

Filière Génie de l'Environnement & Géosciences (S3)

Module : Géomatique

**TP N°4 : Introduction au traitement d'images Landsat :
classification et calcul d'indices de végétation NDVI**



Prof. Morad TAHER

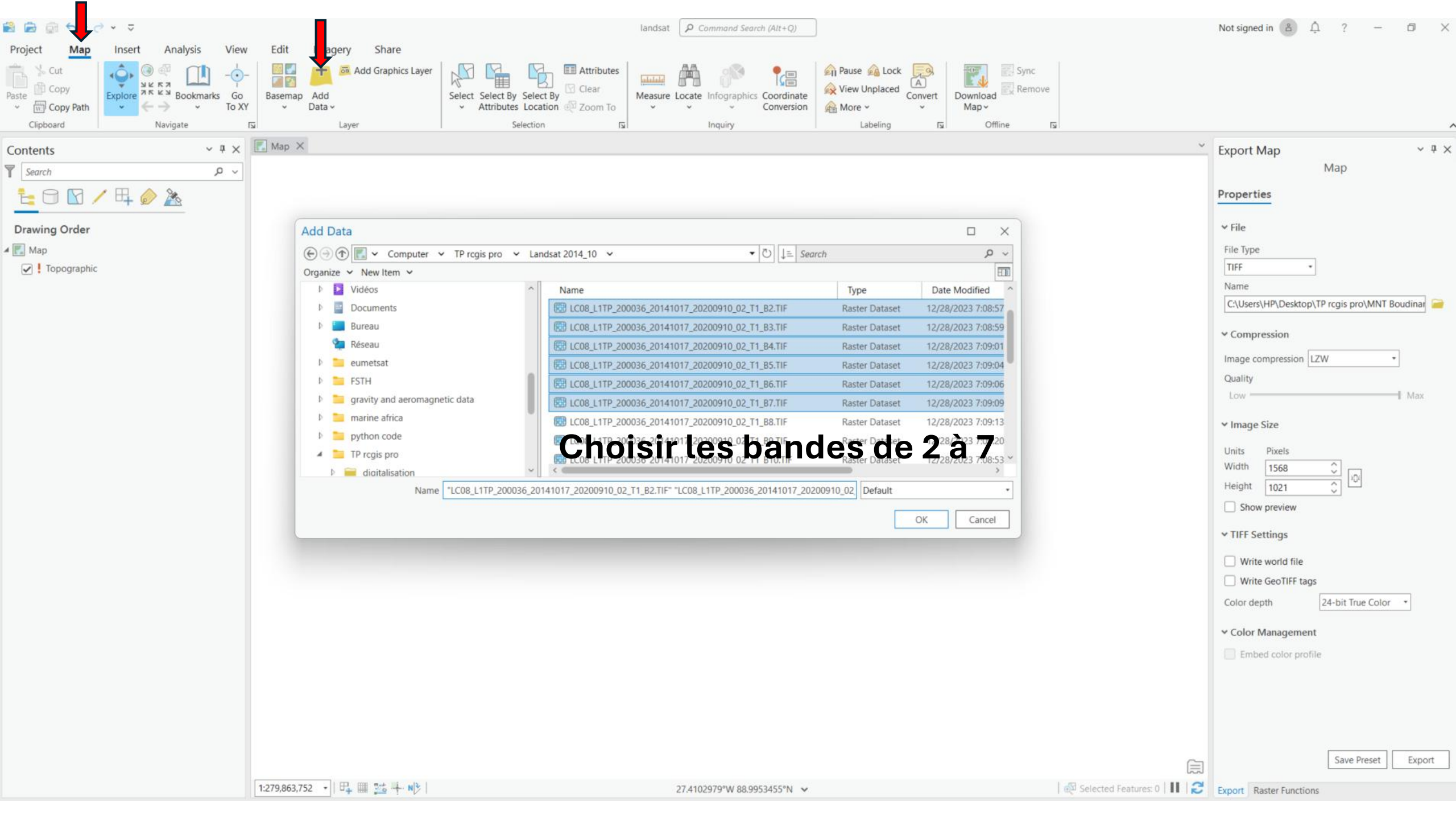
**Programme Landsat –
Chronologie des satellites**

