SINVAQUA PLATFORM

USER MANUAL

1. INTRODUCTION

The SINVAQUA platform is a system based on satellite remote sensing for supporting the early warning and rapid response to the introduction and dissemination of aquatic invasive exotic plants, taking the invasion by the water hyacinth (*Eichhornia crassipes*) [already implemented in the platform] and the large-flowered waterweed (*Egeria densa*) [to be implemented in the platform soon] and as a proof-of-concept case study in two water courses located in northwest Portugal – Lima and Cávado rivers.

The platform provides an intuitive graphical interface to carry out the satellite image classification that allows the mapping of aquatic invasive plant species, using the user's library with Google Earth Engine[1]'s JavaScript API. The platform is available at http://sinvaqua.estg.ipvc.pt

2. USER INTERFACE

The platform's user interface is based on a portal accessible from a web browser. The home page is organized to facilitate the execution of the steps necessary to configure and run the classification procedure for a defined geographic area and the visualization/interpretation of the classification results in the form of a map.

2.1. PLATFORM ACCESS AND GENERAL FUNCTIONALITIES

The main page of the SINVAQUA platform has an interface structured in two main areas: a sidebar on the right with the tools/components for defining the parameters and executing the image classification procedure. The central page area has an interactive map viewer, with the possibility of choosing two languages for the interface: Portuguese and English (Figure 1).

In order to facilitate the use of the SINVAQUA platform, the sidebar has three sections arranged vertically, which correspond to each of the parameters/options necessary to execute the satellite image classification. After the classification process, the results are displayed at the bottom of the sidebar with the possibility of controlling their visualization on a map.

The functionalities described below allow producing spatially-explicit results that are displayed in the form of an interactive map. For each resulting layer, the user can control the layer visibility, view the used symbology on the map, and remove or download the geographic results in GeoTIFF format in order to be used in external GIS software by using the following buttons:

-  - control the geographic layer visibility
-  - view the geographic layer symbology used in map representation
-  - remove the geographic layer
-  - download the geographic layer to a local file in GeoTIFF format.

