



THE PROCESS OF MAPPING OF THE POSIDONIA SEAGRASS IN THE CHOSEN AREA OF INTEREST

PROCESS SUMMARY, RESULTS AND DELIVERABLES

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1. INTRODUCTION

The process of detection of Posidonia Seagrass i.a. consists of searching and downloading the most suitable satellite imagery, while taking into consideration the weather conditions (mostly the cloud coverage and the wind speed parameters), processing of the input data, training of the classification model and the scene classification. This document describes the required input information, processing parameters, results of each computation step, as well as the deliverables. The whole computation process of the Seagrass detection is performed with Python, and it starts with the connection to the Open Source Geospatial Foundation (OSGeo), which allows the usage of native algorithms of Quantum Geographical Information Systems (QGIS) application (to be replaced in the future by independent python packages). Next, various libraries are imported to perform calculations on the raster and vector datasets. Afterwards connections with the weather API (for the weather data information) and Planet.com APIs (for the imagery download) are established. Once the most optimal image is obtained it is then processed, for example, by removing the clouds, land, deep-water areas, and correcting it for the water column effects. For the classification, a classification model is trained (using the sklearn library) and applied to the satellite image (which has been combined with the bathymetric map). This outcome results in detection of regions where the seagrass occurs and where it does not.

2. DEFINITION OF THE STUDY AREA AND INPUT PARAMETERS

2.1. Selection of the area of analysis.

This example Area of Interest (AOI), chosen for this analysis, titled "Formentera AOI", is located around Formentera Island, the smallest of the Balearic Islands (see Figure 1). The initial study area consists of 143.28km², nevertheless it will continue to be reduced during the application of various data masks and further processing. The Mediterranean Sea area, which connects Formentera with another island - Ibiza, located only 19km away, was divided by drawing a latitude line at 38° 48'30'' N. While setting the extent of the AOI, the bathymetry layer is considered, which is another input of the analysis. The maximum depth within the AOI oscillates between -37 and -40m, while the depth range around Formentera, based on the available bathymetry isoline map (obtained from the Ministry for the Ecological Transition and the Demographic Challenge – MITECO in KMZ format), varies from 0 to -87m. The coordinate system of this region is: EPSG: 32631 - WGS 84 / UTM zone 31N.

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Figure 1. Location of the Area of Interest - Formentera AOI (marked in yellow) and the available bathymetric data with the depth values ranging from -1 to -87m.

2.2. Selection of the satellite imagery.

The first step of the satellite imagery selection is to verify the weather conditions during the time frame of the analysis. Connecting via API with one of the climatic stations, located within the AOI, allows the obtainment of the most optimal cloud coverage and wind speed information during a day, which then determines the imagery's acquisition date. In this study we analyse the June 23rd, 2021, with approximately 3% of cloud coverage and 9.25km/h windspeed (Stomrglass.io, 2021). The Planet.com account enables the selection of the most suitable satellite imagery datasets, by connecting to the Planet APIs: Data API and Orders API. The satellite image dataset consists of the satellite image (TIF format), usable data mask layer (udm - TIF format) and the image metadata (XML/JSON formats), and is selected by scenes (portions of the footage recorded by a satellite image scanner) within the specified time frame (Planet, 2023). For this specific area it was necessary to choose 2 scenes to cover the entire Formentera AOI. Using a series of filters we determined the best possible imagery, to get the cleanest results. What is more, the filters allow specification of the acquisition time frame, the cloud coverage of the scene, and finally the AOI coordinates (to which the image scene and the udm layer are clipped before the download). The satellite imagery data set is presented in Figure B1, Appendix B. Please note that the meta data file that comes with the imagery dataset describes the scene and not the AOI. For example, if a 10% cloud coverage is

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specified during the filtration process, it is the cloud coverage of the whole scene, and not the exact coverage of the AOI (the coverage for the AOI will be calculated later in the analysis).

Additionally, Planet.com allows the choice between 4 and 8 band images, scaled to the surface reflectance or the top of atmosphere radiance (which then determine the further processing steps). For this analysis we chose the 8-band, surface reflectance image, with the atmospheric corrections already applied to account for scattering and absorption effects from the atmosphere. The two scenes are described below (Table 1):

Table 1. Specification of the acquired satellite imagery.

Scene ID	Scene Cloud/Cloud Shadow Coverage [%]	Windspeed [km/h]
20210623_095129_05_2420_3B_AnalyticMS_SR_8b	1.00	9.49
20210623_095131_36_2420_3B_AnalyticMS_SR_8b	6.00	9.49

These two PlanetScope Ortho Analytic 8B SR imageries, acquired on the June 23rd, 2021, have resolution of 3m.

3. BATHYMETRY PROCESSING:

The bathymetric information is crucial for this analysis because of two reasons. Firstly, the zones with lower detection accuracy (which are the regions with depths below 35m) should be discarded from the classification process. Secondly, we need the depth information for each pixel of the satellite image, to correct the image for the water column effects (more information about the water column correction is to be found in chapter 5).

3.1. Conversion of the isolines to points

The first objective of this part of processing is to create a bathymetric raster map, with depth values assigned to each pixel. For that a set of points is generated, the points are allocated 1m from each other (the total count of points is 804194 within the Formentera AOI) along the depth isolines. Each point is assigned the value of depth of the isoline. The result of this conversion makes an input for the Multilevel B-Spline Interpolation.

3.2. Multilevel B-Spline Interpolation

The Multilevel B-spline algorithm for spatial interpolation, proposed by Lee, Wolberg and Shin (1997) is a function of SAGA-GIS Tool. It uses a coarse-to-fine hierarchy of control lattices and creates a sequence of bicubic B-spline functions, with a point layer as described above, as input. The result of this interpolation is presented in Figure A1, Appendix A.

3.3. Extraction of desirable depth areas

The second objective of the bathymetry layer processing is the extraction of the “optimal” depth areas, to create a deep-water mask. This “optimal” factor is specific to each AOI and depends, for example, on the clarity of water. For the conditions in the Mediterranean Sea, zones deeper than 35m will interfere with the analysis, hence they will be eliminated with a

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deep-water mask. In Formentera AOI, the interpolated depth values vary from -0.15 to -57.7m, with the medium value being -22.35m. Figure 2 presents the created deep-water mask (marked in blue), which consist of 119.03km² of usable areas, with depth values between -0.15 and -35m, as well as the discarded deep-water regions (marked in red), constituting to 24.25km² of unusable areas.

