JANUARY 7, 2023

OBJECT FEATURES FOR CLASSIFICATION

ASSIGNMENT OBJECT BASED IMAGE UNDERSTANDING

MARÍA PAULA RODRÍGUEZ NAVARRETE
MSC- CDE, ZGIS | UNIVERSITY OF SALZBURG

TABLE OF CONTENTS

OBJECTIVE 2
USED SOFTWARE 2
USED DATA 2
WORKFLOW AND OBSERVATIONS 2
Task 1: load the data in a new eCognition project 2
Task 2: perform a Chessboard Segmentation 3
Question: What becomes obvious when comparing the feature values obtained for 2 different objects of the Chessboard Segmentation? 4
Question: Which features do not make much sense in this case? 5
Task 3: perform a Multiresolution Segmentation 6
Question: How do the shape features (Area & Shape Index) behave now? 7
Question: Which segmentation provides more meaningful objects? 8
Task 3.1: find NDVI thresholds to distinguish between Water, Vegetation and non-Vegetation areas 8
Task 3.2: create and assign the Water, Vegetation and Boat classes 10
Task 3.3: create sub-classes of the class Vegetation to divide it in areas with high/low air quality 14
Task 4: perform again a Multiresolution Segmentation with a smaller Scale Parameter 17
Question: What is the meaning of the distance value when creating a feature? 19
CONCLUSIONS 21
REFERENCES 21

OBJECTIVE

Learn how to address specific object-features in eCognition for rule-based classification purposes.

USED SOFTWARE

- eCognition Developer Trial 9

USED DATA

- Quickbird image of Salzburg
- Air quality layer

WORKFLOW AND OBSERVATIONS

TASK 1: LOAD THE DATA IN A NEW ECOGNITION PROJECT

The **Quickbird image of Salzburg** was loaded in a new eCognition project by going to File→ New project→ Insert. Additionally, the **Air Quality dataset** was added as an additional image layer. To easily identify each of the layers, their aliases were changed based on the associated bands (Layer 1 = Blue, Layer 2 = Green, Layer 3 = Red, Layer 4 = NIR and Layer 5 = Air Quality Layer-AQ)

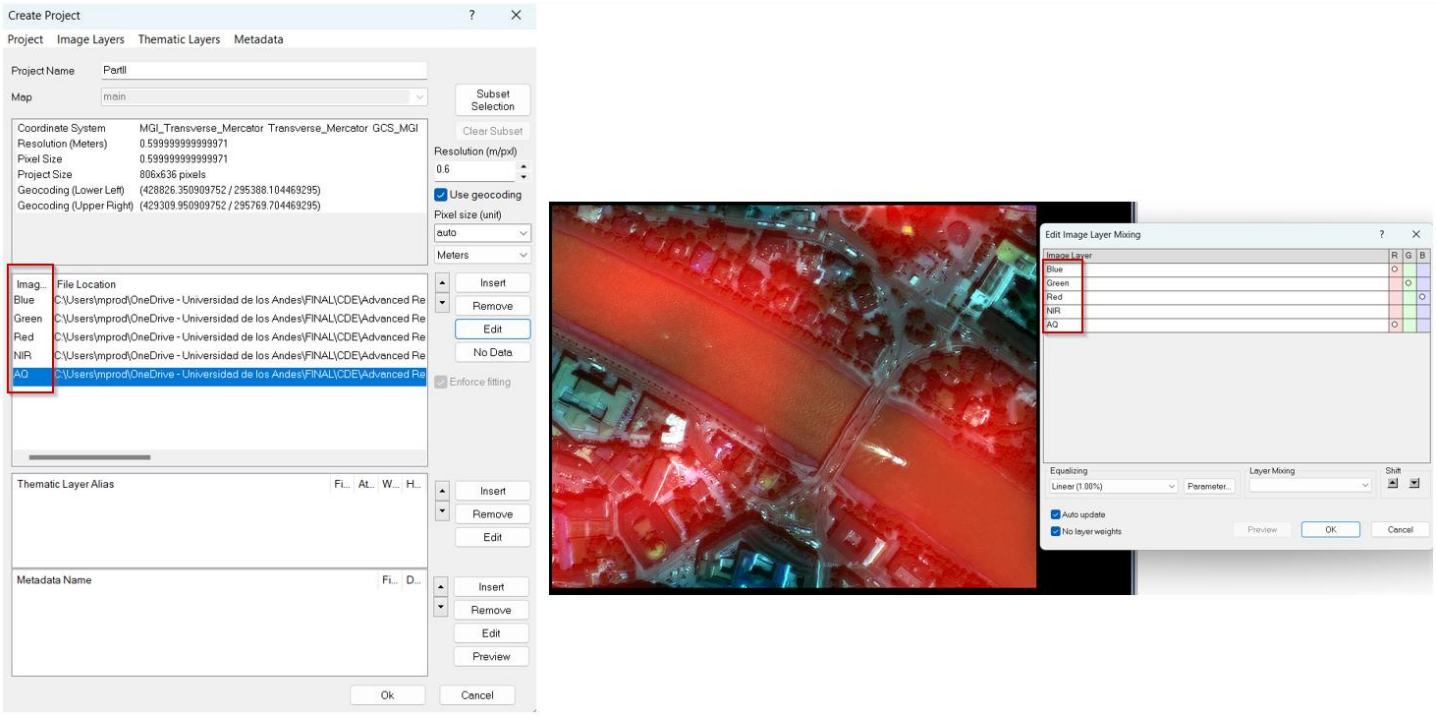


***Figure 1**. Add the data to the eCognition Project, select the appropriate aliases and visualize it on the Map View Window*

TASK 2: PERFORM A CHESSBOARD SEGMENTATION

In the Process Tree Window, selected the "Chessboard Segmentation" algorithm with an object size equal to **10**, which created a new level called **"l1_chessboard"**

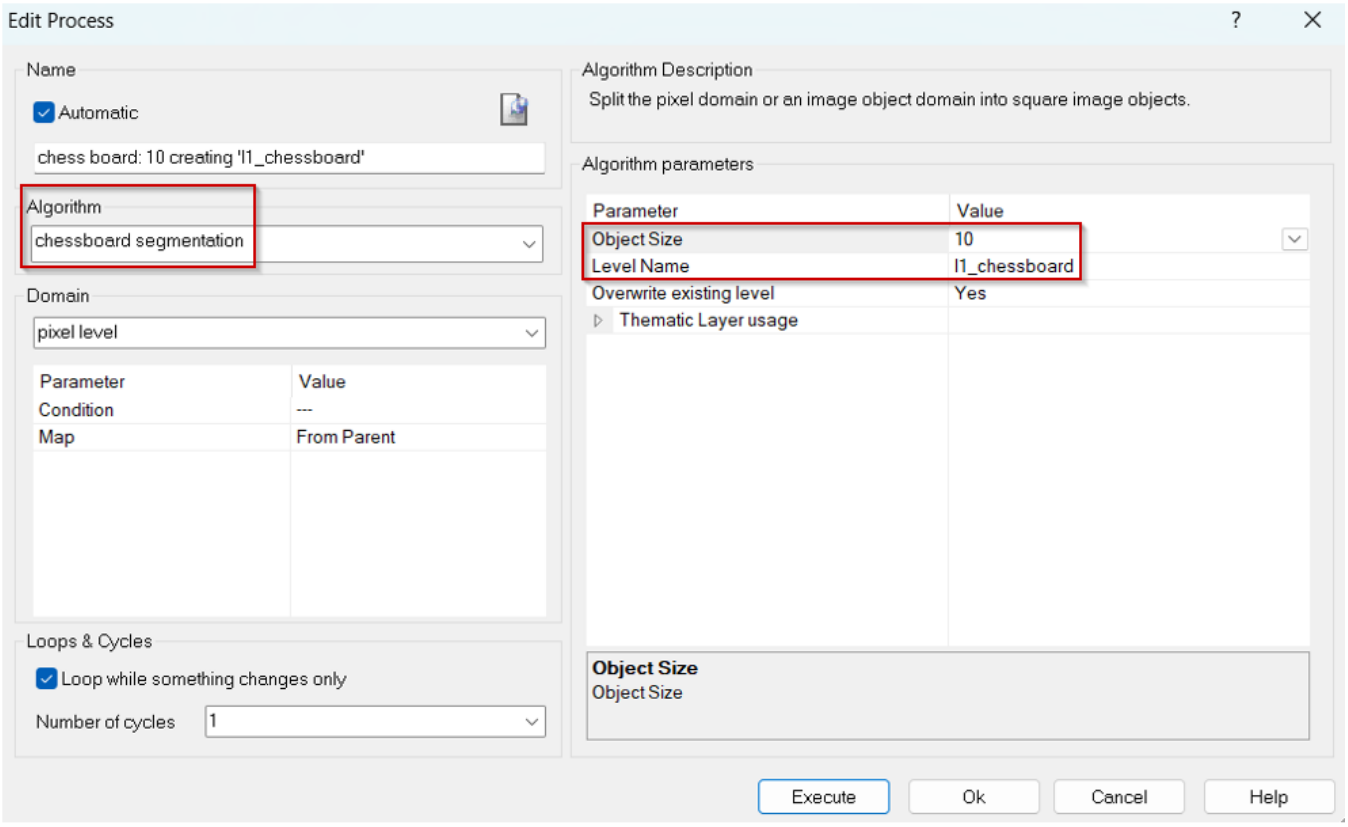


***Figure 2**. Parameters configured for the Chessboard Segmentation*

To display the object features for the newly created objects in the Image Object Information Window, first the features of interest were selected from the Feature View Window:

- Mean value of the blue band (here: Layer 1)
- Max. pixel value of the blue band
- Area of the object
- Shape Index of the object
- NDVI

As the NDVI was not part of the built-in object features, it was created as a customized arithmetic feature in the Feature View Window

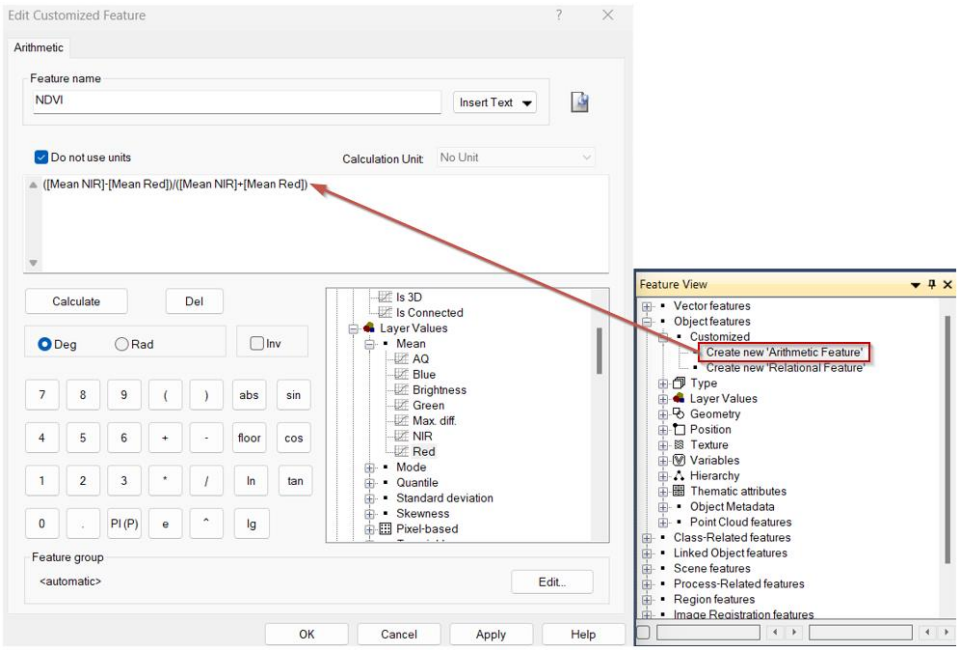


***Figure 3**. Creation of the NDVI customized object feature*

QUESTION: WHAT BECOMES OBVIOUS WHEN COMPARING THE FEATURE VALUES OBTAINED FOR 2 DIFFERENT OBJECTS OF THE CHESSBOARD SEGMENTATION?