[1] https://developers.google.com/earth-engine/tutorials/tutorial_api_01

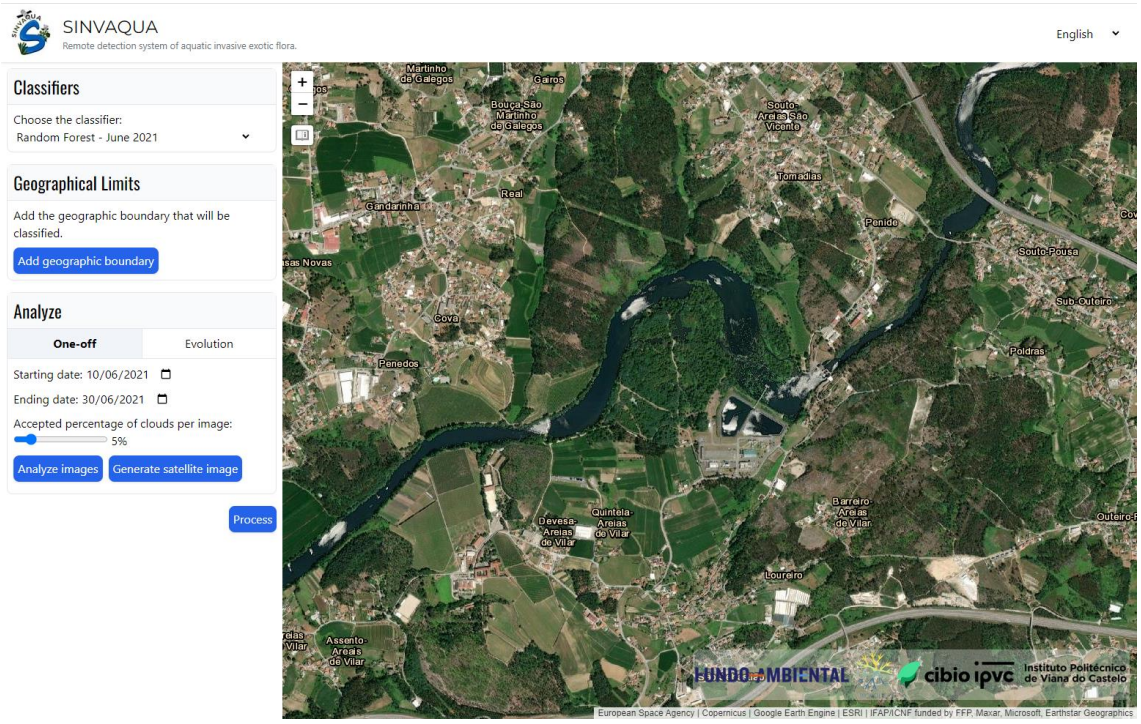

Figure 1- Home page of the SINVAQUA platform

2.2. CLASSIFICATION PROCESS OF GEOGRAPHIC AREAS

To run the image classification, the user must define parameters/options according to the three sections in the sidebar:

(i) "Classifiers" section - allows selecting the classifier to be used;

(ii) "Geographical Limits" section - allows defining the geographic area to be analyzed/classified;

(iii) "Analyze" section – allows selecting the type of analysis to be performed, i.e. to choose a given period or to generate a set of sequential results corresponding to a geographic area classification for a set of sequential periods.

Additionally, the first section ("Classifiers") allows the user to select the classifier to be used in the image classification procedure (Figure 2). The options available on the SINVAQUA platform are:

- Random Forest – June 2021: classifier trained with data collected in June 2021 in the Cávado river area;
- Random Forest – November 2021: classifier trained with data collected in November 2021 in the Cávado river area;
- Random Forest – June/November 2021: classifier trained with data from the two previous periods.

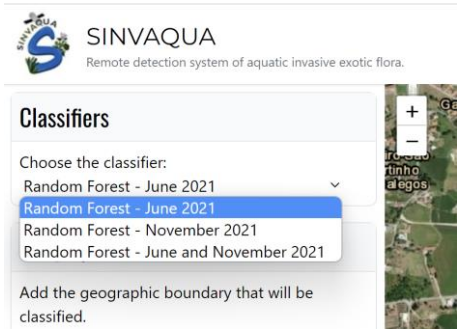

Figure 2 – Selection of the classifier to use

The second section (“Geographical Limit”) allows digitizing on the map the geographic area to classify. The digitization procedure starts by clicking on the “Add geographic boundary” button; then the area is delimited by marking successive points by clicking on the map. The delimitation process ends with a click on the first point (Figure 3).