Satellite	Année de lancement	Année de fin de mission
Landsat 1 (ERTS-1)	1972 (23 juillet)	1978
Landsat 2	1975 (22 janvier)	1982
Landsat 3	1978 (5 mars)	1983
Landsat 4	1982 (16 juillet)	1993
Landsat 5	1984 (1er mars)	2013
Landsat 6	1993 (5 octobre)	Échec au lancement
Landsat 7	1999 (15 avril)	Encore actif
Landsat 8	2013 (11 février)	Actif (opérationnel)
Landsat 9	2021 (27 septembre)	Actif (opérationnel)

Landsat 8 utilise 11 bandes spectrales qui se répartissent en trois instruments, l'OLI (Operational Land Imager) et le TIRS (Thermal Infrared Sensor). Le capteur OLI capte 9 bandes multispectrales (à résolution de 30 m, sauf une panchromatique à 15 m) et le capteur TIRS capte 2 bandes thermiques (à résolution de 100 m). Ces bandes peuvent être combinées différemment pour créer des images qui mettent en évidence des caractéristiques spécifiques comme la végétation, les zones urbaines ou l'eau.

Bande	Nom de la bande	Longueur d'onde (μm)	Résolution (m)	Objectifs / Applications principales
1	Coastal / Aérosol	0.43 – 0.45	30	Étude des zones côtières, aérosols, qualité de l'eau
2	Bleu	0.45 – 0.51	30	Étude de l'eau, bathymétrie, détection des nuages, NDVI
3	Vert	0.53 – 0.59	30	Santé de la végétation, contraste eau/sol, vision naturelle
4	Rouge	0.64 – 0.67	30	Végétation, NDVI, discrimination sol/plantes
5	Proche infrarouge (NIR)	0.85 – 0.88	30	NDVI, couverture végétale, stress hydrique, analyse de l'eau
6	SWIR 1	1.57 – 1.65	30	Humidité du sol, neige, feu, étude des sols et géologie
7	SWIR 2	2.11 – 2.29	30	Analyse des minéraux, sols secs, détection des feux
8	Panchromatique	0.50 – 0.68	15	Image en haute résolution (fusion pansharpening)
9	Cirrus	1.36 – 1.38	30	Détection de nuages cirrus (haute altitude)
10	TIRS 1 (Infrarouge thermique)	10.60 – 11.19	100	Température de surface, agriculture, hydrologie
11	TIRS 2 (Infrarouge thermique)	11.50 – 12.51	100	Analyse thermique complémentaire, détection d'îlots de chaleur

Analyse des combinaisons spectrales des bandes Landsat pour l'interprétation des images satellitaires



1:1,201,890 211,406.89E 3,943,463.51N m Selected Features: 0

Project Map Insert Analysis View Edit Imagery Share

New Workspace Georeference Raster Functions Function Editor Change Detection Classification Wizard Classification Tools

Raster Functions Use raster functions for processing and analysis.

History Show the history of raster functions used. The history is saved with the project.