The values for the object features were compared for **two** objects (one including part of the Boat displayed on the image and other in the middle of the river)

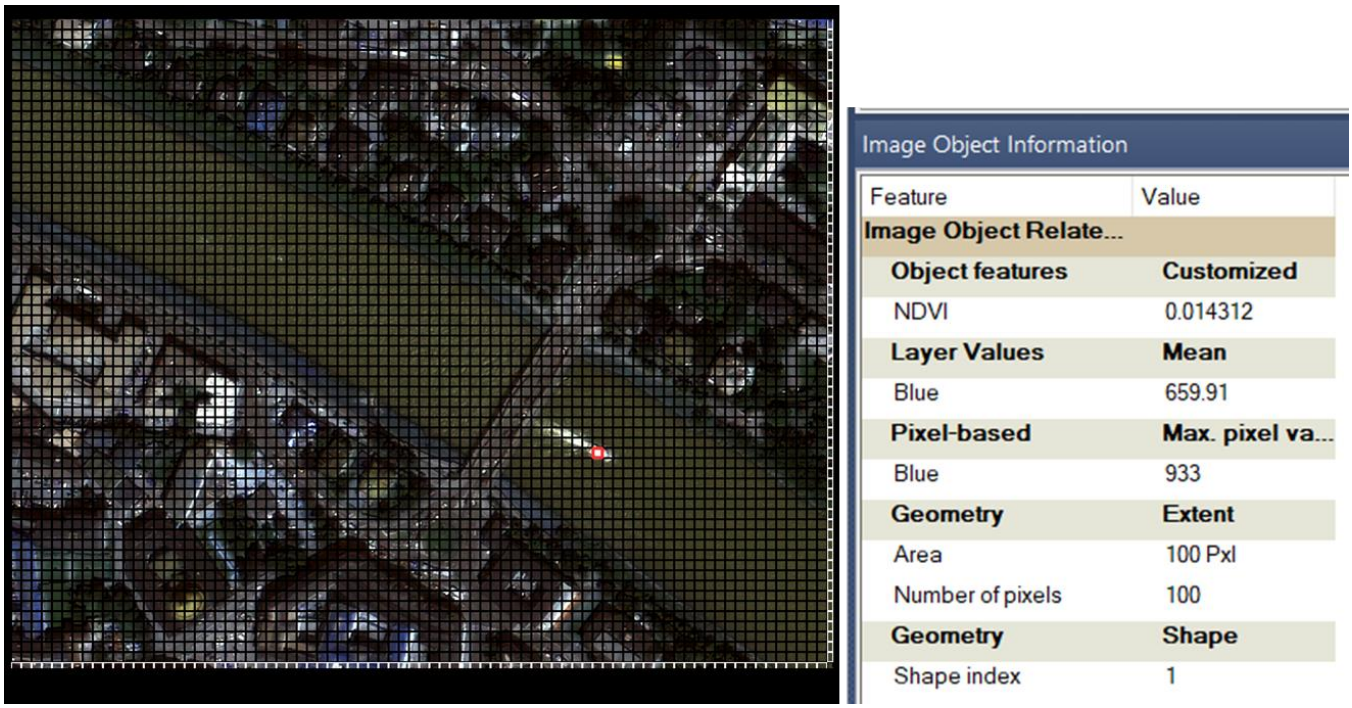


***Figure 4**. Feature Values for Object 1 - Chessboard Segmentation*

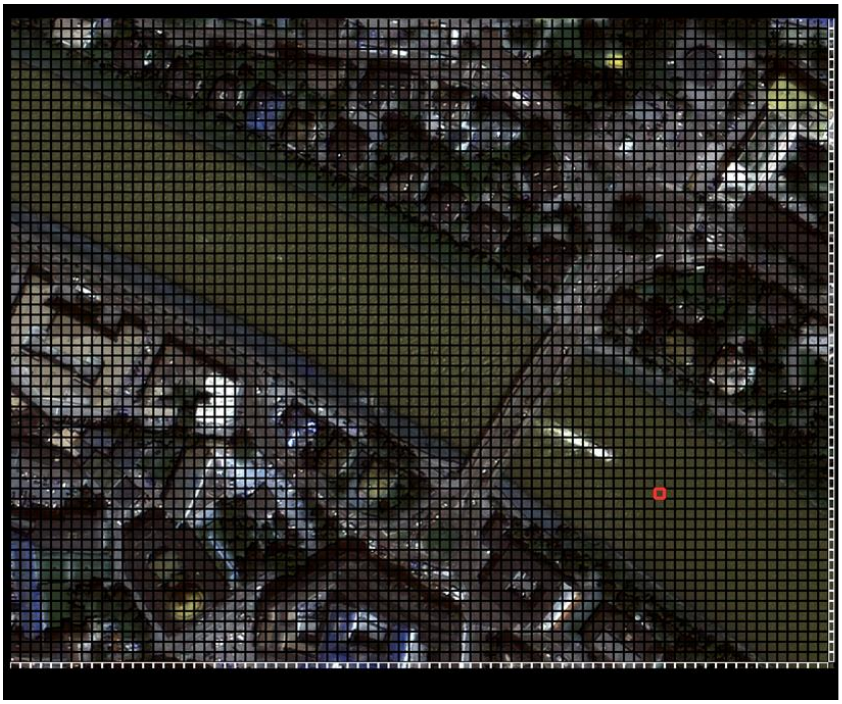


Image Object Information

Feature	Value
Image Object Relate...	
Object features	**Customized**
NDVI	-0.3542
Layer Values	**Mean**
Blue	266.42
Pixel-based	**Max. pixel va...**
Blue	291
Geometry	**Extent**
Area	100 Pxl
Number of pixels	100
Geometry	**Shape**
Shape index	1

***Figure 5**. Feature Values for Object 2 - Chessboard Segmentation*

As the Chessboard Segmentation cut the scene into equal square image objects of 10x10 pixels, the **Area** and **Shape Index** were not differentiator features between the objects. All the objects had the same Area equal to 100 Px and a Shape index of 1.

QUESTION: WHICH FEATURES DO NOT MAKE MUCH SENSE IN THIS CASE?

Additionally, since the Chessboard Segmentation did not consider the underlaying scene, the obtained square objects could include multiple "real world" objects (mix-content). For example, some of the segmented objects included parts of the boat and the water, parts of the bridge and the water, or parts of vegetation and artificial structures.

Therefore, the object features values corresponding to the Mean value of the blue band or the NDVI did not always make sense. For the selected objects, these values were actually representative as the Object 1 was mainly covering part of the boat and the Object 2 was fully covering part of the Salzach River. Then, a positive NDVI value close to 0 for the boat was correct since there was not vegetation present, and a negative vale confirmed the presence of water.

TASK 3: PERFORM A MULTIRESOLUTION SEGMENTATION

To carry out the Multiresolution Segmentation, the level generated in the Chessboard Segmentation (l1_chessboard) was deleted first with the "Delete Image Object Level" algorithm.

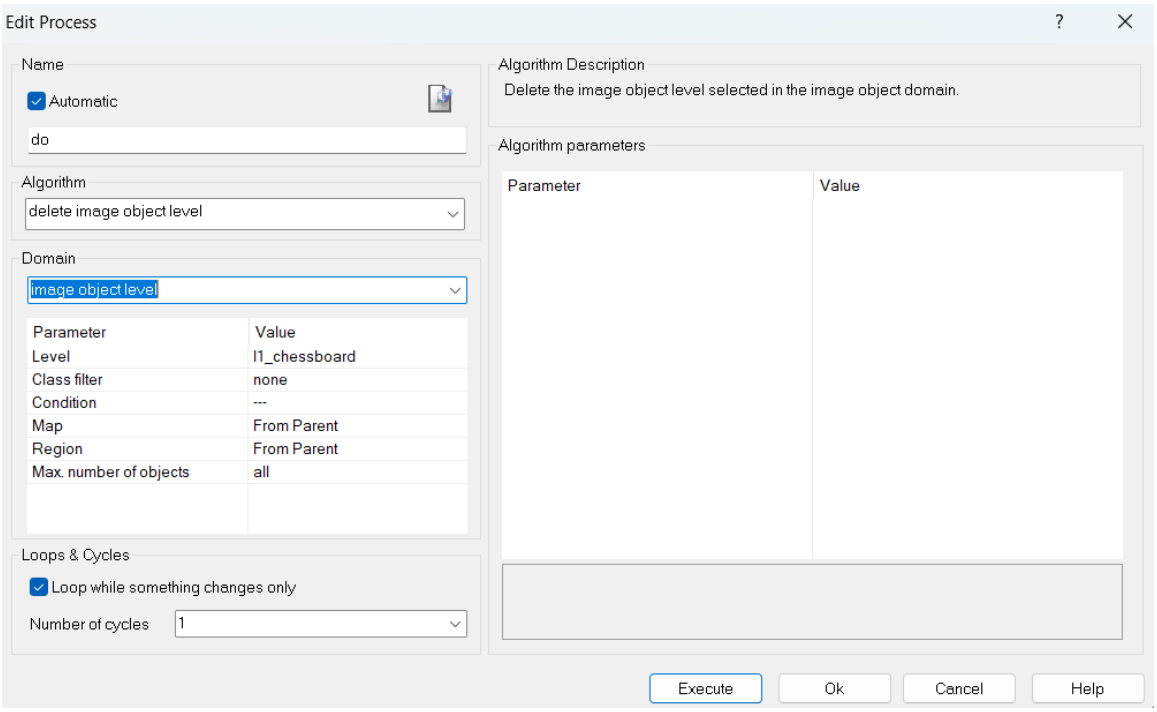


***Figure 6**. Delete the "l1_chessboard" level*

When executing the "Multiresolution Segmentation" algorithm, a new level called **"multires_200"** was created using the input parameters displayed in the following figure. It was verified that the Air Quality Layer was weighted as 0 (not considered) in the process.