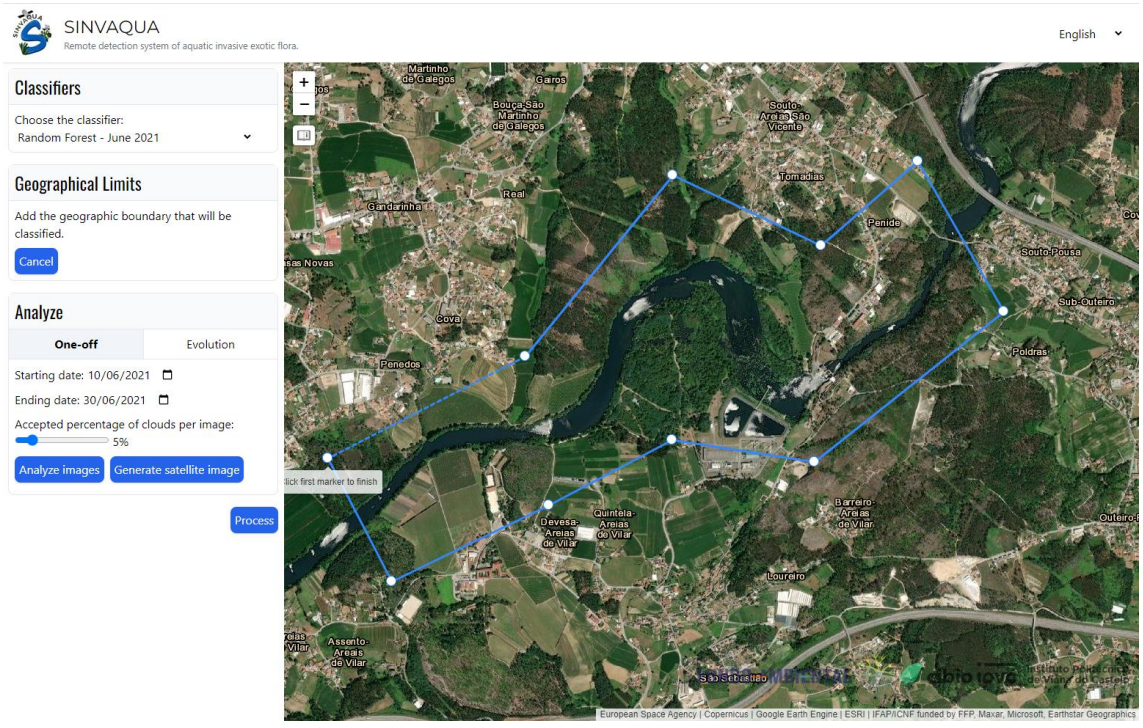

Figure 3 – Digitizing the limits of the geographic area to classify

The third section (“Analyze”) allows selecting the type of analysis and the criteria/conditions to be used in the classification procedure, with two possible options: “one-off analysis” or “evolution analysis”.

The one-off analysis allows classifying the delimited geographical area for a given time interval. The time interval to be covered is defined by selecting dates in the input boxes “Starting date” and “Ending date”. In addition to the dates, it is necessary to indicate the maximum percentage of cloud cover to select images for the classification procedure (Figure 4).

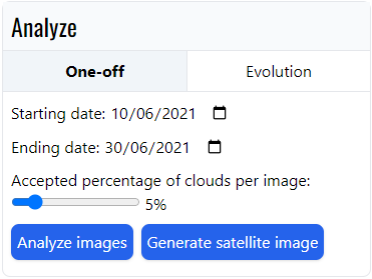

Figure 4 – Definition of the execution parameters for a one-off analysis

For the one-off analysis, and in order to know the number of satellite images that can be used in the classification procedure, the following operations can be performed:

- "Analyze images" button - adds two layers to the map: a first one with the count of the number of images that meet the defined conditions (Figure 5) and a second one that displays the percentage of the number of images relative to the maximum number of images (Figure 6);
- "Generate satellite image" button - allows previewing of the satellite image resulting from the average of the images that meet the user-defined criteria (Figure 7).