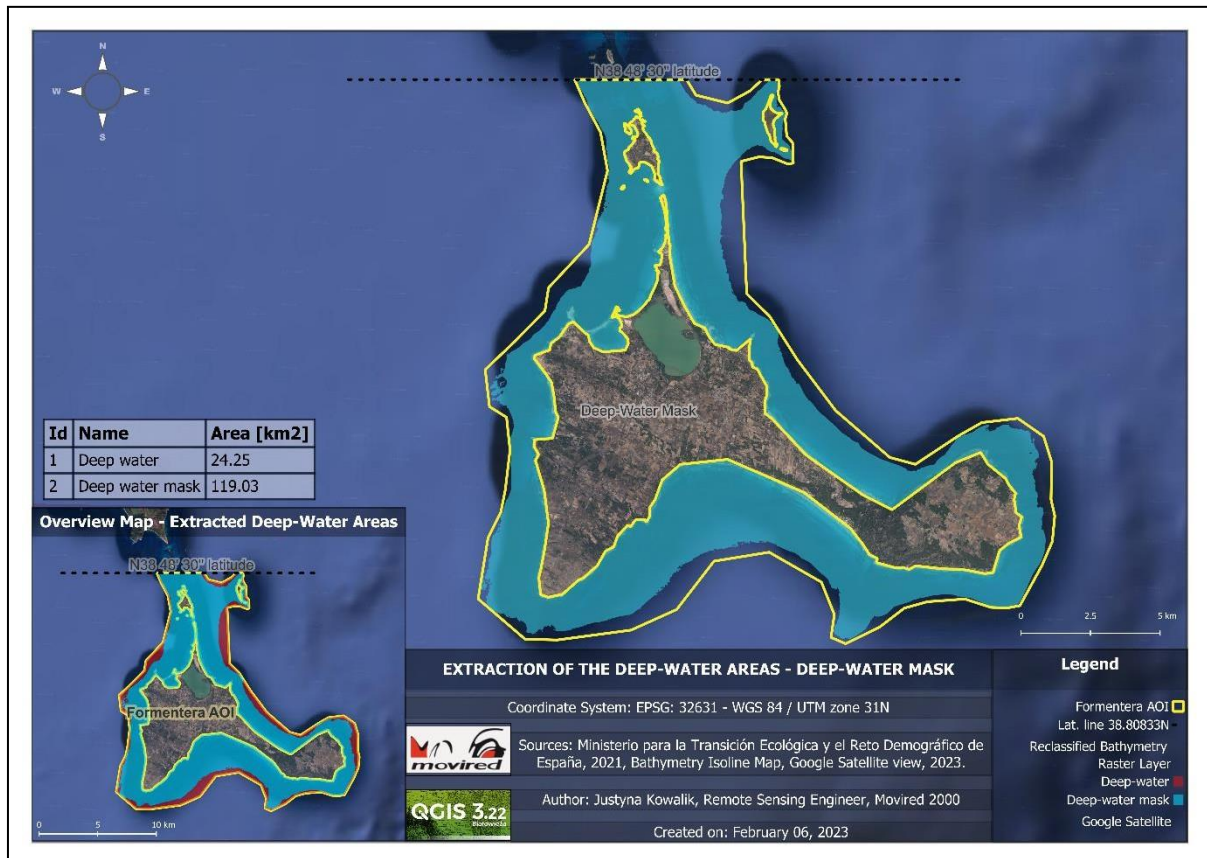


Figure 2. Extraction of the deep-water areas (marked in red, covering 24.24km²). The deep-water mask (light blue) consists of the usable areas, between -0.15 and -35m. It consists to approximately 119.07km² of the AOI.

4. IMAGE PREPROCESSING:

4.1. Evaluation of the usable data mask layer

The usable data mask layer, included in the imagery dataset, provided the information about clouds, cloud shadows, snow, haze etc. within the scene. This raster layer also consists of 8 bands: B1 indicates the clear, usable area, B2 shows the snow, B3 indicates the cloud shadows, Bands 4 and 5 present the light and heavy haze, B6 estimates the cloud areas, B7 includes the confidence raster (with a scale from 0 to 100%) of the aforementioned effects and B8 estimates the unusable areas. Within Formentera AOI there are a few clouds in the southern part of the island (visible in Figure 3), hence the satellite imagery needs to be masked to eliminate those affected zones.

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4.2. Masking of the satellite imagery

4.2.1. Deep water masking

The masking of the satellite imagery begins with the application of the created before deep-water mask, which results in elimination of the zones deeper than 35m, covering approximately 24.25km² of the AOI. The masked satellite image, as well as the deep-water mask are presented in Figure 3.

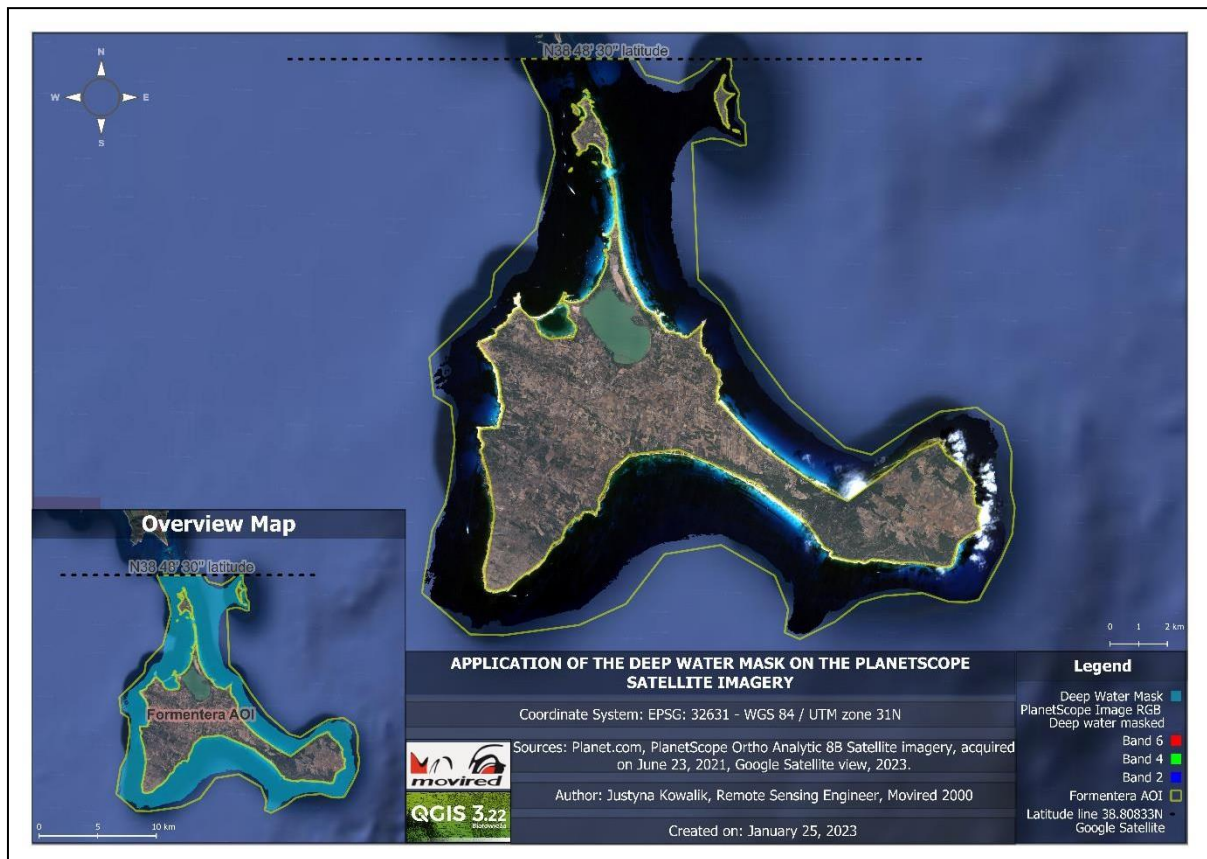


Figure 3. Application of the deep-water mask (marked in light blue) on the PlanetScope Satellite Imagery.

4.2.2. Cloud Masking

Once the satellite image is masked for the deep-water interference zones, it is ready for the cloud removal. The 3 most relevant bands of the udm raster layer were compared in Figure 4. The first image on the map (left, upper corner) shows the satellite image, the second represents the unusable areas, affected by clouds, cloud shadows, snow, haze, and others (Band 1). The cloud shadows (from the Band 3) are presented in the third image (left, lower corner) and the clouds (Band 6) are on the fourth image. All the interference areas are marked in white. Nevertheless, during the analysis of these bands we noticed that some of the clouds were not detected, and some of the seagrass areas were wrongly classified as cloud shadows. Therefore, for the final cloud masking process, we used only the information from the Band 6 (presenting the cloud extent, excluding the cloud shadows), so that we minimize the masking of seagrass zones.