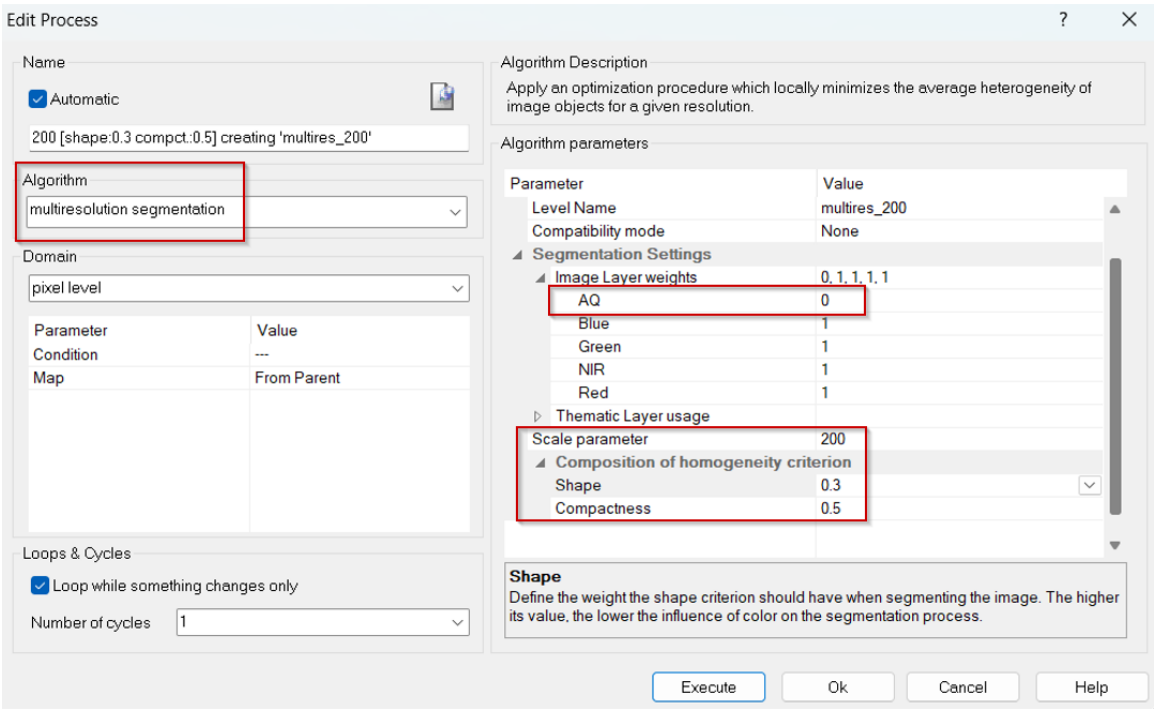


***Figure 7**. Parameters input for the Multiresolution Segmentation*

QUESTION: HOW DO THE SHAPE FEATURES (AREA & SHAPE INDEX) BEHAVE NOW?

Again, the values of the same object features selected before were compared for **two** objects

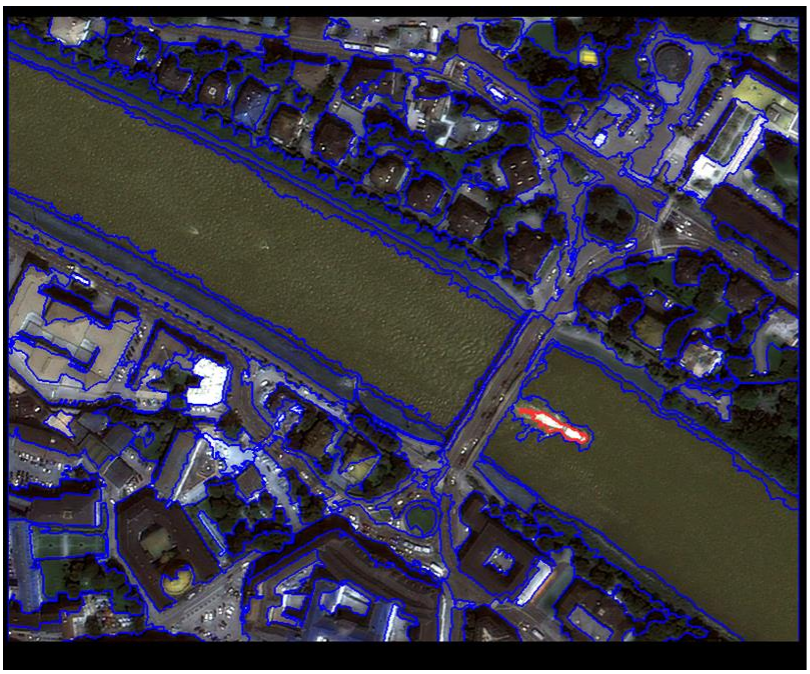


Image Object Information

Feature	Value
Image Object Relate...	
Object features	**Customized**
NDVI	-0.1305
Layer Values	**Mean**
Blue	553.76
Pixel-based	**Max. pixel value**
Blue	948
Geometry	**Extent**
Area	676 Pxl
Number of pixels	676
Geometry	**Shape**
Shape index	2.269

***Figure 8**. Feature Values for Object 1 - Multiresolution Segmentation*

Image Object Information

Feature	Value
Image Object Relate...	
Object features	**Customized**
NDVI	-0.3111
Layer Values	**Mean**
Blue	265.81
Pixel-based	**Max. pixel value**
Blue	376
Geometry	**Extent**
Area	45593 Pxl
Number of pixels	45593
Geometry	**Shape**
Shape index	2.000

***Figure 9**. Feature Values for Object 2 - Multiresolution Segmentation*

In this case, the **Area** and **Shape Index** values were not the same for all the objects as the Multiresolution Segmentation did consider the underlying scene by evaluating the homogeneity criteria of its pixels to create the resulting image objects. Hence, the boat object (Object 1) had a lower Area than the Salzach object (Object 2). Moreover, as Object 1 had a more irregular/compart shape than Object 2, its Shape Index value was higher.

QUESTION: WHICH SEGMENTATION PROVIDES MORE MEANINGFUL OBJECTS?

The Multiresolution Segmentation provides then more meaningful objects as it locally minimizes the average heterogeneity of image objects and maximizes their spectral and shape homogeneity (Trimble, 2022).

The Chessboard Segmentation, which is faster and do not consider the spectral/context information of the image objects, can better be used for example:

- To obtain a more detailed result or refine small image objects when there is an existing segmentation (Trimble, 2022).
- As an initial step before applying a more detailed segmentation.

TASK 3.1: FIND NDVI THRESHOLDS TO DISTINGUISH BETWEEN WATER, VEGETATION AND NON-VEGETATION AREAS

In the Feature View Window, by clicking the NDVI object feature → activating the "Update Range" option → checking the range box at the bottom, it could be explored the NDVI values which approximately delimited the objects associated with Water, Vegetation, and non-Vegetation in the Map View Window.

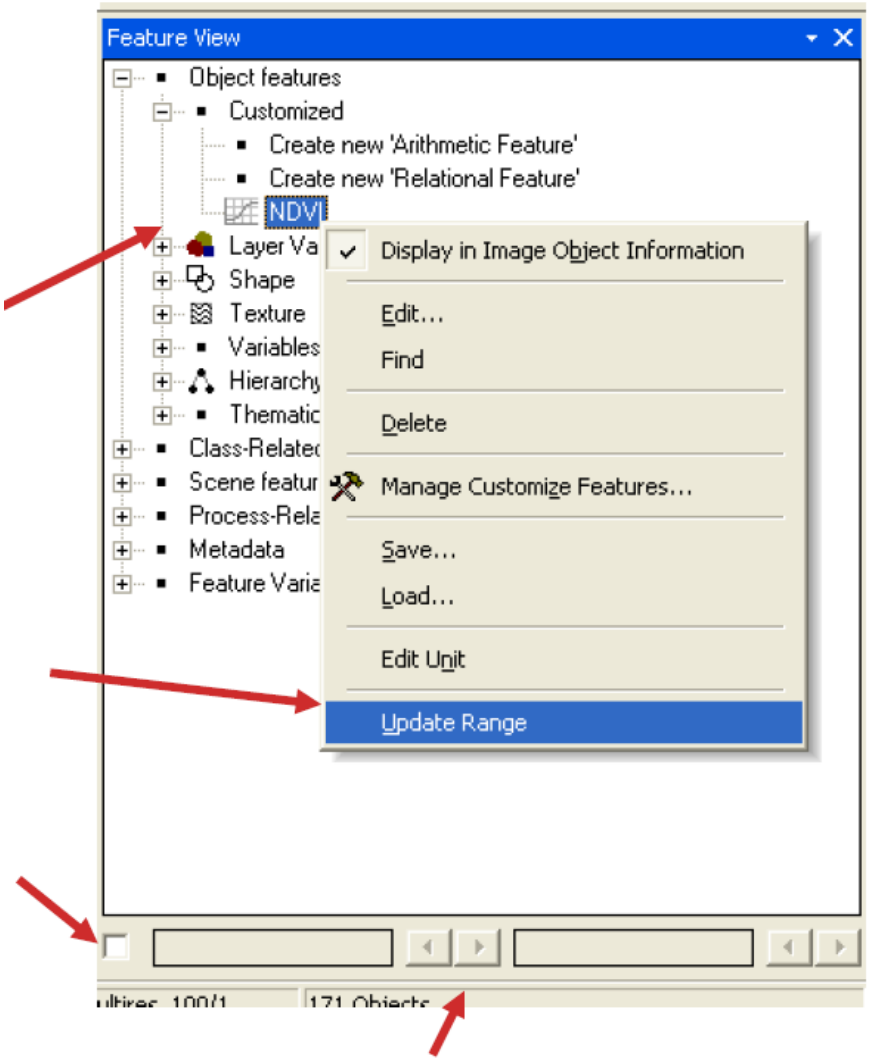


***Figure 10**. Method to updated and examine the range of the NDVI feature*

The obtained thresholds were:

- Water less or equal to **-0.2**
- Vegetation greater or equal to **0.36**

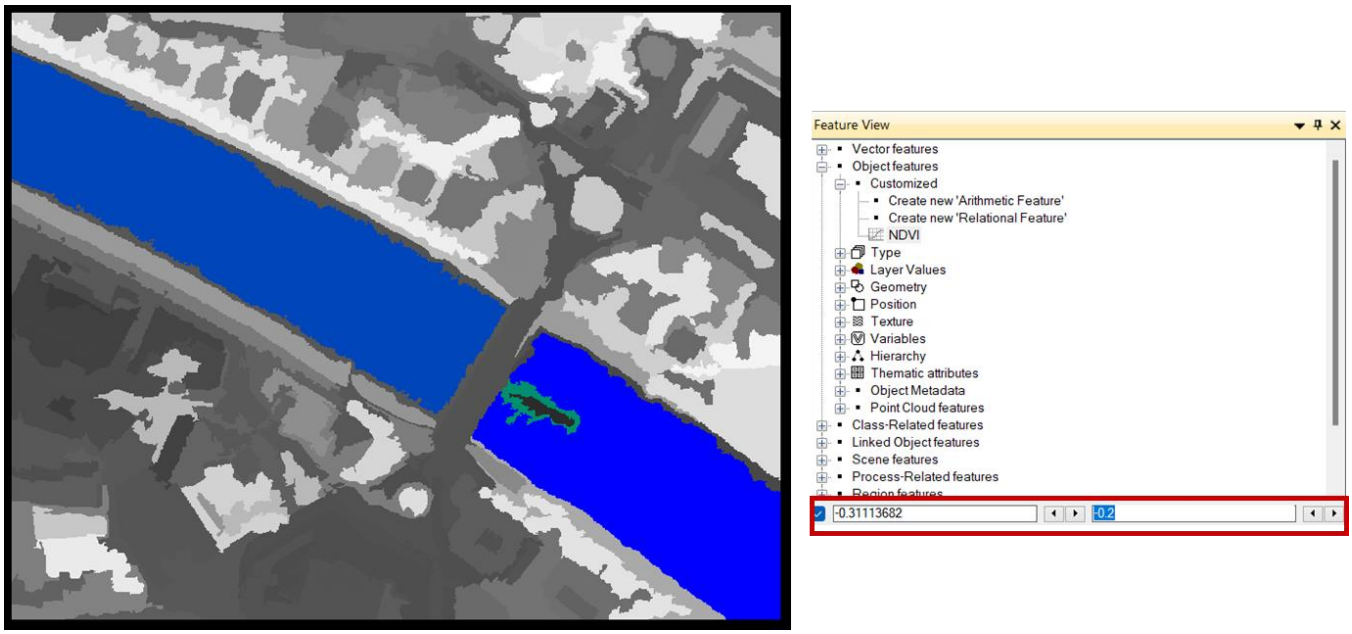


***Figure 11**. Threshold for Water objects*

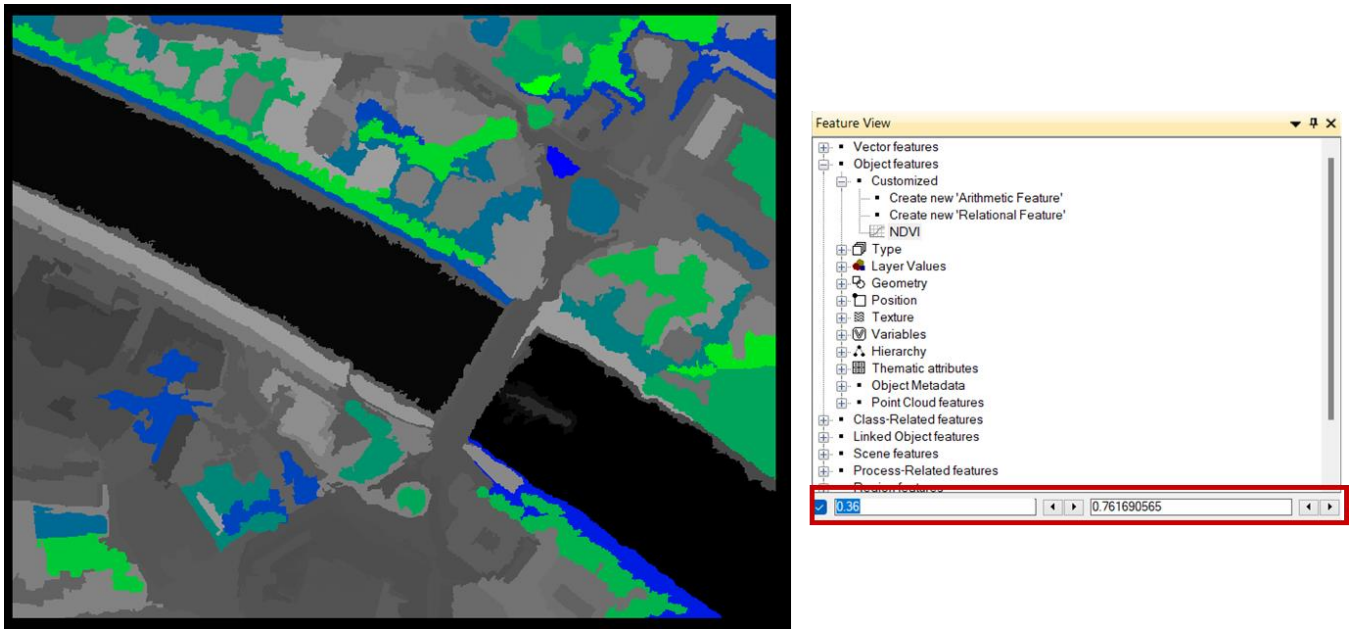


***Figure 12**. Threshold for Vegetation objects*

TASK 3.2: CREATE AND ASSIGN THE WATER, VEGETATION AND BOAT CLASSES

The classes were added in the Class Hierarchy Window

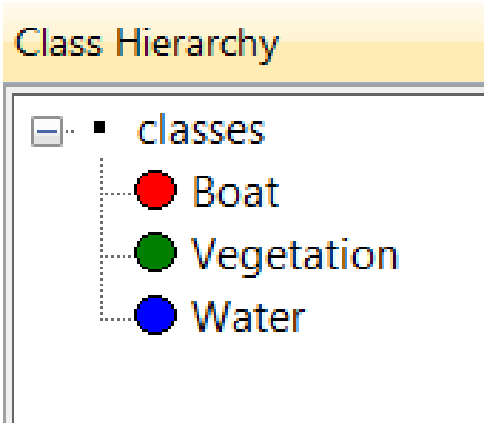


Figure 13. New classes Water, Vegetation and Water added in the Class Hierarchy Window

The "Assign Class" algorithm was run afterward to classify the objects according to their NDVI values. Specifically, the found thresholds were used to classify the **Water** and **Vegetation** classes

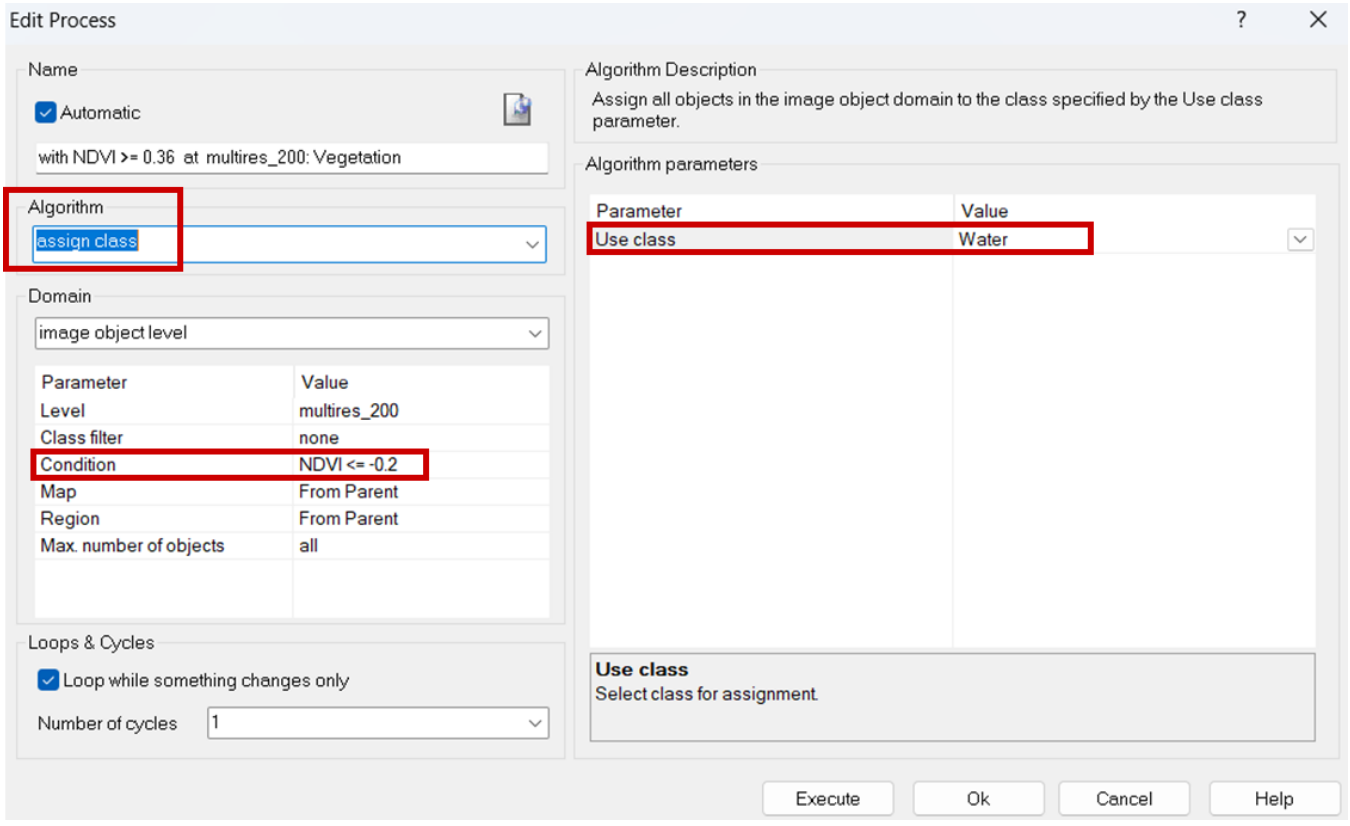


Figure 14. NDVI condition set to classify Water objects

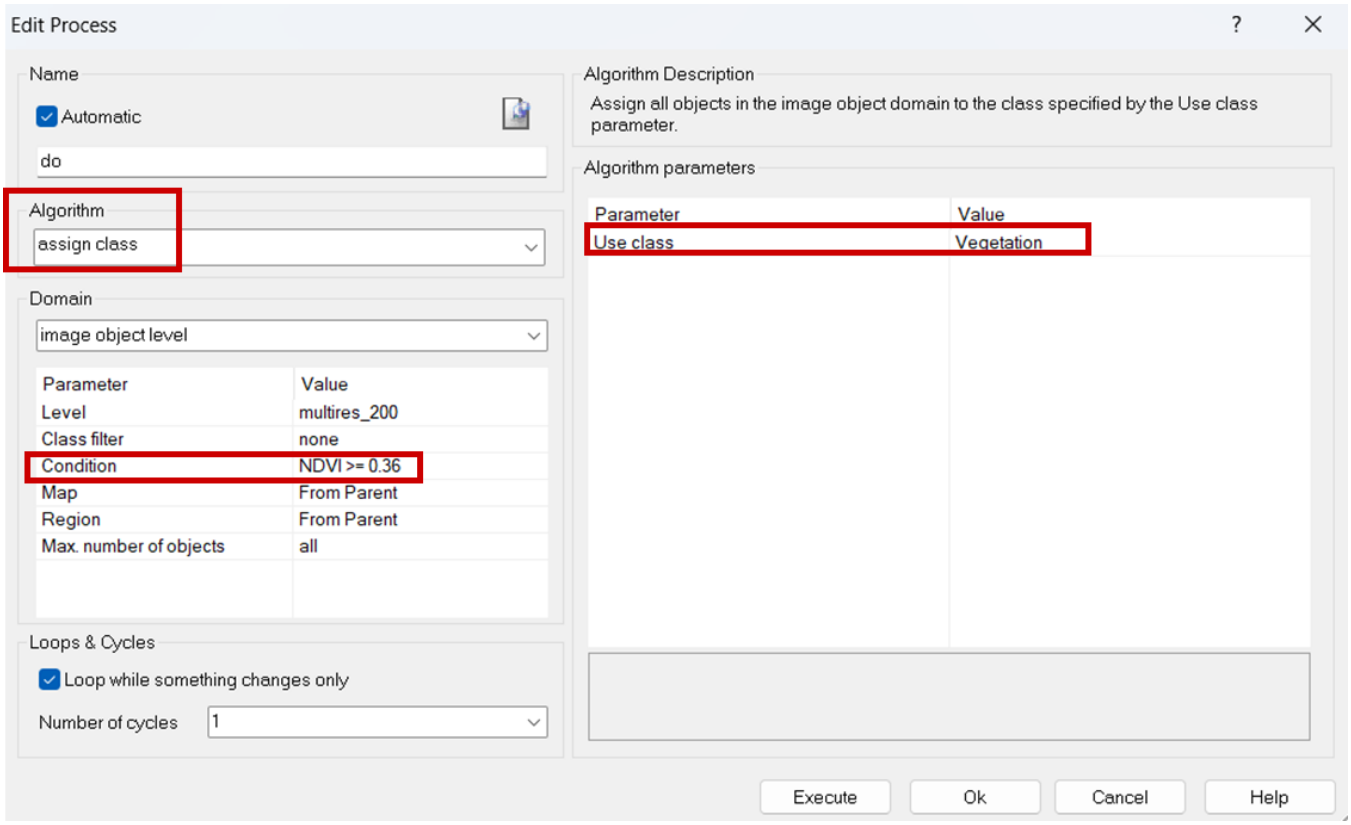


Figure 15. NDVI condition set to classify Vegetation objects

For the **Boat class**, the classification condition was not based on the NDVI, but in its relative border to the Water class. This feature was selected in the Feature View Window under the Class Related Features