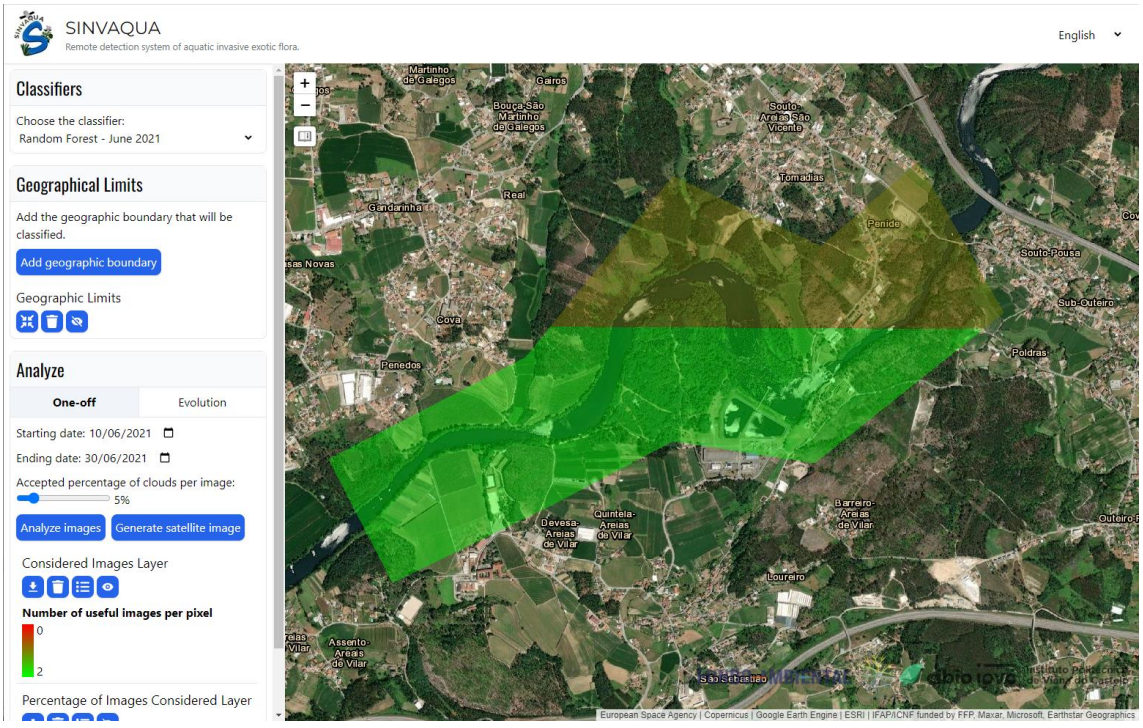

Figure 5 - Count of the number of images that verify the criteria defined for a one-off analysis

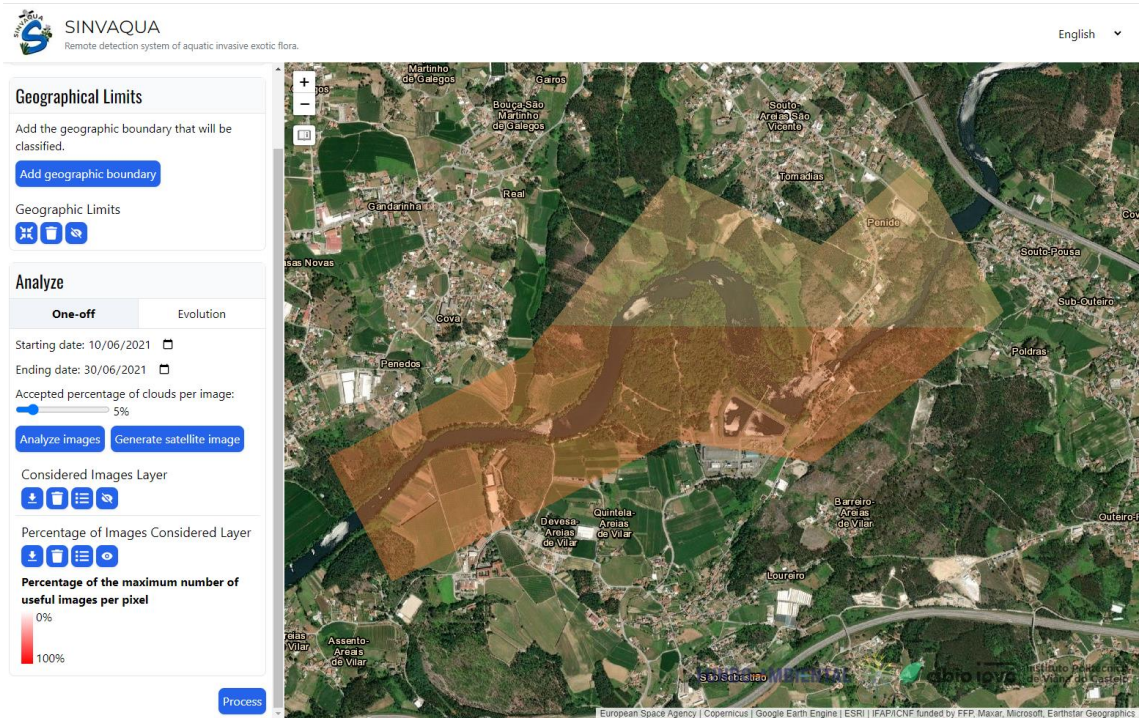

Figure 6 - Percentage of the number of images, relative to the maximum number, that meet the criteria defined for a one-off analysis