Contents Search

Drawing Order

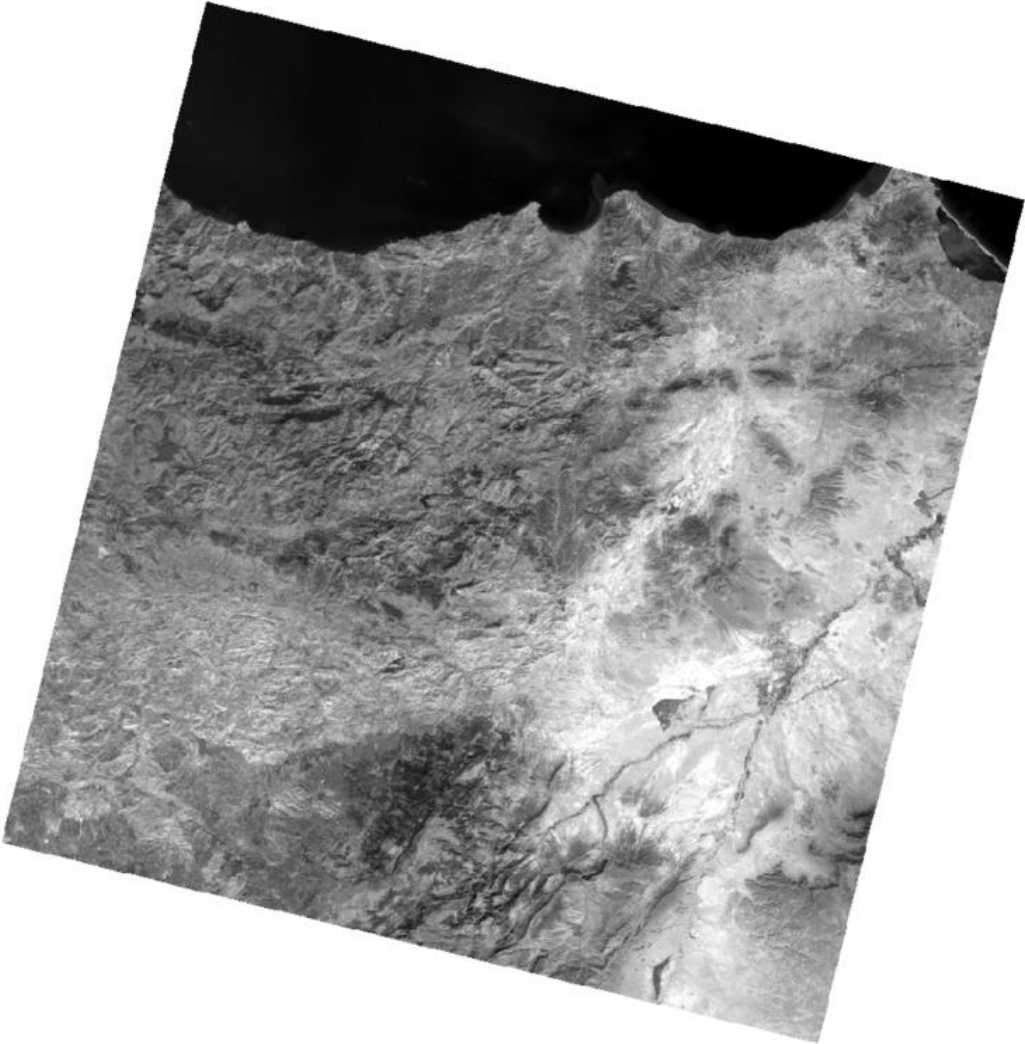
Map

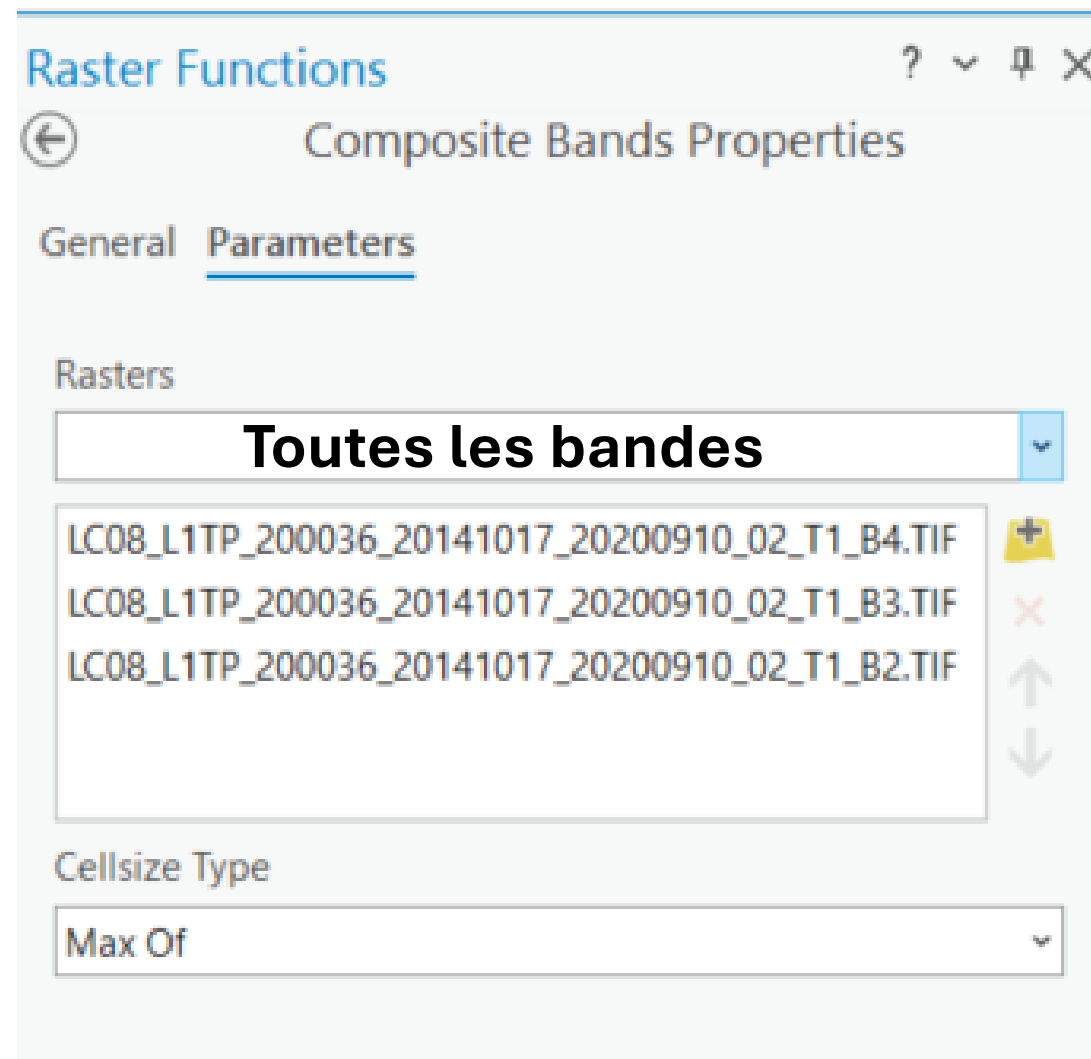
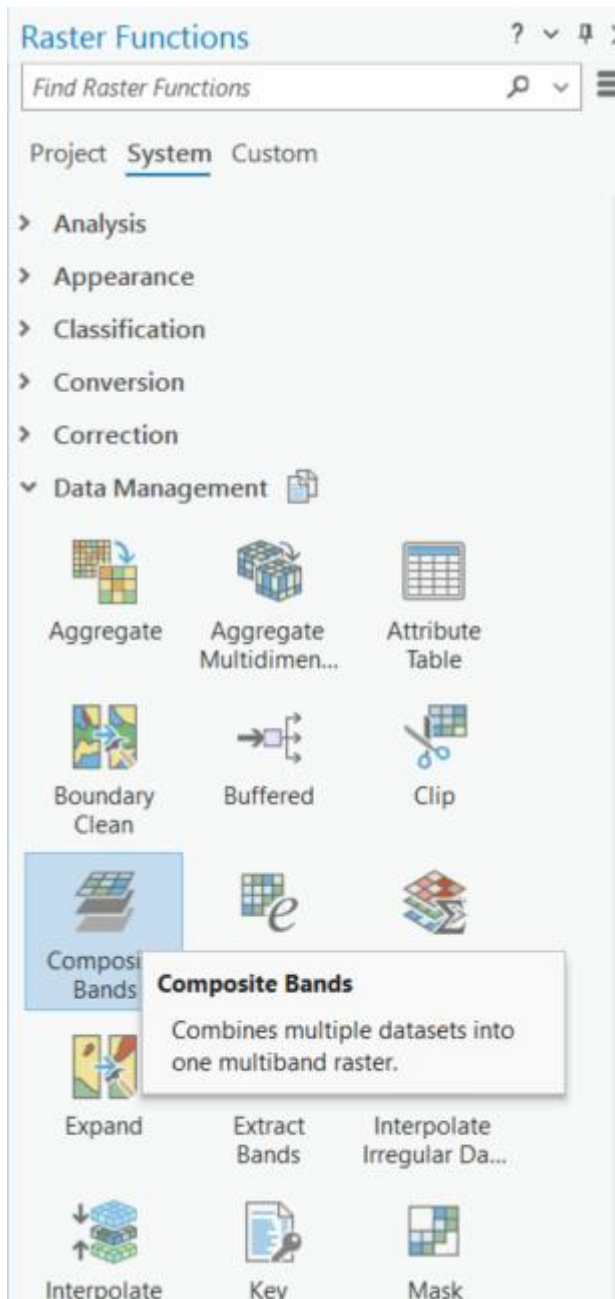
- LC08_L1TP_200036_20141017_20200910_02_T1_B3.T
Value
24128
6220
- LC08_L1TP_200036_20141017_20200910_02_T1_B4.T
Value
24886
5656
- LC08_L1TP_200036_20141017_20200910_02_T1_B5.T
Value
28597
4884
- LC08_L1TP_200036_20141017_20200910_02_T1_B6.T
Value
56689
4689
- LC08_L1TP_200036_20141017_20200910_02_T1_B7.T
Value
65535
4931
- LC08_L1TP_200036_20141017_20200910_02_T1_B2.T
Value
21614
7139
- Topographic