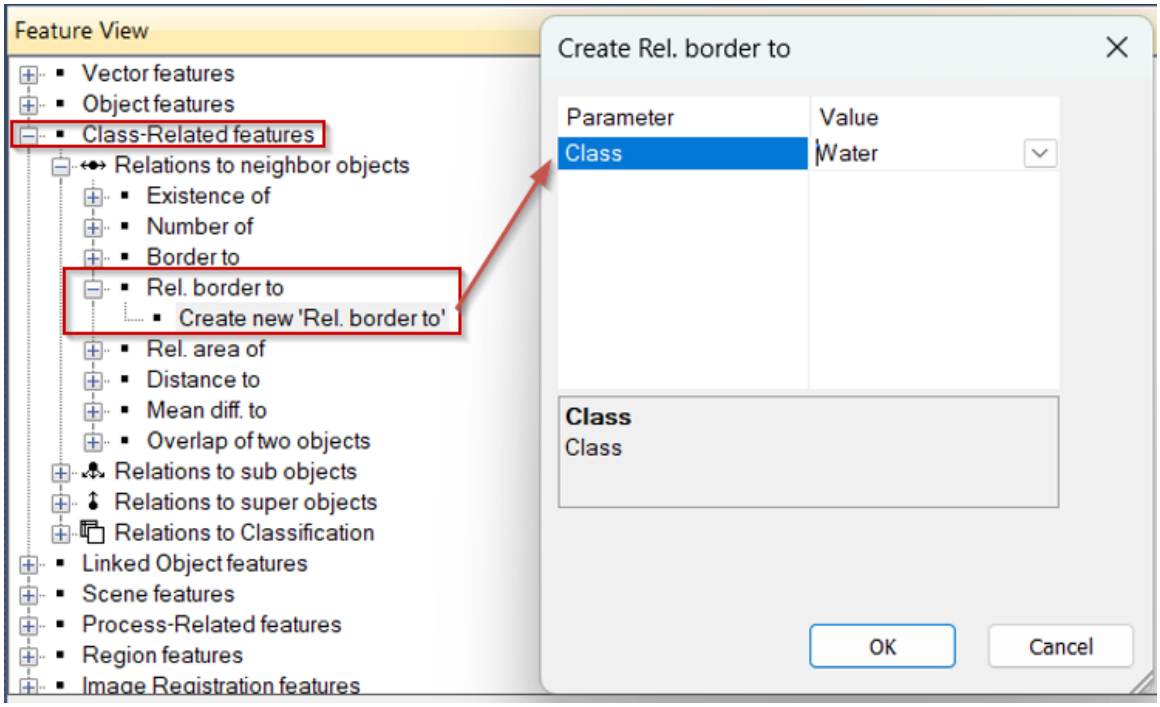


Figure 16. Add "Rel. border to" object feature

As the Boat was on the river, the value for this feature was 1=100%. This was the input condition in the "Assign Class" algorithm for the Boat class.

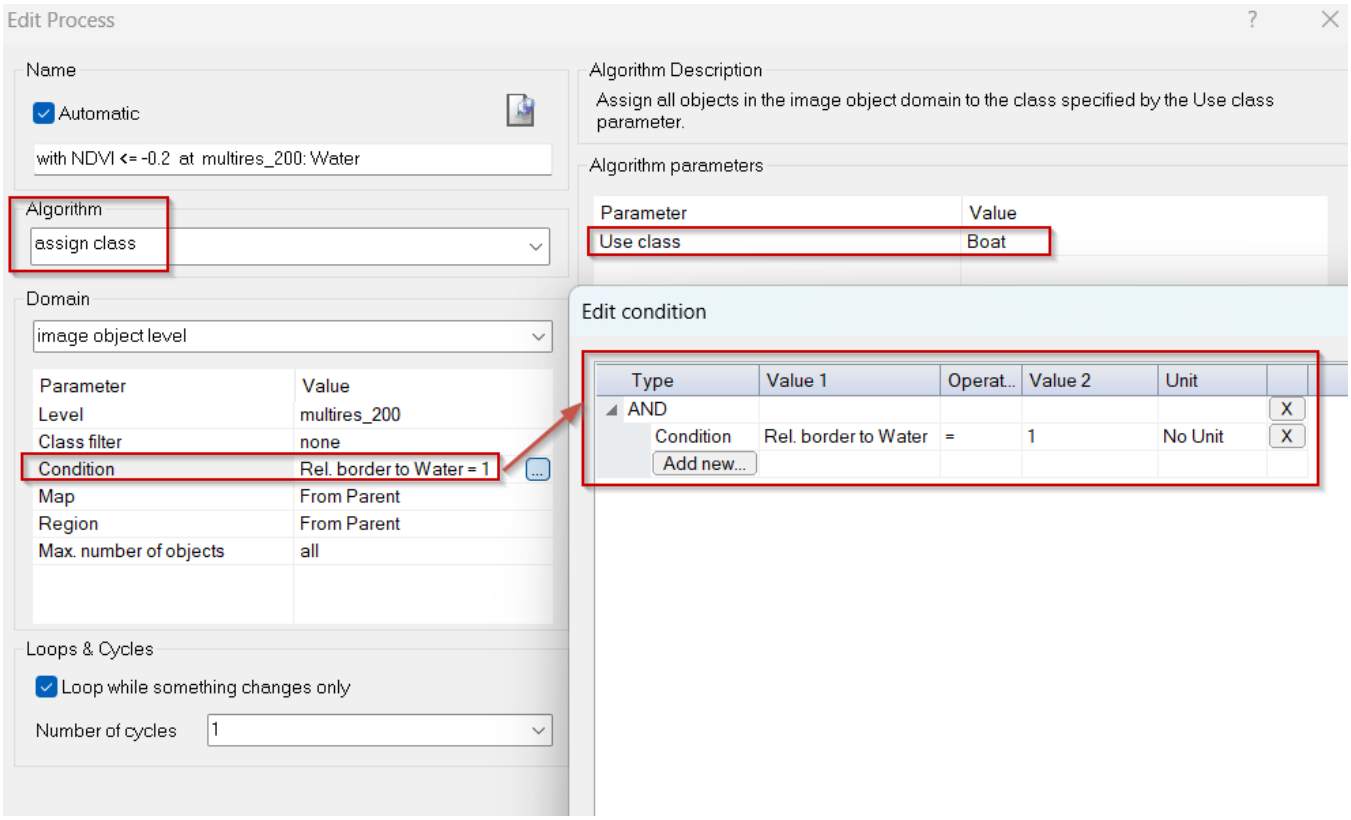


Figure 17. *Classification of the Boat object based on the relative boarder with the Water class*

The result could be visualized by changing to the View Classification mode in the View Settings Toolbar

Figure 18. *Water, Vegetation, and Boat classified objects*

QUESTION: HOW MANY OBJECTS WERE CLASSIFIED AS WATER?

In order to count the number of objects classified as Water, in the Feature View Window, under the Scene Features→ Class Related, the "Number of classified objects" feature was added, and the class Water was chosen.

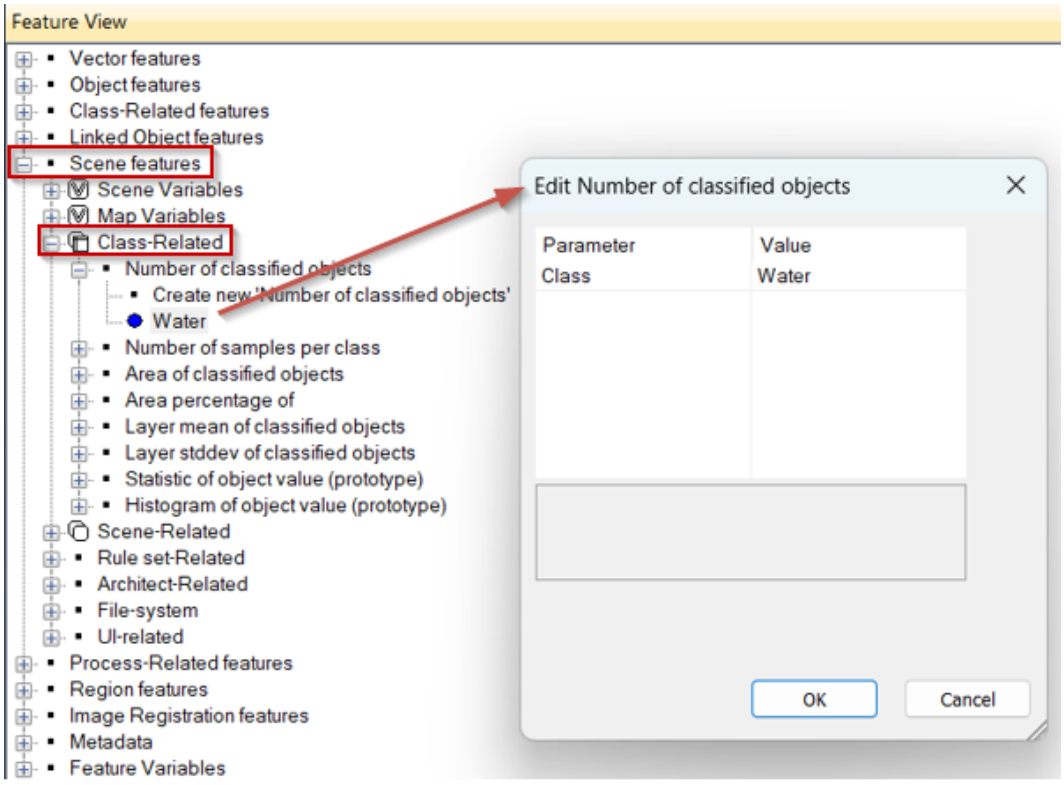
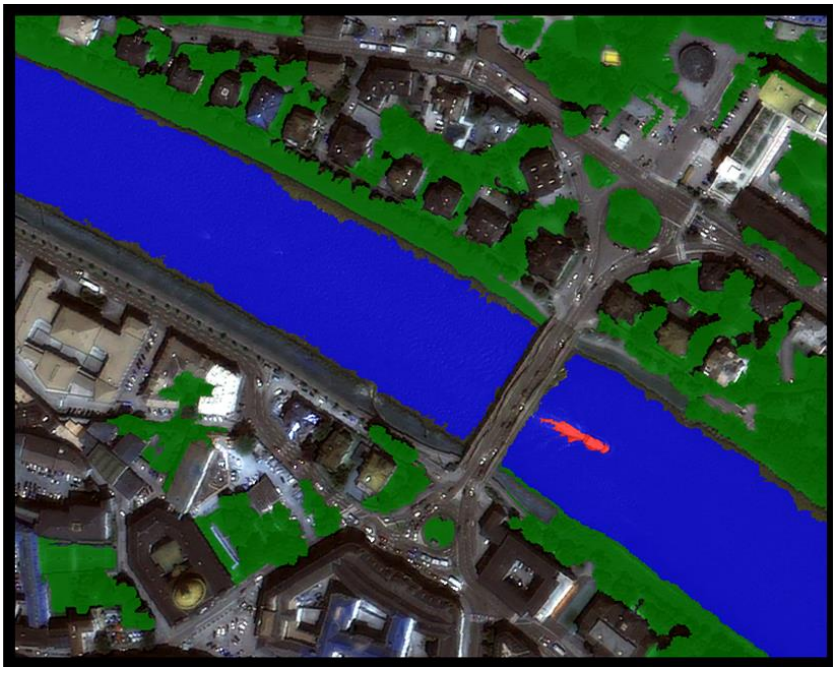
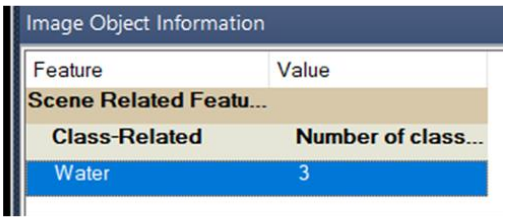


Figure 19. Add "Number of classified objects" object feature to the Water class

The feature value was then verified on the Image Object Information Window. **Three** objects were classified as Water.