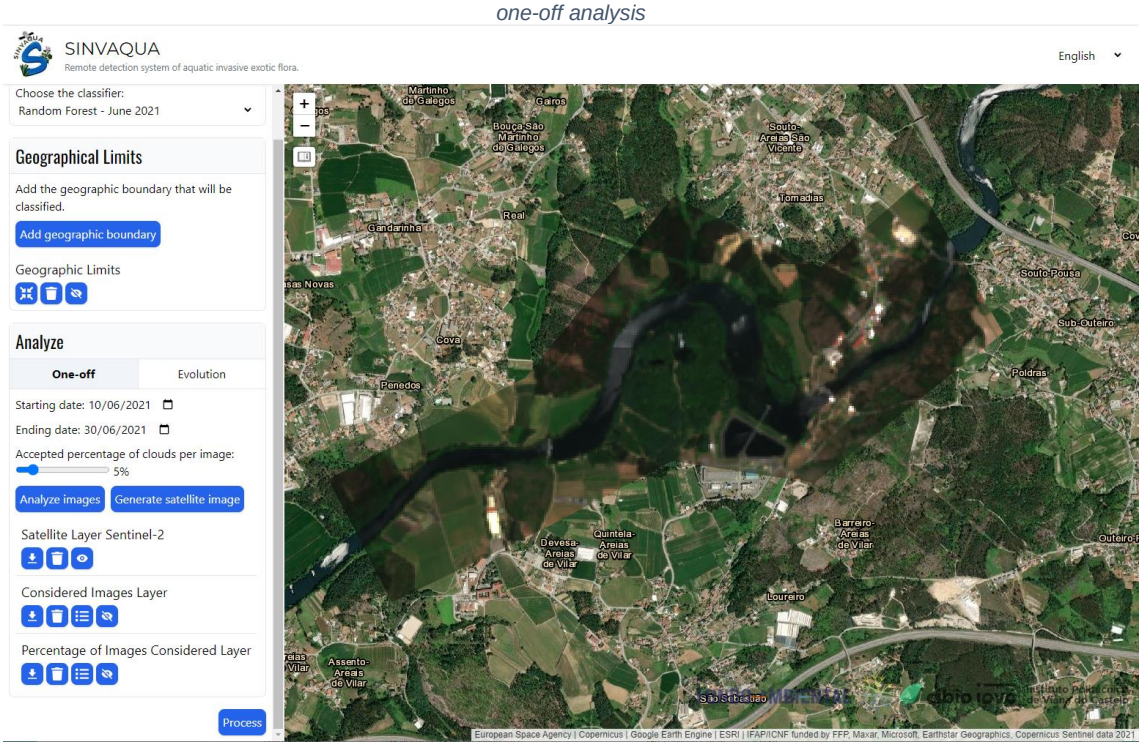

Figure 7 - Image resulting from the average of satellite images pixel values that verify defined criteria

In the evolution analysis option, it is possible to generate an animation composed of a succession of images resulting from the classification procedure for a sequence of time intervals. The temporal division of the image sequence is defined by setting the following variables: the start date for the sequence in the “Starting date” input box, the number of sequential days to be considered for each classification process (resulting in an image), and the number of images to be generated (which will be combined in an animation).

For example, in the case of the values specified in Figure 8 (starting date with value 10/06/2021, number of days per image equal to 10 and, number of generated images equal to 5), the analysis execution will generate an animation with images resulting from the classification process for the following five periods: 10/06/2021 to 24/06/2021, 10/06/2021 to 08/07/2021, 08/07/2021 to 22/07/2021, 22/07/2021 to 05/08/2021, 05/08/2021 to 19/08/2021. In the case of this analysis, it is also necessary to define the maximum percentage of cloud cover to consider when selecting the images to be included in the animation.

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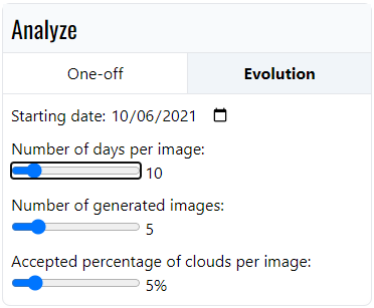

Figure 8 - Definition of parameters for an evolution analysis execution

After selecting the desired type of analysis and specifying the parameters described in the previous points, the classification process can be started by clicking on the “Process” button. The procedure starts the classification process by internally invoking the Google Earth Engine library.

The generated results are (according to the type of analysis selected in the previous phase):

- One-off analysis - two new geographic layers are added: a first layer with the classification indicating the presence or absence of the target aquatic invasive species (Figure 9), and a second layer with the presence probability value of the species (Figure 10). In this case, it is still possible to obtain the probability value for a given location by selecting the tool  (in the upper left corner of the map) and clicking on the map to obtain the probability value at the selected position;
- Evolution analysis - a new geographic layer is added with an animation that sequentially presents the images where the presence or absence of the species was detected for each time interval, according to the parameters defined in the previous point, being possible to pause and start the animation by respectively clicking on the buttons  e  (Figure 11).