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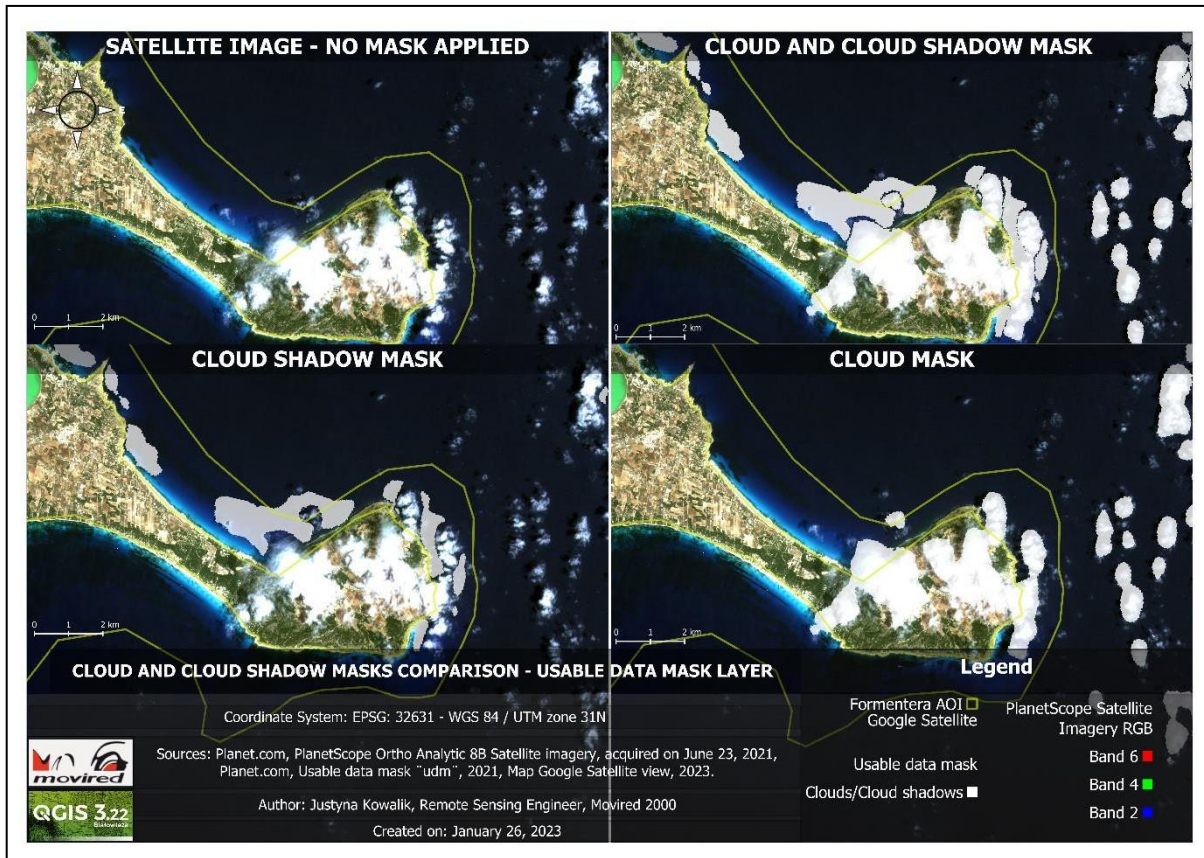


Figure 4. Comparison of the clouds and cloud shadows masks, extracted from the usable data mask layer provided by Planet.com. The masks marked in white are the areas affected by the clouds and cloud shadows.

The few clouds present in the south-eastern part of the island constitute to an area of 3.96km^2 , which makes 2.76% of the current AOI. The result of the application of cloud mask is showed in Figure 5. The resulting study area consists now of approximately 115.07km^2 .

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Figure 5. Extraction of the cloud areas (marked in white in the overview map) and the cloud masking of the PlanetScope Satellite image. The cloud areas are clipped out from the image.

4.2.3. Calculation of the Normalised Difference Built-Up Index

Deep-water areas and clouds are not the only signals, which could interfere with the detection process. Such signals also come from objects on the land, as well as the ships and ship wakes. Spectral Indices are mathematical equations applied to the spectral bands of the satellite imagery to enhance the visibility of certain spectral features (GIS and Earth Observation University, 2023). In our study we analysed a few of the Spectral Indices and chose The Normalised Difference Built-Up Index (NDBI), which selection is appropriate for the detection of the land, urbanized areas, ships etc. It is calculated using 2 of the satellite imagery's bands: Coastal Blue I (B1, 431-452nm) and Red: (B6, 650 - 680nm). The values of the calculated NDBI usually oscillate between -1 and 1, depending on the analysed zone. Negative values indicate the built-up, artificial areas, while the positive values represent water or water containing surfaces. The calculated NDBI raster image is presented in Figure 6, its values range from -0.582173 to 0.828839.

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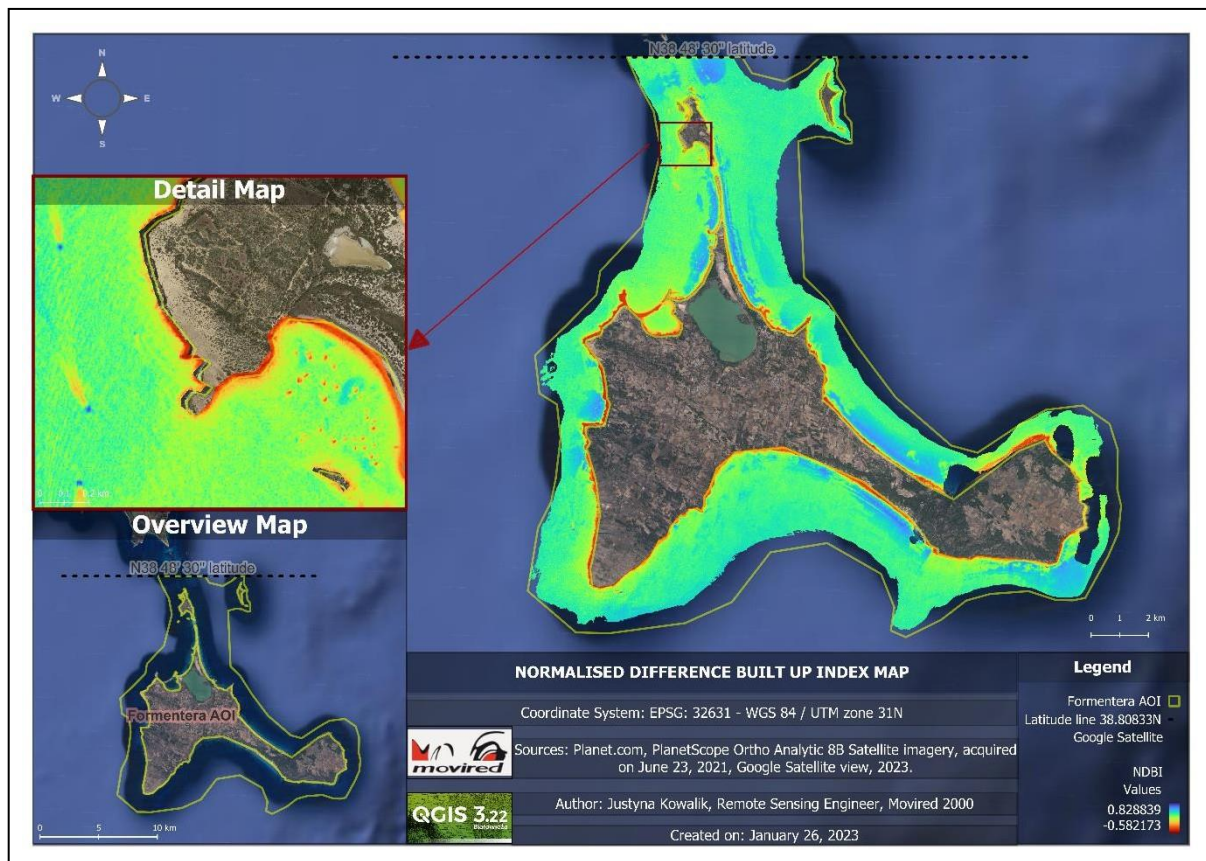


Figure 6. Calculated Normalised Difference Built-Up Index. Min. value (-0.582173), in red indicates the built-up zones and ships, while the max. value (0.828839), in blue, marks water surfaces.