Raster Layer Data

Point Distance Area Mensuration

Results Process Indices Pixel Editor Image Information Create Hosted Imagery Share Video Search Motion Imagery





landsat Command Search (Alt+Q)

Project Map Insert Analysis View Edit Imagery Share Raster Layer Data

In Beyond <None> Transparency 0.0% Swipe
Out Beyond <None> Layer Blend Normal Flicker 500.0 ms
Clear Limits Feature Blend Normal

Visibility Range Effects Compare

Symbology Stretch Type DRA Lock stats Resampling Type Band Combination Masking

Enhancement 0 10 1.5 Rotation Type

Contents

Search

Drawing Order

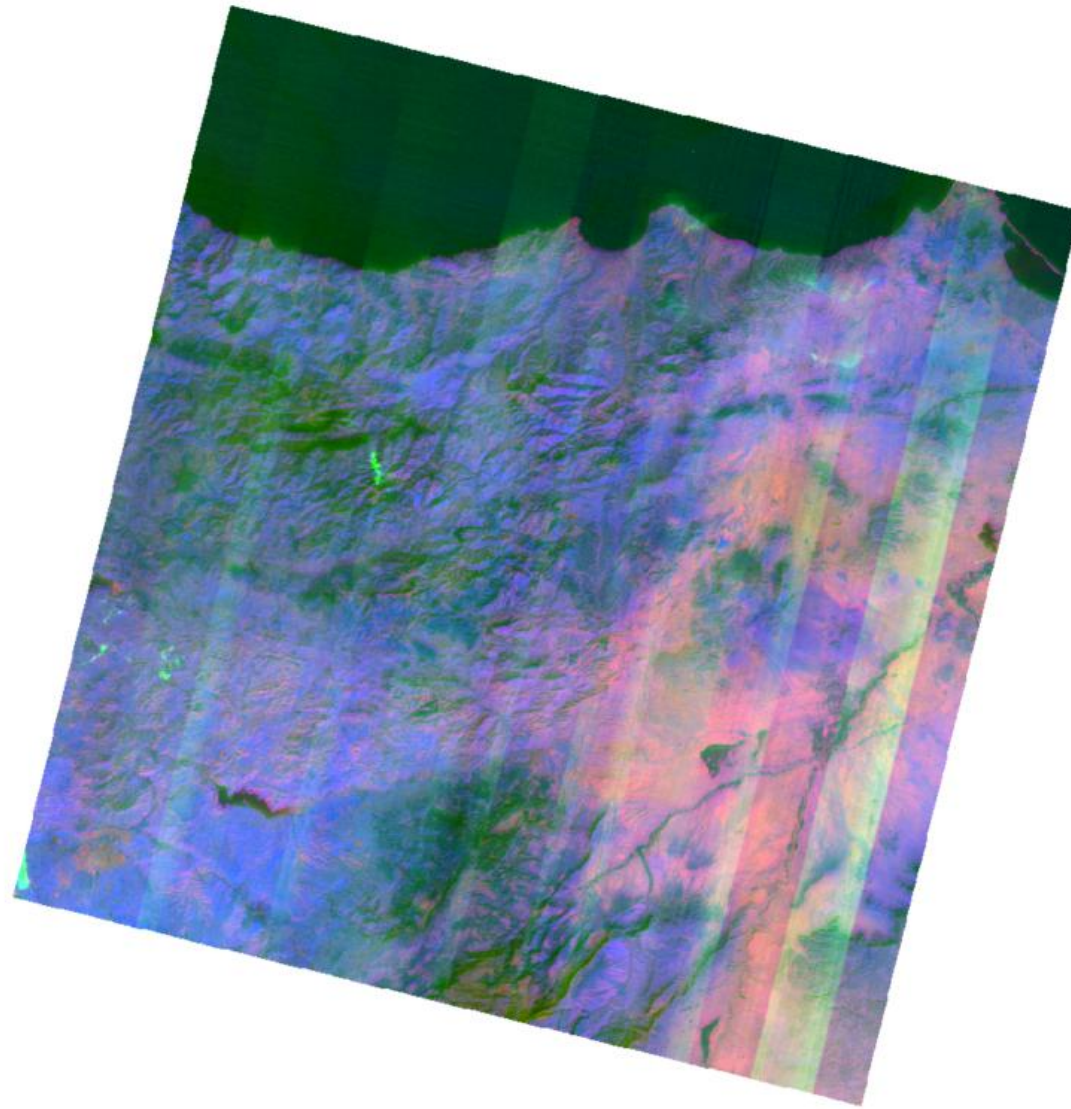
- Map
 - Composite Bands
 - RGB
 - Red: Band_1
 - Green: Band_2
 - Blue: Band_3
 - LC08_L1TP_200036_20141017_20200910_02_T1_B
 - Value
 - 24128
 - 6220
 - LC08_L1TP_200036_20141017_20200910_02_T1_B
 - Value
 - 24886
 - 5656
 - LC08_L1TP_200036_20141017_20200910_02_T1_B
 - Value
 - 28597
 - 4884
 - LC08_L1TP_200036_20141017_20200910_02_T1_B
 - Value
 - 56689
 - 4689
 - LC08_L1TP_200036_20141017_20200910_02_T1_B
 - Value
 - 65535
 - 4931
 - LC08_L1TP_200036_20141017_20200910_02_T1_B
 - Value
 - 21614
 - 7139