Finally, Figure 12 presents a summarized graphic representation of the classification procedure of geographical areas using SINVAQUA platform.

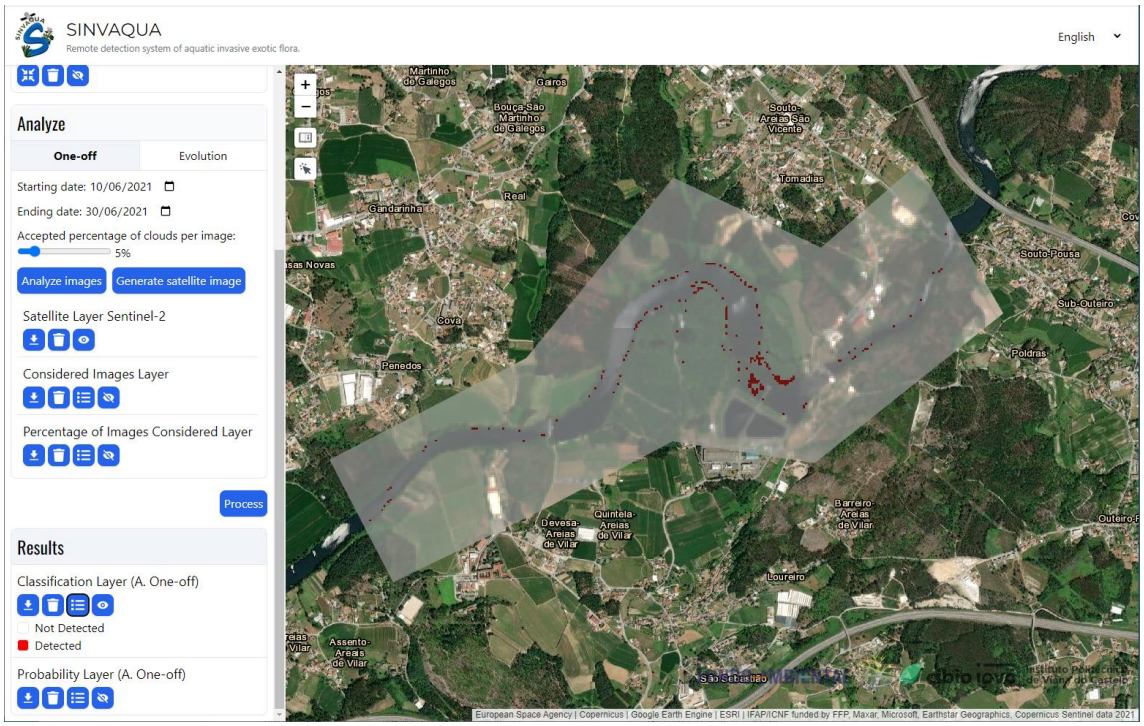

Figure 9 - Geographic layer with the classification of presence (or absence) of aquatic invasive species