TASK 3.3: CREATE SUB-CLASSES OF THE CLASS VEGETATION TO DIVIDE IT IN AREAS WITH HIGH/LOW AIR QUALITY

The air quality layer was utilized with the objective of refine the classification and identify the Vegetation objects with high and low air quality. The "High Air Quality" and "Low Air Quality" were then added as sub-classes of the Vegetation class in the Class Hierarchy Window.

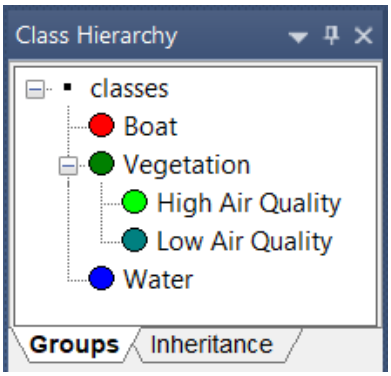


Figure 20. New sub-classes High Air Quality and Low Air Quality added in the Class Hierarchy Window

Two additional times, the "Assign Class" algorithm was executed to split the Vegetation objects in the new subclasses considering the subsequent thresholds:

- High Air Quality was represented by a mean value in the AQ layer of 50 or more
- Low Air Quality was represented by a mean value in the AQ layer less than 50

Moreover, to guarantee that the algorithm did only consider the Vegetation objects, the Class Filter parameter was applied.

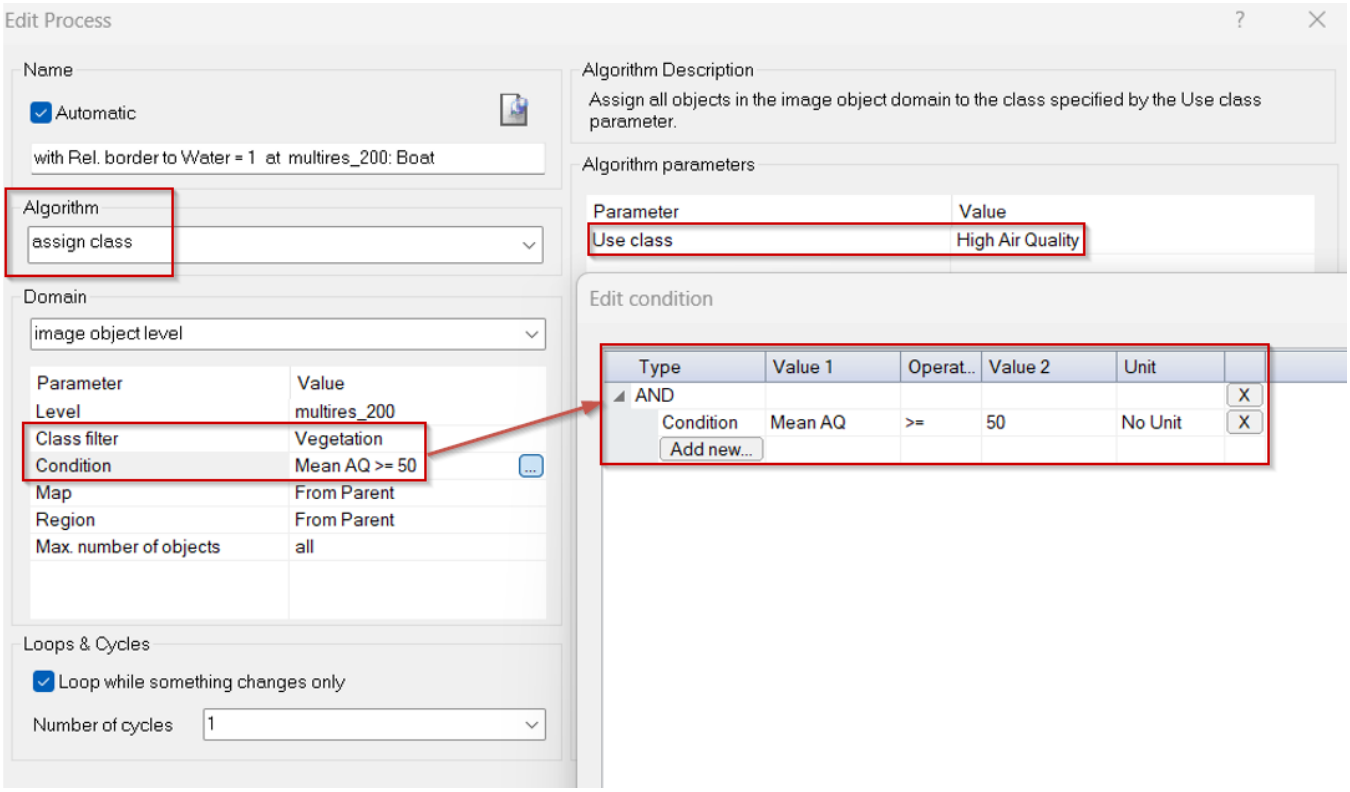


***Figure 21**. Sub-classification of the High Air Quality Vegetation objects based on the Mean AQ feature value*

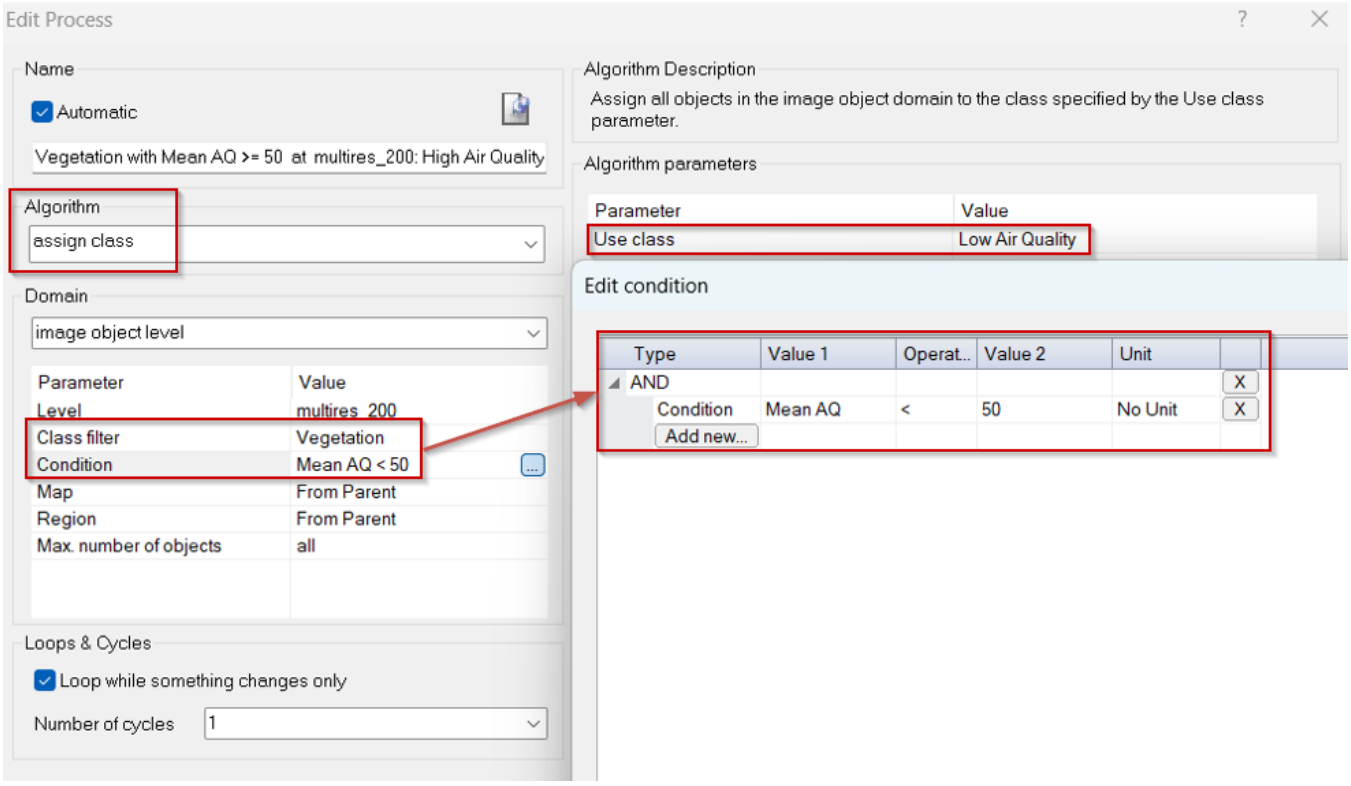


Figure 22. *Sub-classification of the Low Air Quality Vegetation objects based on the Mean AQ feature value*

The sub-classification result was visualized on the Map View Window:

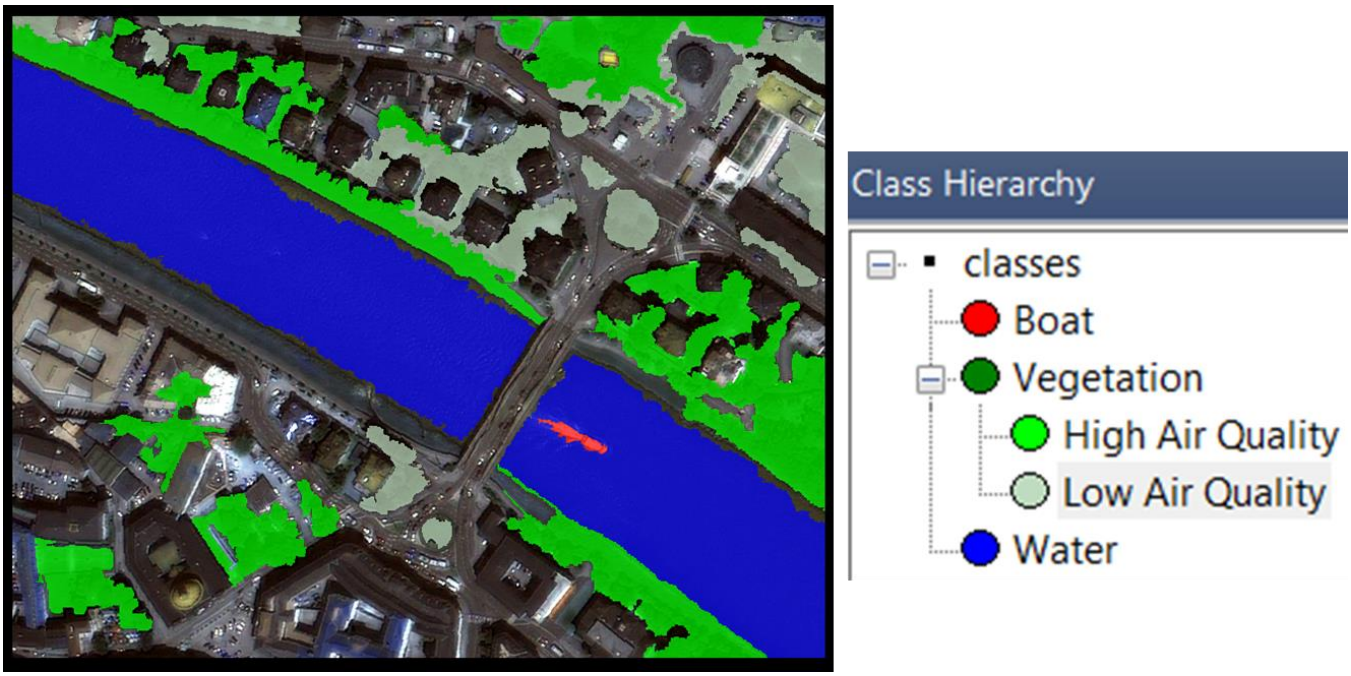


Figure 23. *Air Quality Sub-classification result displayed on the Map View Window*

QUESTION: WHAT HAPPENS IF THE VEGETATION SUPER-CLASS IS COLLAPSED?