4.2.4. Land masking

The calculation of the NDBI raster image allowed an accurate detection of the land as well as the adrift (floating) ships, but it did not indicate well the moving ships, but only their wakes. The raster layer is then reclassified by a threshold of -0.05 (see Figure 7), so that all the values below the threshold represent interference areas, and the values above it, are assigned as usable zones. The outcome, which we named as "land mask", is then simplified with majority filter, so that the single, outlier pixels can be removed. The affected area of 6.75km² is discarded from analysis, leaving 108.32km² of usable water zones (see Figure 8). All of the raster images containing the calculated masks are available in TIFF format and are compared in Figure C1, Appendix C.

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Figure 7. Result of the reclassification of the calculated Normalised Difference Built-Up Index. The unusable areas are marked in red, while the usable, water areas are marked in green.

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Figure 8. Result of the application of the land mask (marked in blue) on the PlanetScope Satellite Image. The land, ships and ship wakes are clipped out from the satellite image.

5. WATER COLUMN CORRECTION

The water column effects play an important role in mapping of submerged areas. Extracting information from the optical remote sensing is hindered by depth, especially in the zones below 10-15m deep (Lyzenga D., 1978). To improve the accuracy of the mapping, these effects can be minimized by decorrelating the satellite image bands from depth, therefor obtaining an image not affected by the water column. For this purpose, a few algorithms have been studied with the final application of the most widely used one, known as Lyzenga's method (Lyzenga D., 1978).

5.1. Extraction of the deep-water values

To apply the Lyzenga's method it is necessary to first extract the reflectance signal of water, no longer affected by the sea bottom features. For this purpose, we define a small deep-water zone (of 0.54km²), located next to the Formentera AOI, characterized by depths below -40m (see Figure 9). Further, we calculate the mean reflectance values for each band of the satellite image, within the deep-water polygon.

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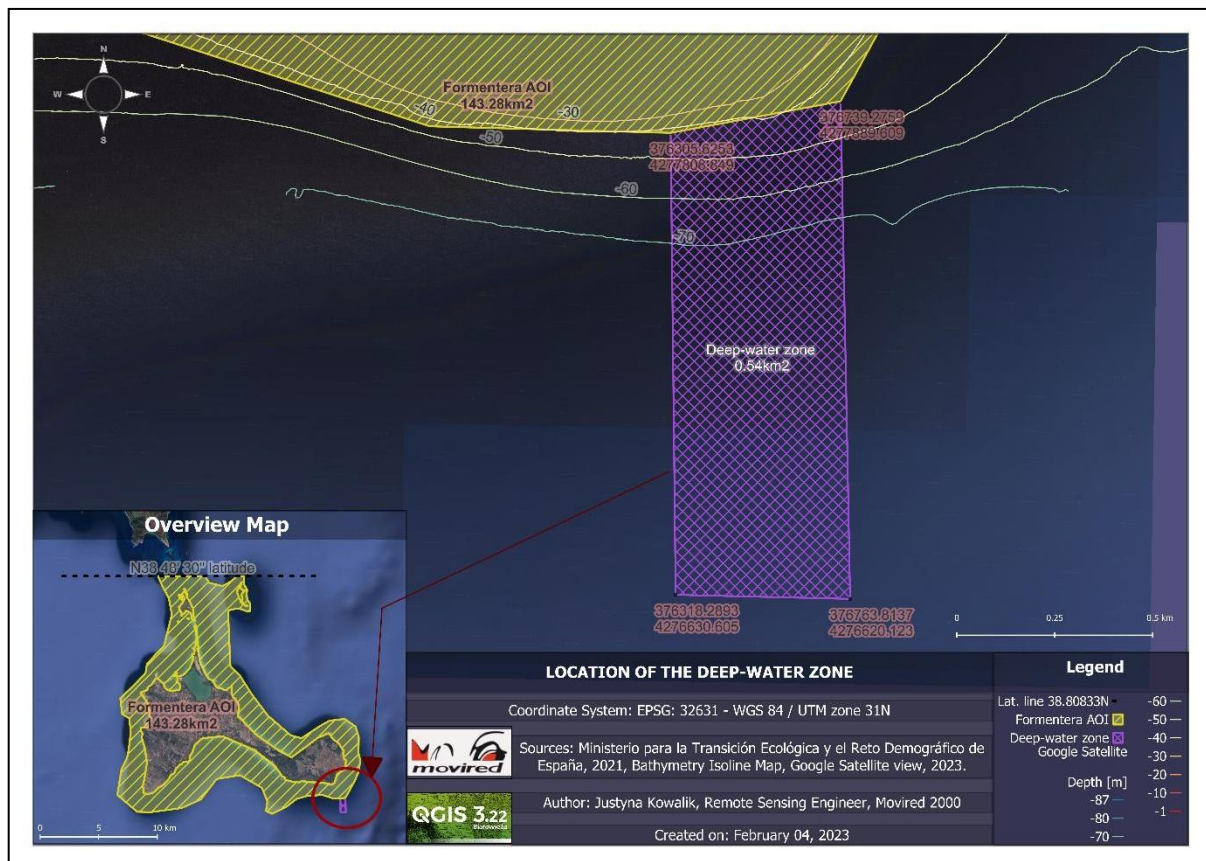


Figure 9. Location of the deep-water zone. The deep-water area (marked in purple) covers around 0.54km².

5.2. Creation of the depth invariant image

The computation of the depth invariant image is performed in python and is based on the recreated script of Teo Nguyen (Nguyen T.,2021). The script was adapted to our AOI conditions, nevertheless it uses the Lyzenga's algorithms (Lyzenga D., 1978) presented in Figure 10. To start the water column correction, the 8 satellite image bands are split, converted into arrays, and logarithmically transformed (while subtracting the deep-water values), like in the equation 7. Next, the regression line is calculated (equation B1), using the logarithmically transformed reflectance values and the bathymetry map as parameters. After that, the matrix of the coordinate system rotation parameters is calculated (equations B5-B7), and each band is rotated in order to obtain a depth invariant image (equation 8). The example of the first band of the satellite image, compared with the result of the water column correction can be observed in Figure 10. It appears as if the water layer had been removed, so that in result the same objects show similar reflectance, even though located at different depths. The water column correction has not been applied to the whole Formentera AOI yet, hence this analysis presents the results of Posidonia detection based on the uncorrected (for water column effects) imagery.

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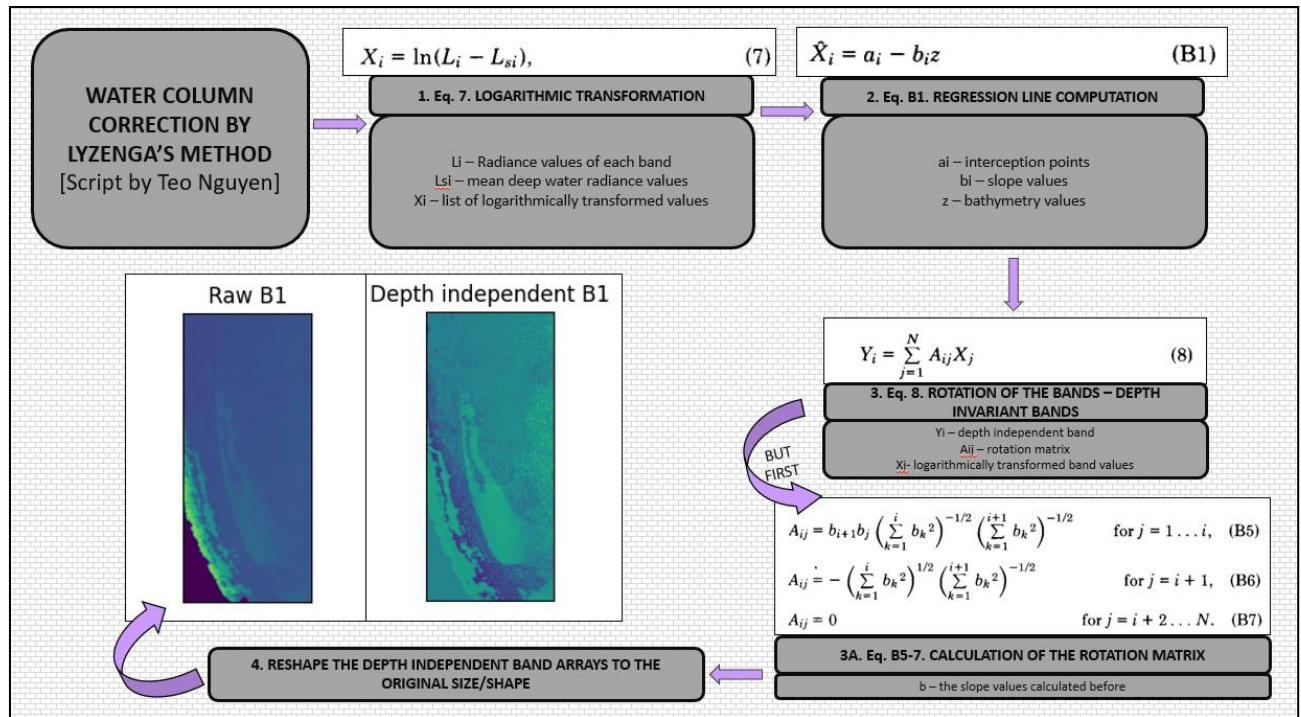