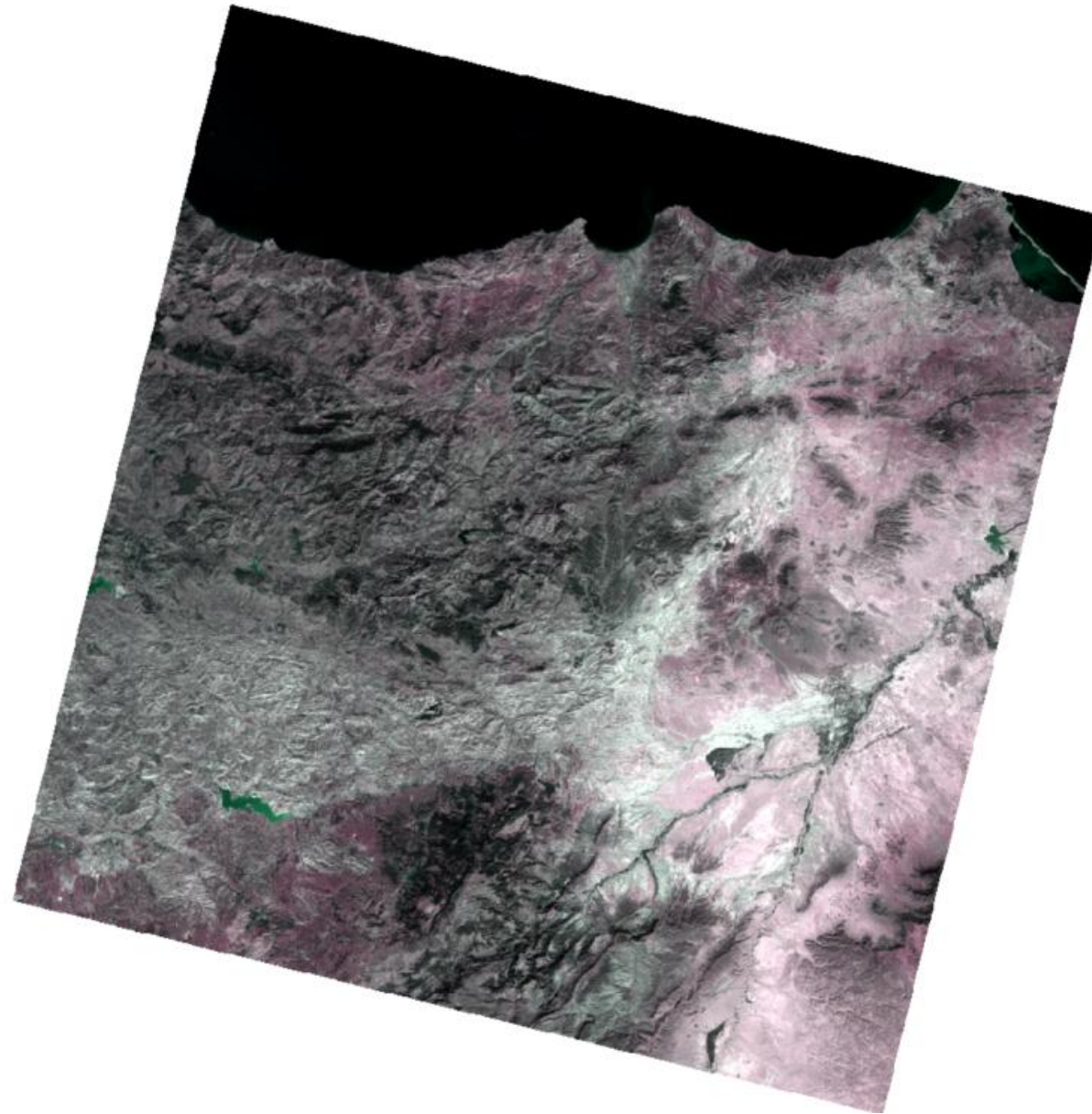
1:1,201,890

273.735.03E 3,927,690.67N m