When, the Vegetation class was collapsed, the sub-classification of the objects was no longer shown in the Map View Window. The super-class vegetation was a container for the two air quality classes and could be directly used to address both sub-classes at once

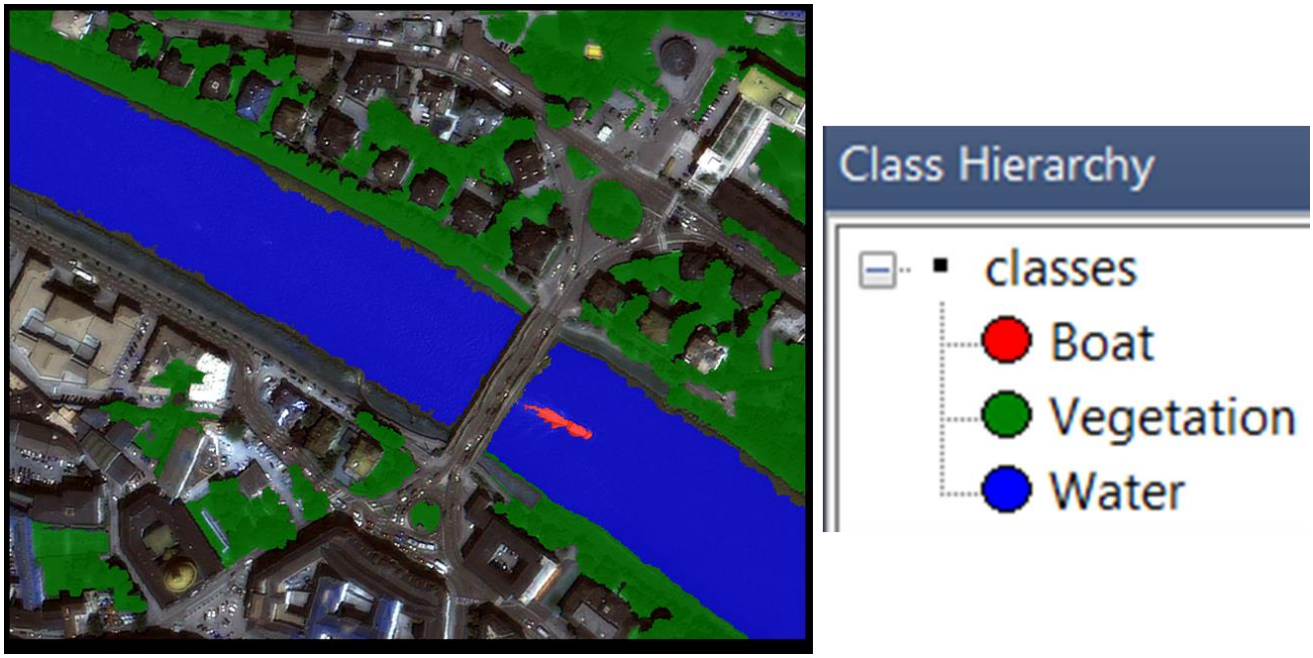


***Figure 24**. Air Quality Sub-classification no longer displayed on the Map View Window when the Vegetation class is collapsed*

QUESTION: WHAT IS THE AREA OF THE WHOLE VEGETATION CLASS? DOES IT SUMMARIZE THE VALUES FROM THE GROUPED SUB CLASSES?

Likewise, under the Scene features→ Class-Related of the Feature View Window, the "Area of classified objects" feature was also selected to find the Vegetation class and subclasses areas. The units were configured to be displayed in m^2

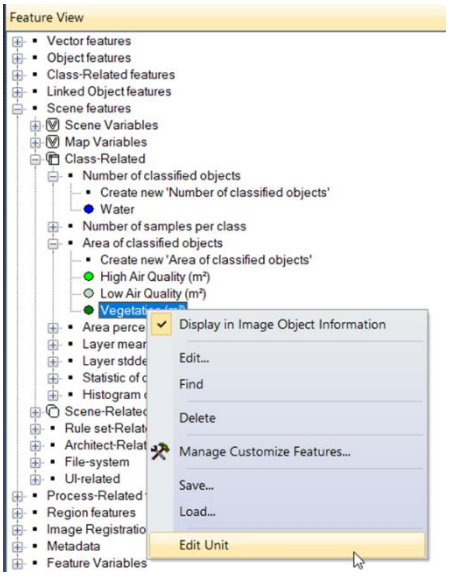


***Figure 25**. Add "Area of classified objects" object feature to the Vegetation class and subclasses*

According to the retrieved values, effectively, the Vegetation class area (40,853.16 m^2) summarized the values from the grouped sub classes (11,383.20 m^2 and 29,469.96 m^2)

***Figure 26**. Areal values of the Vegetation, High Air Quality and Low Air Quality classes*

TASK 4: PERFORM AGAIN A MULTIRESOLUTION SEGMENTATION WITH A SMALLER SCALE PARAMETER

Using again the "Multiresolution Algorithm", a new level called **"multires_50"** was created below the existing one ("multires_200"). This is only possible by working with a Scale Parameter smaller to the value input before. Larger objects cannot be below a higher lever following the object hierarchy→ going from bottom (smaller objects) to the top (larger objects).

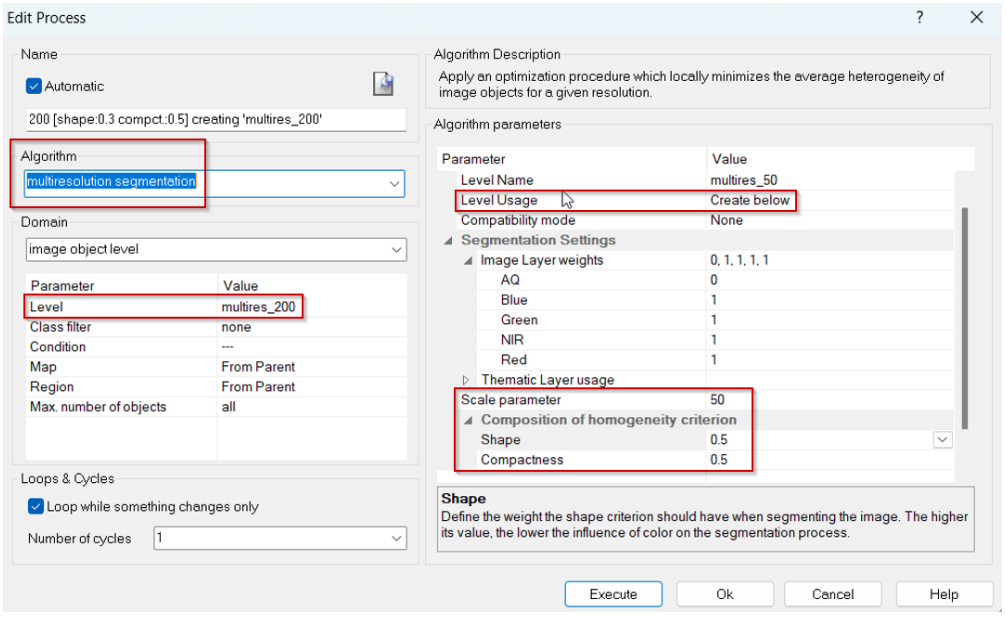


***Figure 27**. Parameters input for the second Multiresolution Segmentation*

The objects of the previous level (“multires_200”) had lower resolution and were split into several sub-objects in the new level (“multires_50”).

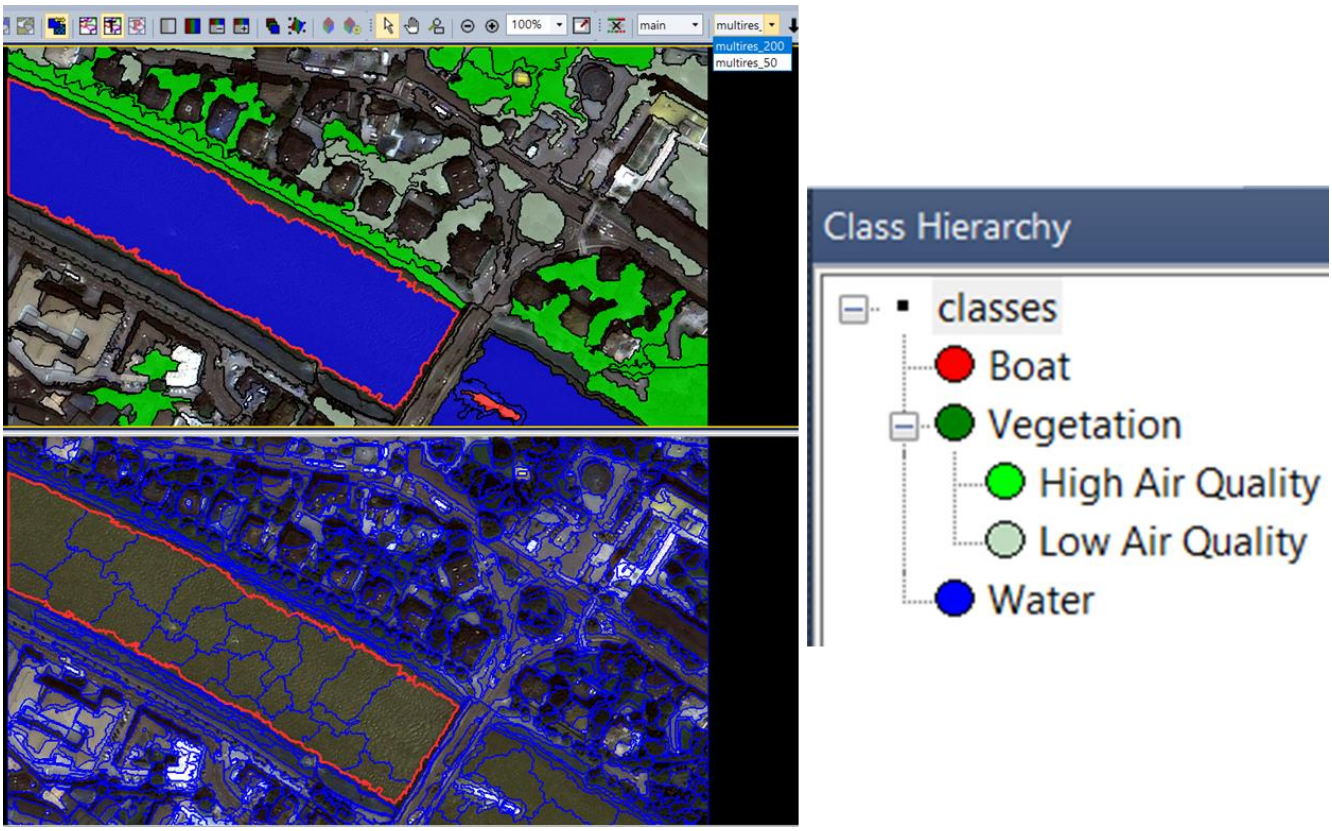


***Figure 28**. Above: "multires_200" level. Below: "multires_50" level*

In the Feature View Window, with the Class-Related features→ Relations to super objects, the image objects of the “multires_50” level were described based on the existence of image objects classified as Vegetation on the higher image object level “multires_200”.