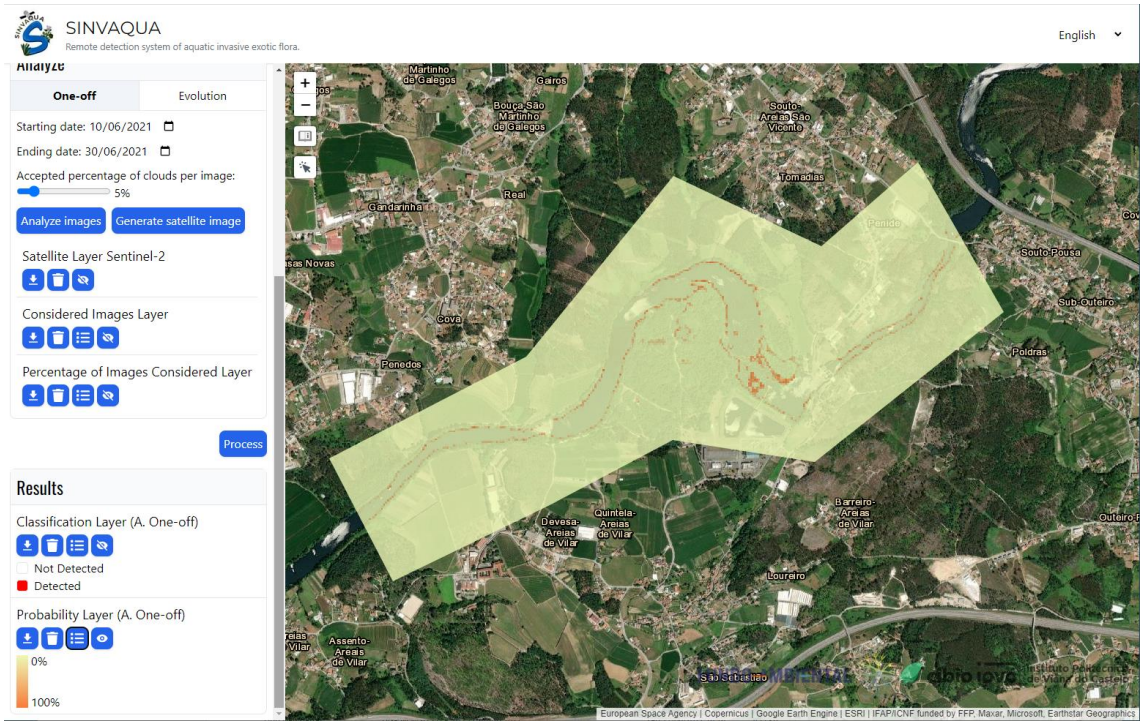

Figure 10 - Geographic layer with the probability of invasive species presence

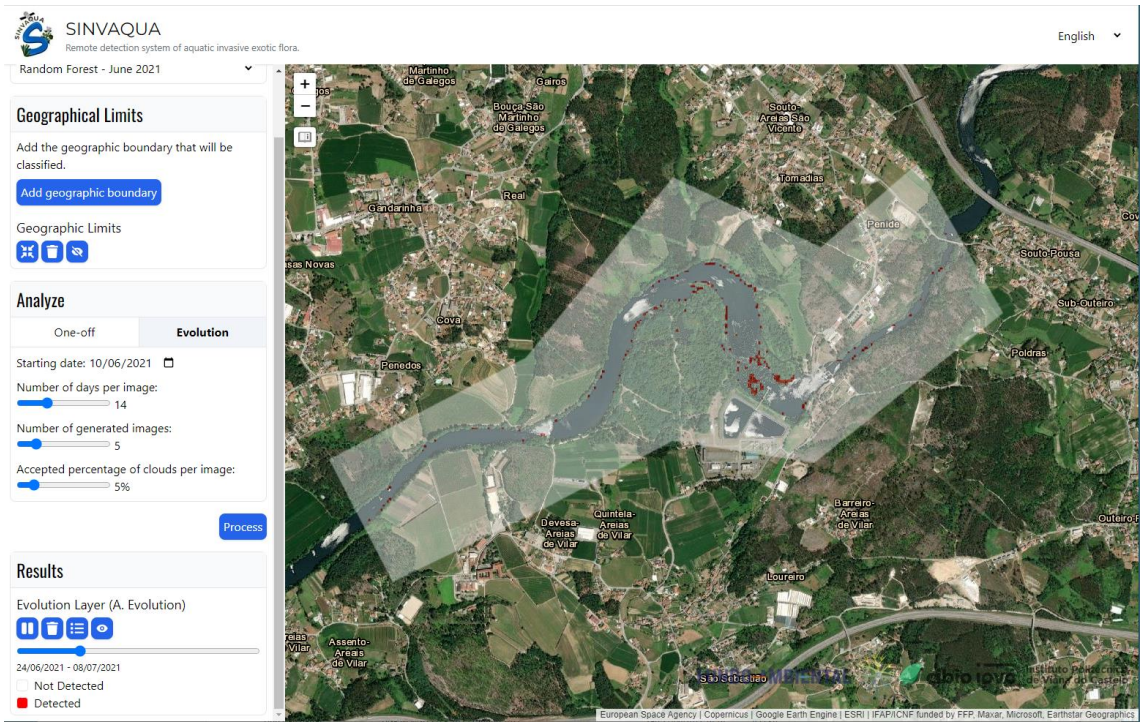

Figure 11 - Animation showing the predicted presence/absence of the target invasive species