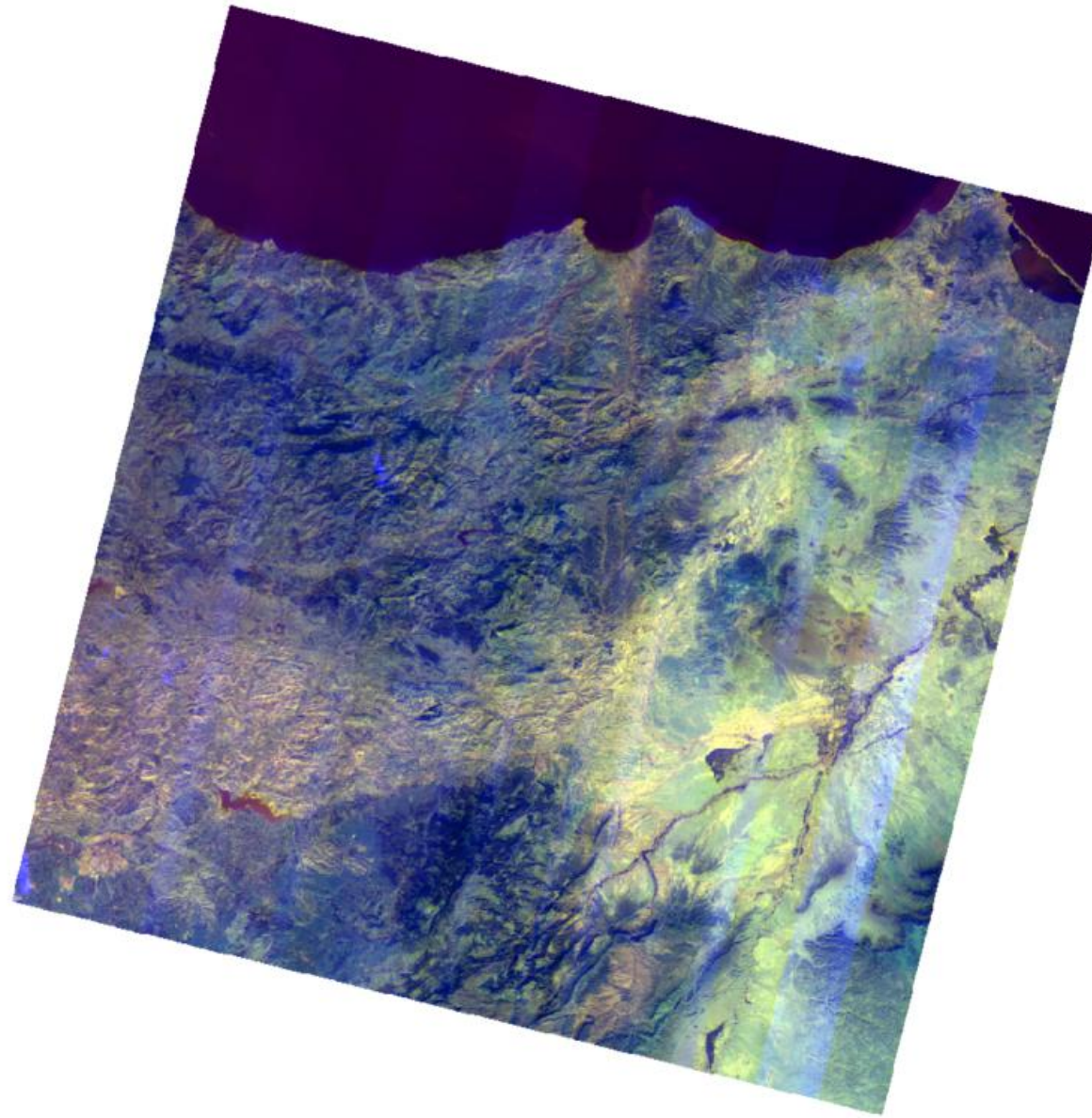
Natural color **R** = Bande 4 **G** = Bande 3 **B** = Bande 2