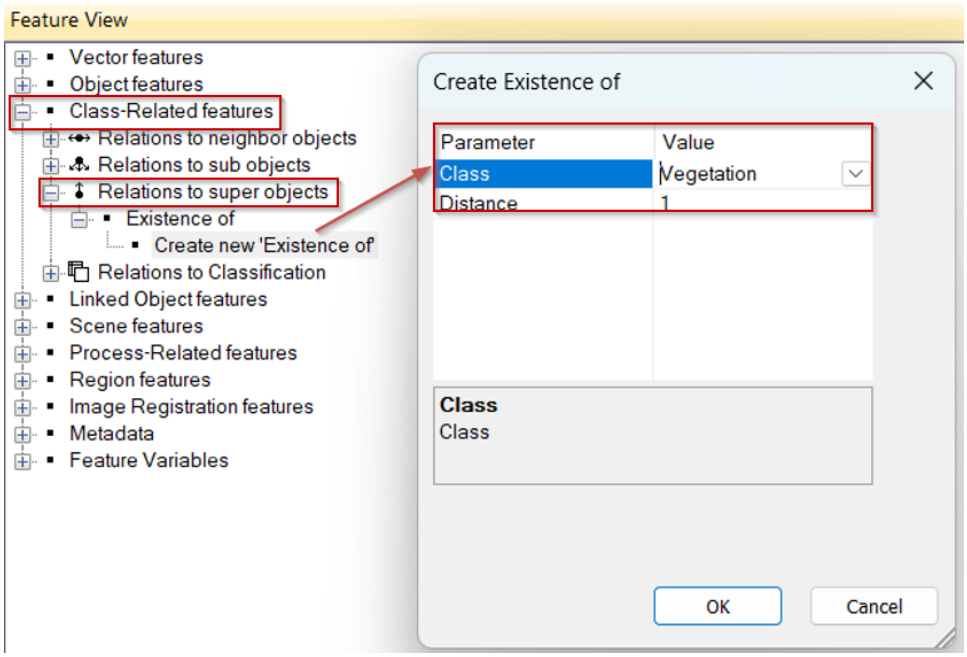


***Figure 29**. Add "Existence of" object feature to the Vegetation class*

QUESTION: WHAT IS THE MEANING OF THE DISTANCE VALUE WHEN CREATING A FEATURE?

When working with relations to super or sub objects, the Level distance parameter indicates the **hierarchical** distance from the current image object level to the level containing the image objects of interest (sub-objects or superobjects) (Trimble, 2022).

As in this case, there were only 2 created levels (multires_200 and multires_50), the level distance between them was 1.

Values of 1 for the added object feature indicated presence of the Vegetation class in the upper level and were displayed in the Map View Window with bright colors.

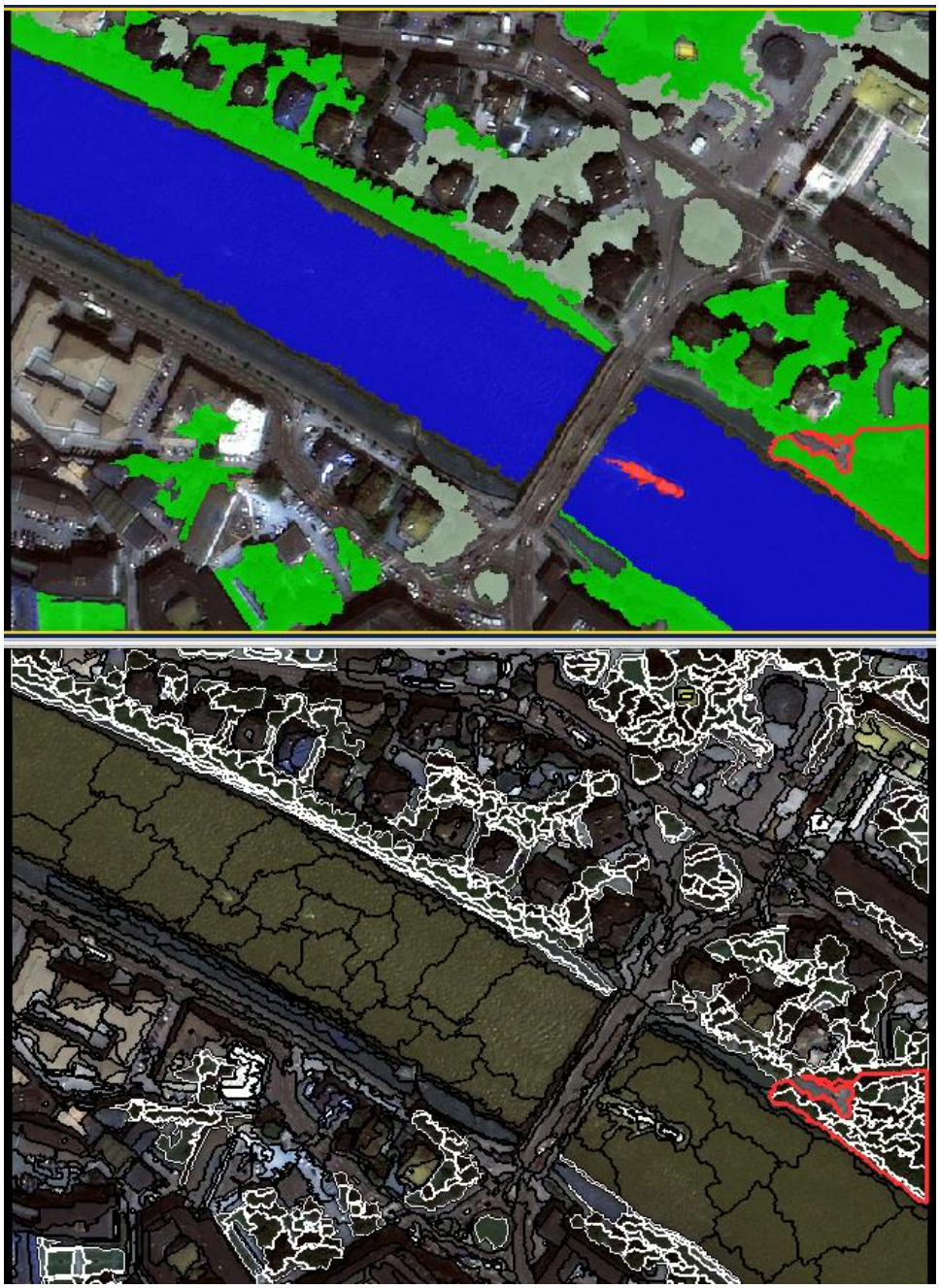


***Figure 30**. "multires_50" level symbolized according to the presence or absence of Vegetation in the upper level*

The created feature could further be used as the condition to classify the “multires_50” level objects with the “Assign Class” algorithm.

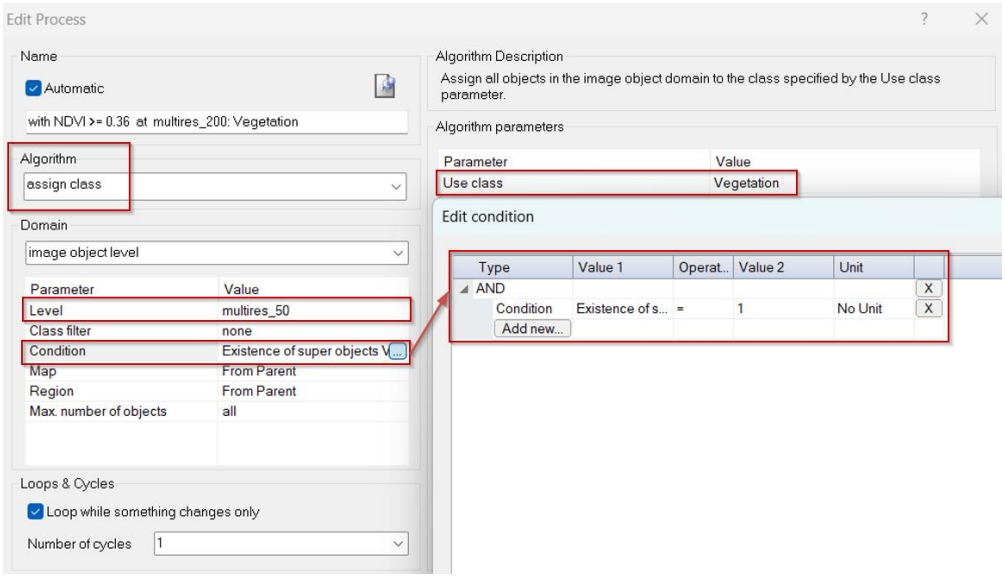


***Figure 31**. Classification objects the “multires_50” level objects as Vegetation considering the presence or absence of Vegetation in the upper level “multires_200”*

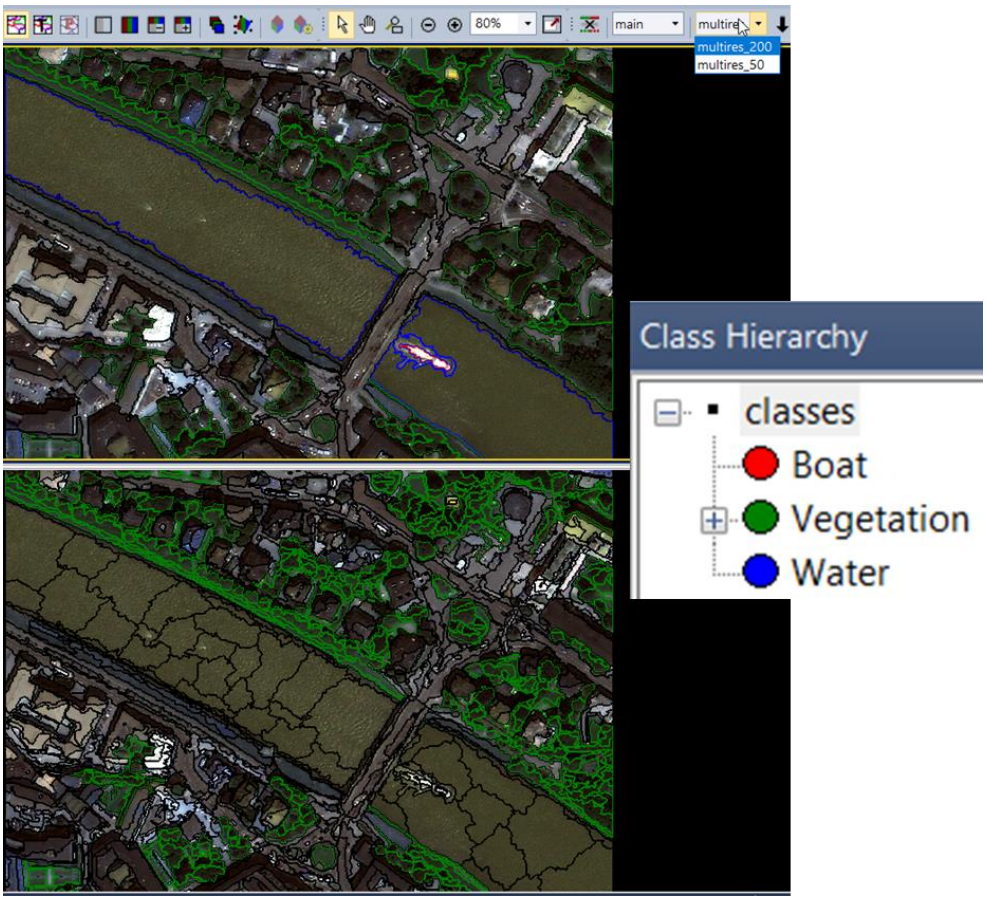


***Figure 32**. "multires_50" level symbolized according to the classification*

Other class related features can be also applied to continue classifying the lower level based on the properties/classification provided on the upper level.

CONCLUSION

Image objects can be characterized by a wide variety of features that are not only related to their own properties (color, shape, texture or hierarchy), but also to their relation with neighborhood image objects or to objects in different hierarchical levels (sub or super objects). These features are then fundamental to formulate rules for the objects to be assigned to classes of interest.

REFERENCES

Trimble, T. (2022). ECognition Developer 10.2 Reference Book. *Trimble Germany GmbH: Munich, Germany*, 34-43.