Figure 10. Application of the Lyzenga's method of water column correction of the satellite image.

6. CLASSIFICATION OF THE SATELLITE IMAGERY

6.1. Classification

The Random Forest (RF) Classification Model was trained to detect areas where the Posidonia seagrass occurs and other zones where it does not occur. The RF is one of the most common supervised learning algorithms (Pedregosa et al., 2011), and in our study resulted in the highest prediction accuracy among various classification models (i.e., Gaussian Mixture Model or Support Vector Machines). The RF classifier was previously trained, using the Sklearn library in python, to map areas assigned in two different classes: "Posidonia" and "No Posidonia". Each pixel of the satellite image, depending on the class it is classified to, is assigned a specified value; 1 for Posidonia and 2 for No Posidonia. The trained this way model is applied to the deep-water, cloud and land masked satellite image and it results in a raster image with predicted Posidonia and No Posidonia areas within the AOI. The confusion matrix, calculated after training the model indicated the overall detection accuracy of 80.4% (see Figure 11). The final. The Random Forest Model was able to detect 69.67km² of areas occupied by the seagrass and 38.77km² of other areas, as presented in Figure 12.

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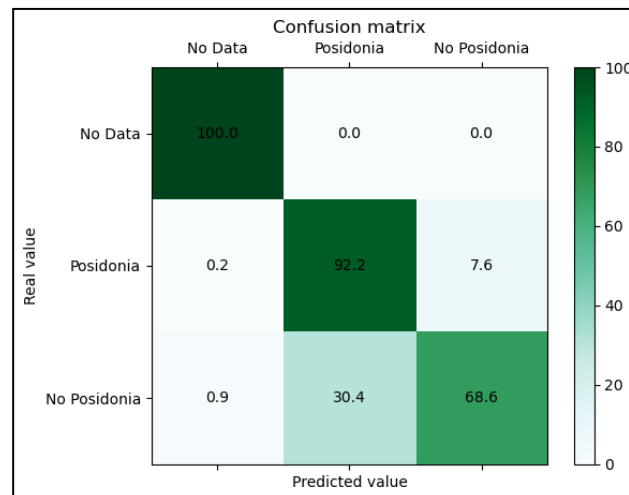


Figure 11. Confusion Matrix of the trained Random Forest Model. It presents the accuracy (in %) of the predicted areas of "Posidonia" and "No Posidonia", as well as the "No Data" zones.

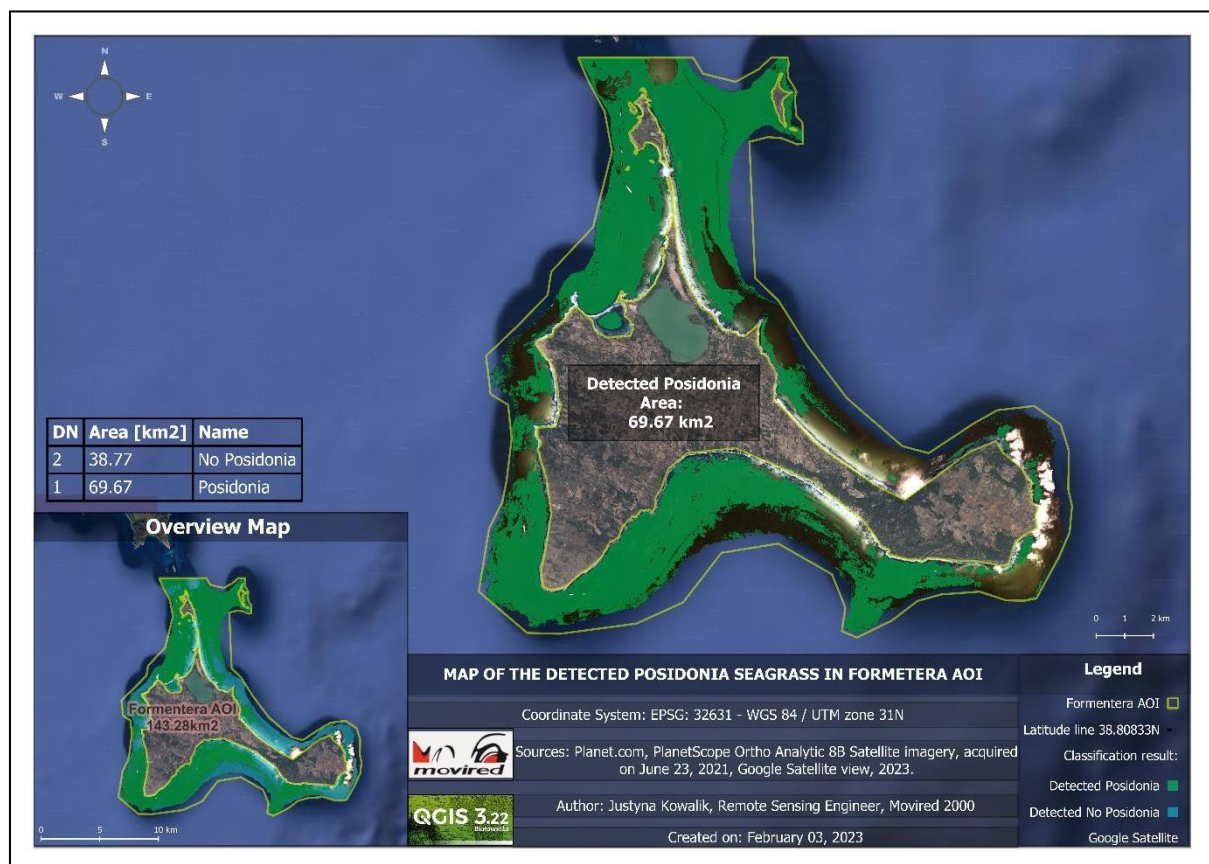


Figure 12. Result of the satellite imagery classification using previously trained Random Forest Classification Model. The green areas (69.67km²) indicate the presence of Posidonia, while the light blue areas (38.77km²) indicate the absence of Posidonia.

7. CALCULATION OF THE MODEL'S ACCURACY

Should the exact precision of the classification be of the client's interest, we calculate the accuracy of the performed mapping analysis by determining the minimum number of

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validation points, with their coordinates located within the AOI. The further step is based on the client's "in situ" evaluation of the area, providing back the information of the presence or absence of Posidonia, within the suggested coordinates.

7.1. Confusion Matrix

The pixels of the raster image are converted to a point layer. Each point contains the classified by the model value, which indicates the occurrence and the absence of Posidonia. This information is then contrasted with the "in situ" measurements and the confusion matrix parameters (TP/TN/FP/FN) are calculated. In the final step the real prediction accuracy, measured as the F1 Score is estimated.