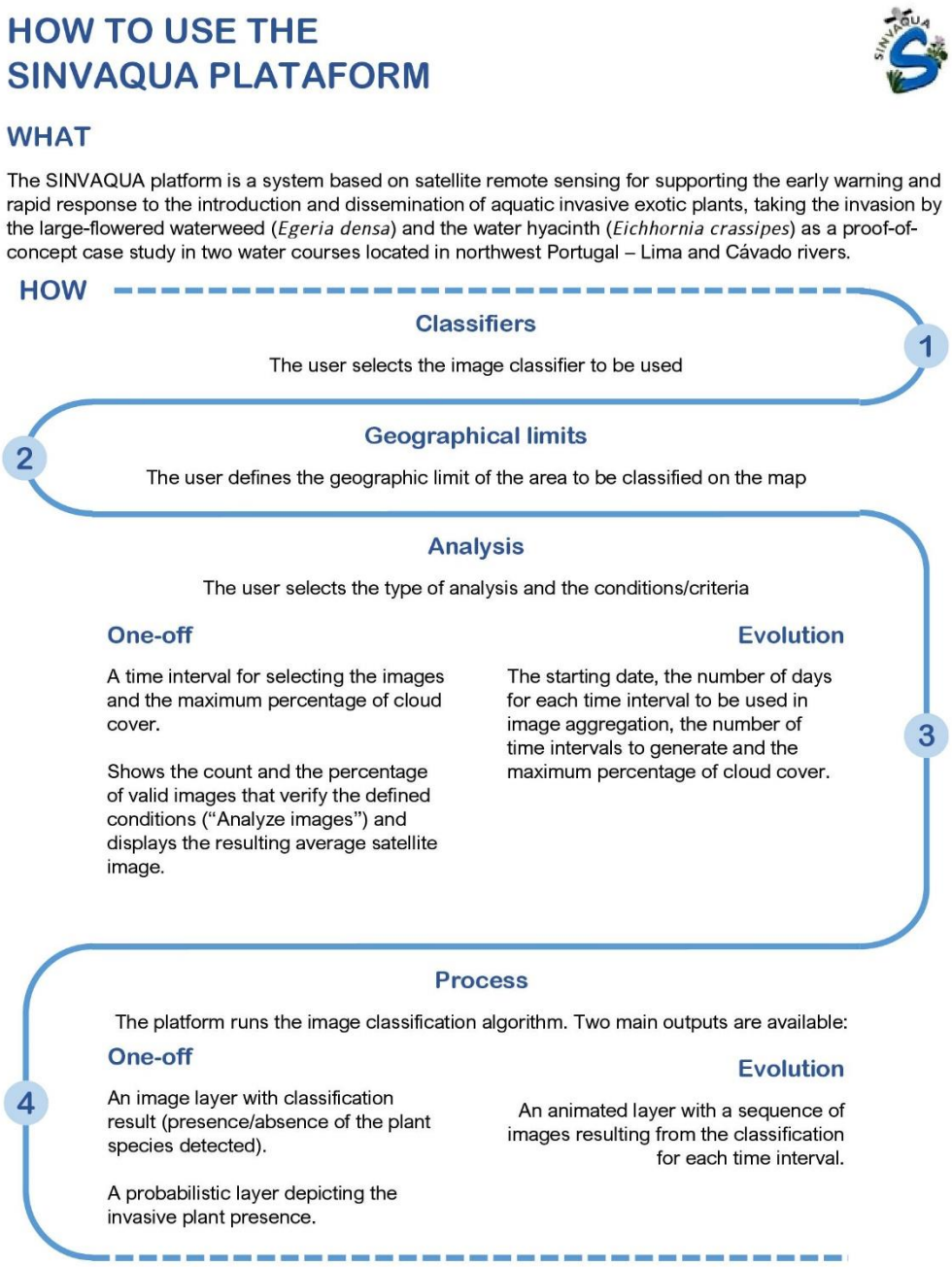

Figure 12 - Graphical representation of the steps required to perform the classification procedure