default outputs of the analysis are the following:

- The total area of the selected unit and the total area of all cropped area
- A bar-chart displaying the total area per crop type. The figure can be downloaded as PNG file (click on the icon).

- A table presenting the crop area statistics.

4.2 Optional outputs can be activated by ticking the corresponding checkboxes inside the 'Outputs' panel.

- '*Create Crop Map Download Link*': **Download** the **Crop Map** as georeferenced TIF image
- '*Create Double Crop Planting Map Download Link*': **Download** the **Double Crop** Planting Map as georeferenced TIF image
- '*Show Crop Area Development over Time*': Display a chart showing the **crop areas of all other available years**, given the example of the labeled crop map of the currently selected year. Be aware that this option implies the processing of a lot of data. It will therefore take some time until the results can be displayed, and the calculations are likely to exceed Earth Engine Memory Capacity. If this is the case, an error message will be displayed. If Earth Engine Memory Capacity is exceeded, the user can still try to re-run the analysis. Second attempts have higher changes of be successful (click a second time on the Post-Processing 'Submit' button and tick the checkbox again).

The download options are already available for the initial outputs, before post-processing.

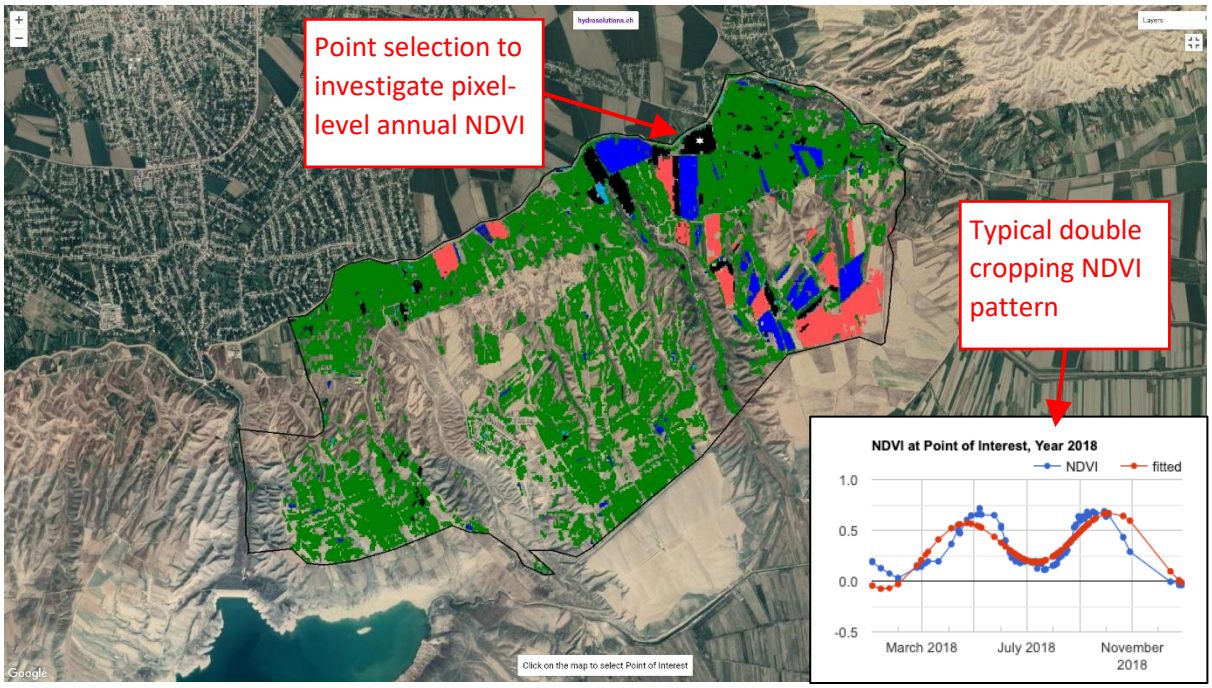

Figure 2: Crop Map, Double Crop Area Map and typical NDVI pattern of double crop area. Clusters 3,4,6 and 7 from the example above (Figure 1) were assigned the same class label ('Orchard'). Cluster 5 (light blue) is almost exclusively designates double crop area.

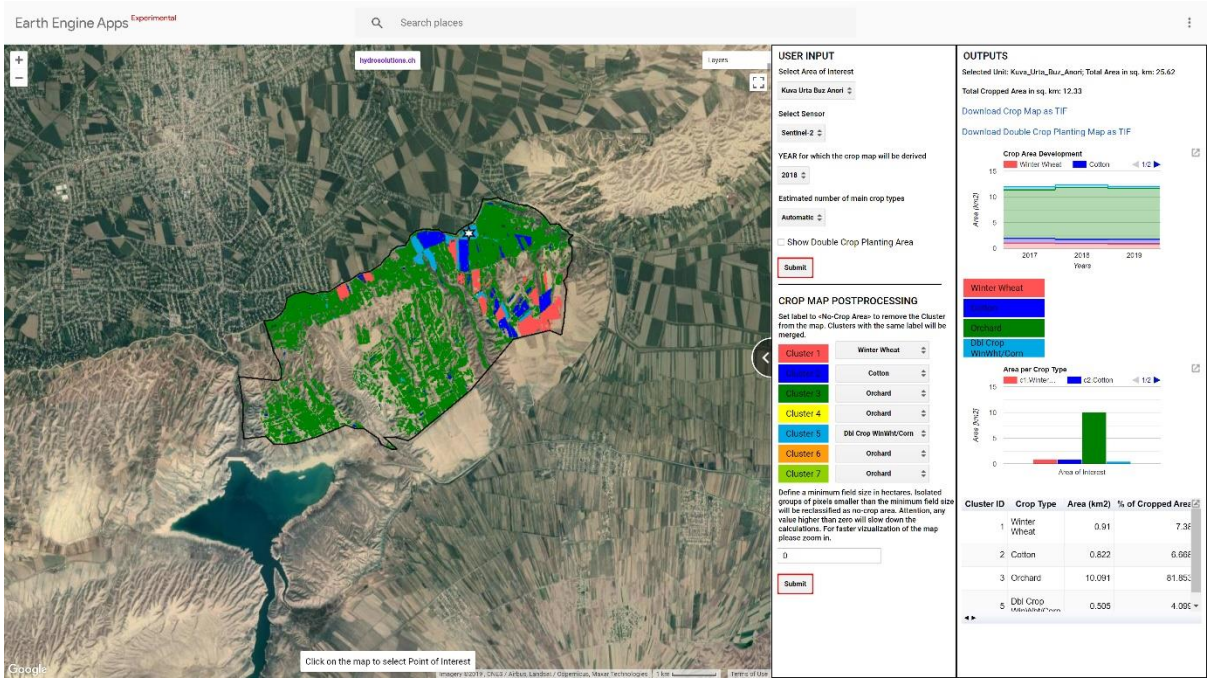

Figure 3: Final outputs of the analysis.