8. CONCLUSION AND DISCUSSION OF THE RESULTS

We attempted to calculate the accuracy of Posidonia detection at various steps of analysis. Firstly, after training the model on a subset of data (10% of the whole Formentera AOI) we computed the confusion matrix of that classified subset. It indicated the overall prediction accuracy of 80.4%. Next, after the application of the RF classification model on the whole AOI, we computed the zonal analysis, dividing the AOI into 3 depth zones: 0 to -15m, -15 to -25m and -25 to -35m and comparing the classified satellite image with the ground truth data of Posidonia, obtained from Oceansnell (OCEANSNELL, 2021). The resulting confusion matrix is presented in Figure 13. It indicates that the best overall classification accuracy (around 92%) was estimated in the 2nd zone: between -15 to -25m, while the result for 1st zone was accurate in 87% and in the 3rd zone in 86%.

The lower precision in the zones 1 and 3 could be caused by various factors. First of all, the nearshore areas are affected by the ships and ship wakes, and while the land mask was able to detect the majority of those affected areas, the calculation of the NDBI Index (which was made use of in the land masking process) could be optimised in the future. Another experience issue was the usable data mask provided by Planet.com. Its accuracy is not of 100% therefore some of the clouds and cloud shadows were not delineated and some of the areas covered by the Seagrass were wrongly detected as cloud shadows. The solution could be a new cloud detecting algorithm, developed by Movired, nevertheless a more thorough analysis needs to be conducted. Last, but not least, this example analysis is performed on the satellite image acquired in 2021. The validation data (cartography of Posidonia) was collected in limited areas, which means that the south and south-east regions of Formentera AOI were not included in the resulting confusion matrix.

In order to know the exact precision of the seagrass detection, as mentioned in chapter 7, we will generate a set of points and provide their coordinates, so that the information of Posidonia occurrence can be collected "in situ" (see Table 3, Appendix H).

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Zones	2021	TP	FN	FP	TN	Precision	Recall	Specificity	F1 Score		Legend
-25m to -35m	Z1	1745093	249214	322798	836191	0.8439	0.875037	0.721483	0.859187		The lowest overall classification accuracy
-15m to -25m	Z2	1988345	92918	246532	347041	0.889689	0.955355	0.584664	0.921353		The medium overall classification accuracy
0m to -15m	Z3	1887516	88939	393185	774946	0.827603	0.955001	0.663407	0.889097		The best overall classification accuracy
OVERALL										0.889097	

Figure 13. Calculation of the zonal confusion matrix of the classified satellite image compared with the validation data of Posidonia.

9. LIMITATIONS

The time and effectiveness of Posidonia detection also depends on other factors:

9.1. The size and complicity of the Area of Interest

The computation time of the analysis depends to a large extent on the size of the AOI. It not only increases the required computation time and power but also impacts the number of downloaded satellite images, which need to meet required conditions as well. The complicated AOI polygon must be simplified in order to use it in the Planet APIs during the filter applications.

9.2. The time frame of the desired analysis

It is possible that the desired time frame of the study is not suitable, and no satellite images (optimal for the analysis) can be found in the Planet.com database. In that case we will be looking for another date, close to the initial time frame.

9.3. The availability of the bathymetric data

As mentioned before, the bathymetric data is crucial for the Seagrass detection. If the client cannot meet this requirement, we will need to find an alternative, what can substantially increase the necessary analysis time.

9.4. The development of cloud detection algorithms

In case of development of our own cloud detection algorithms, which almost certainly would improve the overall detection accuracy, we will need to extend the computation time by minimum a month. That is if the satellite imagery requires cloud masking and cloud free image is not available.

10. DELIVERABLE RESULTS

10.1. Bathymetry Map

APPENDIX A.

- Interpolated Bathymetry Map in a GeoTIFF format. See

10.2. Satellite Imagery data set

APPENDIX B

10.2.1. Original 8 Band Satellite Image

- PlanetScope Ortho Analytic 8B SR Product in GeoTIFF format.
- Usable and Unusable Data Mask related to the product in GeoTIFF format.
- Metadata file of the obtained imagery in XML format.

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10.2.2. Masked 8 Band Satellite Image

- Satellite image masked for the interference (land, ships, deep water) zones in GeoTIFF format.

10.2.3. Corrected Satellite Image

- Satellite image corrected for the water column effects in GeoTIFF format*

*water column correction yet to be performed

10.3. Masking Layers

APPENDIX C

- Vector layers of unusable zones within the specified AOI in SHP format. The data set contains the deep-water areas, clouds, and land zones.

10.4. Deep Water Extent

APPENDIX D

- Vector layer of the deep-water extent, used for the water column correction process, in SHP format.

10.5. Classification Raster

APPENDIX E

- Raster layer, resulted from the application of the model, containing the classes (Posidonia, no Posidonia) in GeoTIFF format.

10.6. Vector Map of Posidonia

APPENDIX F

- Polygon layer containing the extent of Posidonia within the specified AOI in SHP format.

10.7. Parameters Specification

APPENDIX G

- Table containing all the parameters, specific to the current AOI (e.g., coordinates, calculated masked areas, depth values, bands reflectance values) in CSV format.

10.8. Validation Parameters

APPENDIX H

- Table containing the coordinates of the validation points*

*to be added in the next phase of the project.

- Confusion matrix & F1 Score in CSV format *.

*to be calculated after providing the information of the validation points.

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V. APPENDICES

APPENDIX A. BATHYMETRY MAP

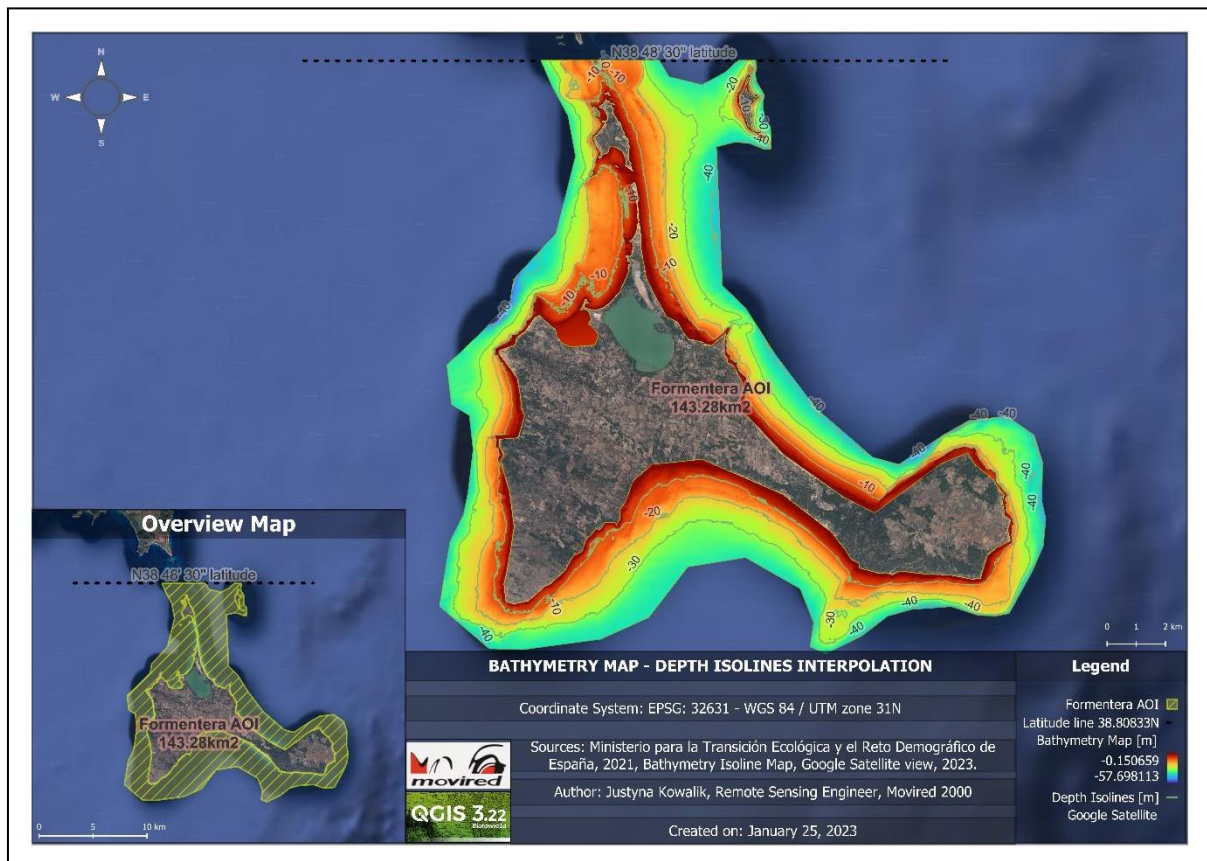


Figure A 1. Result of the Multilevel B-Spline interpolation of bathymetry isolines in the Formentera AOI. The depth values range from -0.15 to -57.7m.

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APPENDIX B. SATELLITE IMAGERY DATASET

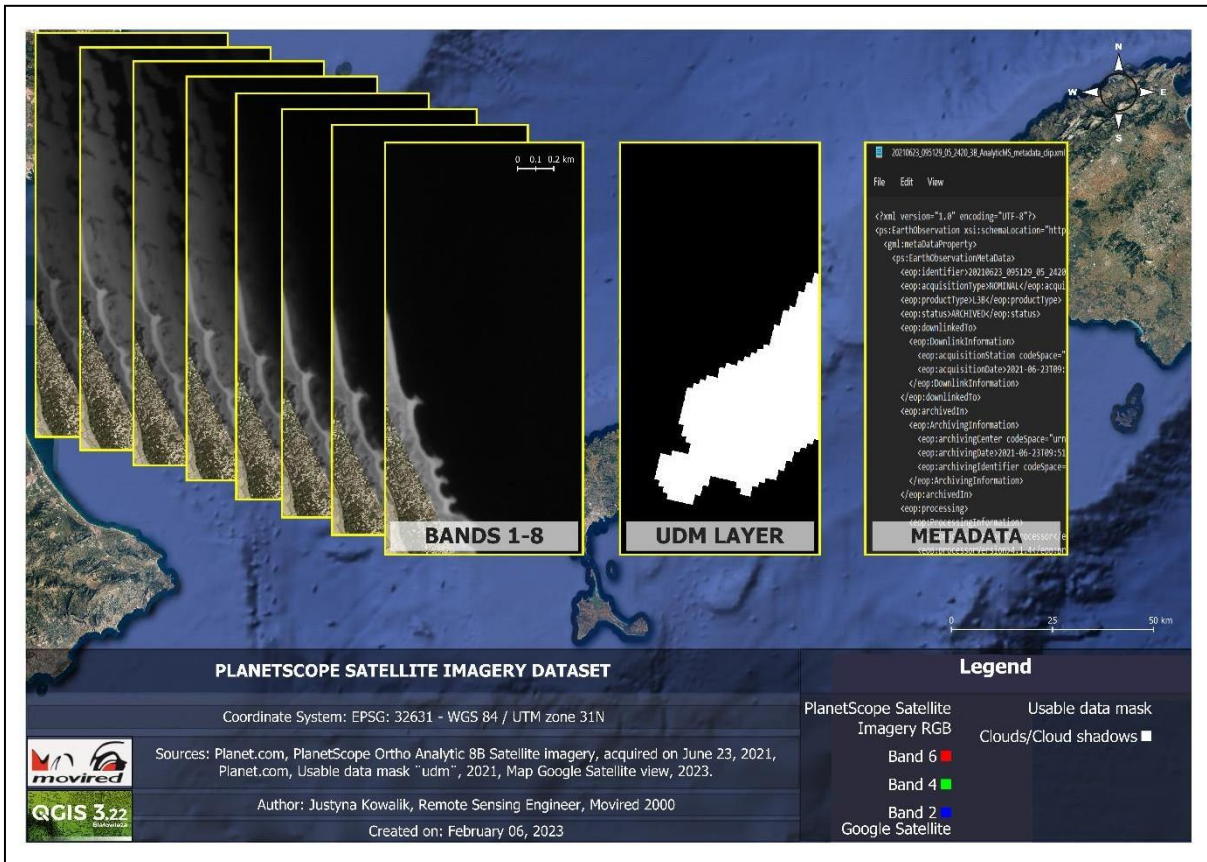


Figure B 1. PlanetScope Satellite Imagery Dataset. It consists of the 8-band satellite image, usable data mask and the metadata of the scene covering the selected AOI.

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Figure B 2. PlanetScope Satellite Image masked for the interference areas. Prepared like this image is ready for the application of the classification model.

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APPENDIX C. MASKING DATA LAYERS

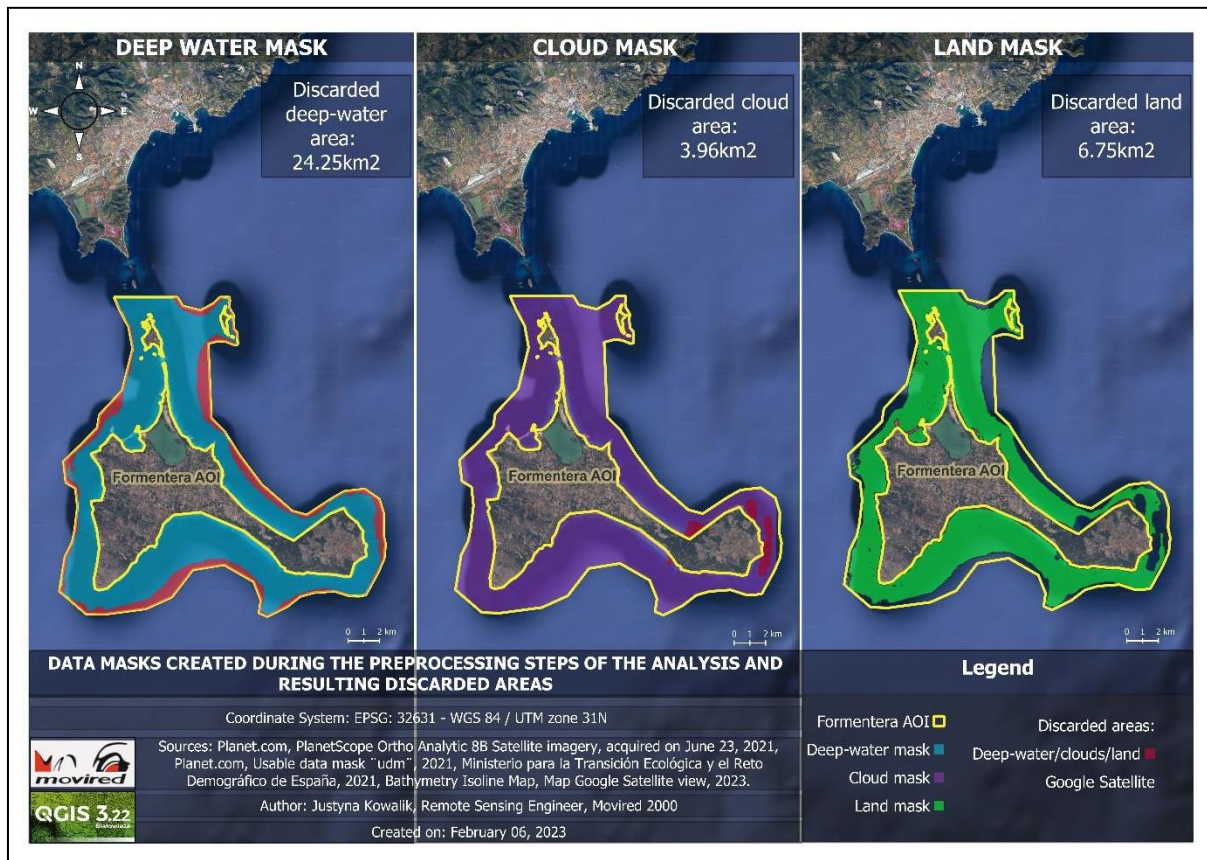


Figure C 1. Comparison of the data masks used in the pre-processing steps of the analysis. The deep-water mask, marked in light blue allowed elimination of the 24.25km² of the interference areas, the cloud mask (in purple) eliminated 3.96km² of cloud covered zones and the land mask (in green) allowed delineation of the 6.75km² of the land and ship/ship wakes zones.

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APPENDIX D. DEEP- WATER EXTENT

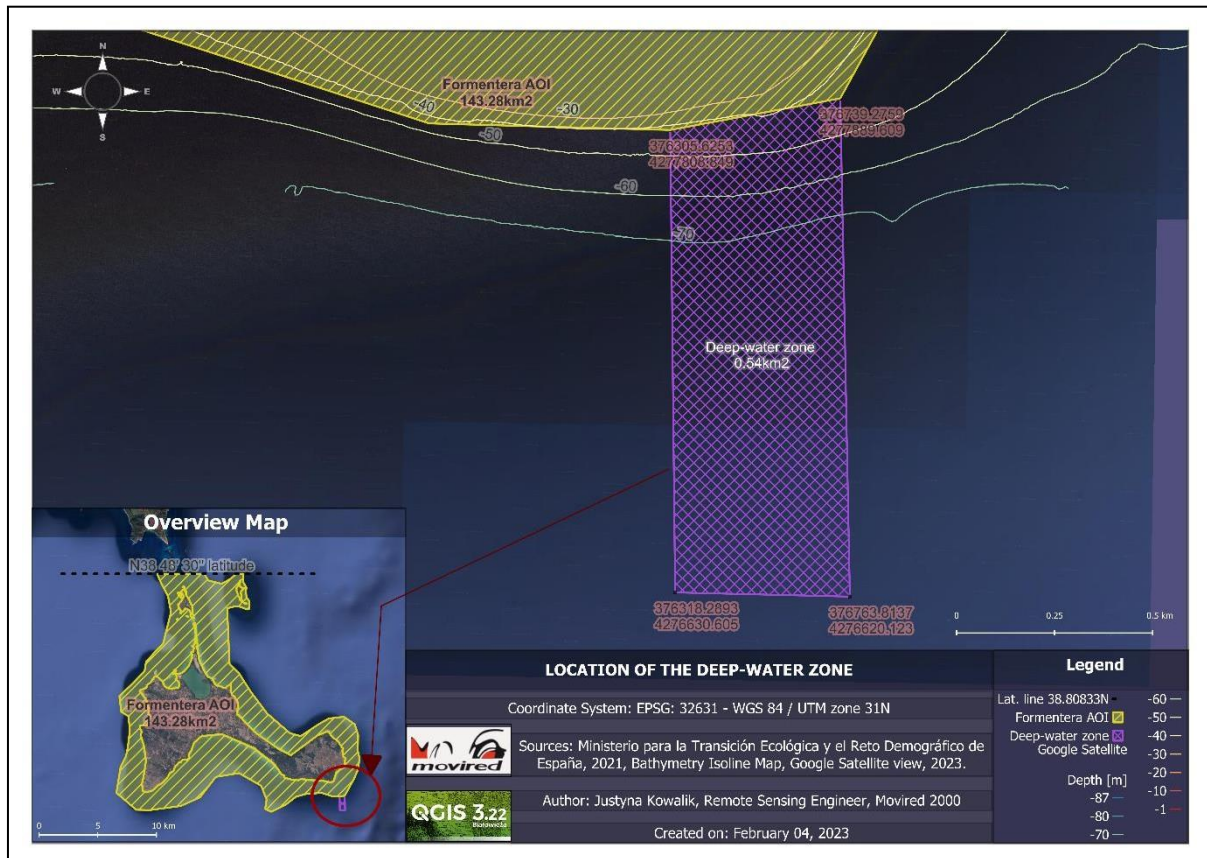


Figure D 1. Deep-water polygon, covering an area of 0.54km² outside of the Formentera AOI.

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APPENDIX E. CLASSIFICATION RASTER LAYER



Figure E 1. Resulting raster image from the application of the RF classification model on the PlanetScope Satellite Image.

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APPENDIX F. VECTOR LAYER OF THE DETECTED POSIDONIA



Figure F 1. Vector layer with the detected Posidonia extent is marked in green. The RF classification model predicted the occurrence of Posidonia covering approximately 69.67km².

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APPENDIX G. TECHNICAL SPECIFICATIONS

Table 2. Technical parameters of the analysis.

COORDINATE SYSTEM	EPSG: 32631 - WGS 84 / UTM zone 31N		
AOI COORDINATES	X		Y
Due to a high number of coordinate pairs (485) delineating the Formentera AOI, this information is included in the Delivery_File1.csv			
AOI AREA [km ²]	143.28		
SUBTRACTED (UNUSABLE) DEEP-WATER AREA [km ²]	24.25		
SUBTRACTED (UNUSABLE) CLOUD AREA [km ²]	3.96		
SUBTRACTED (UNUSABLE) LAND AREA [km ²]	6.75		
WATER AREA USED FOR THE MAPPING [km ²]	108.32		
DEPTH EXTENT WITHIN AOI [m]	MIN.	MAX.	MEAN
	-0.15	-57.7	-22.35
DEEP WATER ZONE COORDINATES	X		Y
0/0/0	376739.27590		4277889.60900
0/0/1	376763.81370		4276620.12300
0/0/2	376318.28930		4276630.60500
0/0/3	376305.62530		4277889.60900
0/0/4	376739.27590		4277889.60900
DEEP WATER ZONE AREA [km ²]	0.54		
SATELLITE IMAGERY ADCQUISITION DATA	DATE	CLOUD COVERAGE [%]	AVERAGE WIND SPEED [km/h]
	23/06/2021	5.4	9.49
SATELLITE IMAGERY REFLECTANCE VALUES (LAND MASKED IMAGE)	MIN.	MAX.	MEAN
B1 (Coastal Blue 431-452nm)	263	1477	385.6574645719353
B2 (Blue: 465-515nm)	303	1507	384.3673810838395
B3 (Green I: 513. - 549nm)	297	1473	388.2617577674045
B4 (Green: 547. - 583nm)	251	1674	354.2110458598939
B5 (Yellow: 600-620nm)	203	1621	292.7073399253794
B6 (Red: 650 - 680nm)	210	1521	279.7826632535261
B7 (Red-Edge: 697 - 713nm)	155	1495	267.2873395907578
B8 (NIR: 845 - 885nm)	141	1350	278.4067995114524
DEEP WATER VALUES	MIN.	MAX.	MEAN
B1 (Coastal Blue 431-452nm)	304	569	427.570908515353
B2 (Blue: 465-515nm)	295	493	373.925249647472
B3 (Green I: 513. - 549nm)	225	426	305.622722956056
B4 (Green: 547. - 583nm)	177	398	258.254237532015
B5 (Yellow: 600-620nm)	133	362	223.388313332758

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B6 (Red: 650 - 680nm)	147	353	219.886615442171
B7 (Red-Edge: 697 - 713nm)	66	358	195.133557800225
B8 (NIR: 845 - 885nm)	1	374	214.163745719301
CLASSIFIED POSIDONIA AREA [km ²]	POSIDONIA		NO POSIDONIA
	69.67		38.77

APPENDIX H. VALIDATION INFORMATION

Table 3. Validation points for the "In situ" data collection.

POINT ID	COORDINATES		RESULT [POSIDONIA (1), NO POSIDONIA (0)]
	X	Y	
1.			
2.			
3.			
4.			
5.			
6.			
7.			
8.			
9.			
10.			
11.			
12.			
13.			
14.			
15.			
16.			
17.			
18.			
19.			
20.			
21.			
22.			
23.			
24.			
25.			

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Table 4. Confusion Matrix Parameters.

CONFUSION MATRIX (IN SITU VS. MAPPED WITH THE SATELLITE IMAGERY)	
True Positive	
False Negative	
False Positive	
True Negative	
Precision	
Recall	
Specificity	
F1 Score	

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