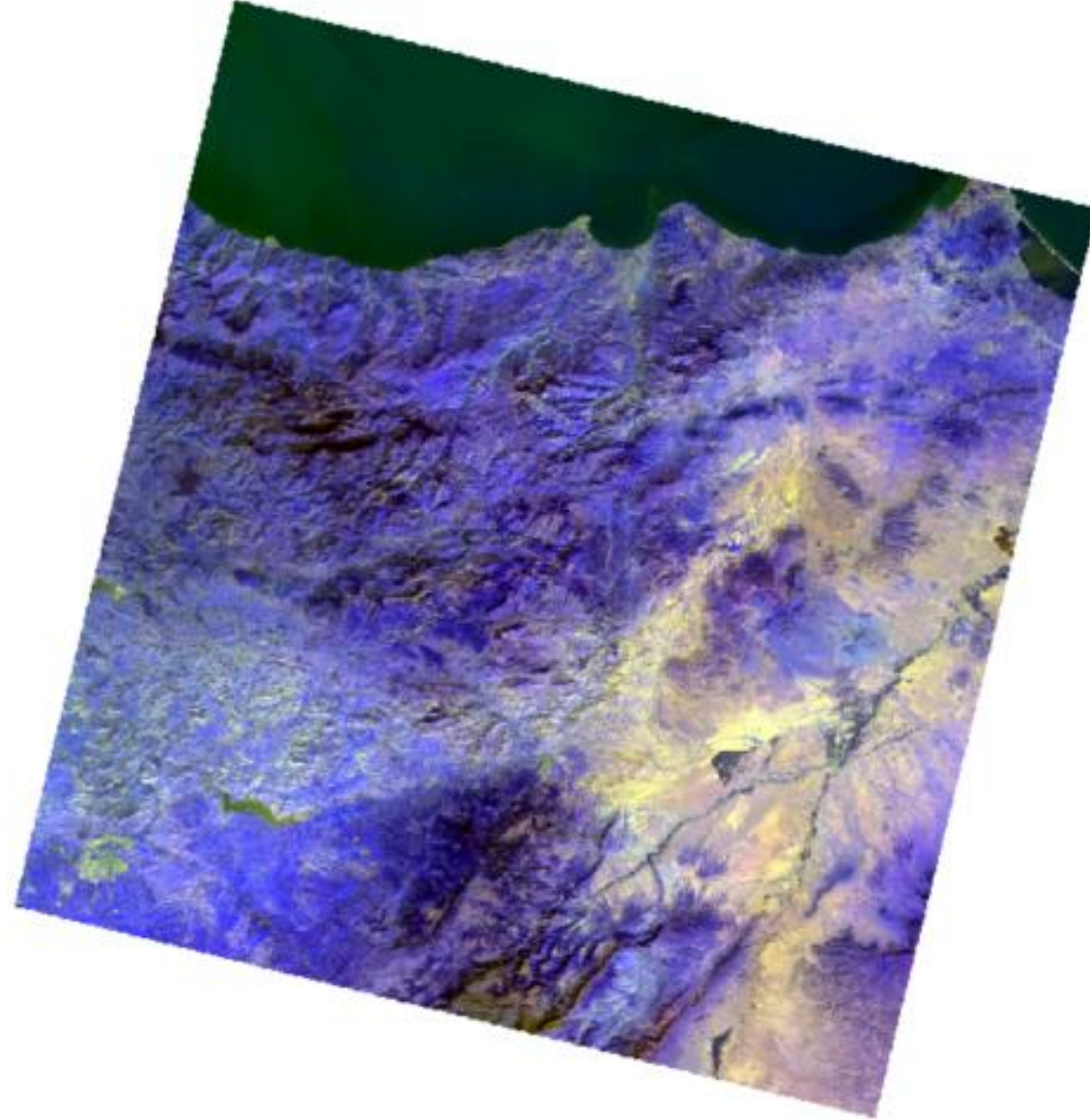
False color (urban) R = Bande 7 G = Bande 6 B = Bande 4



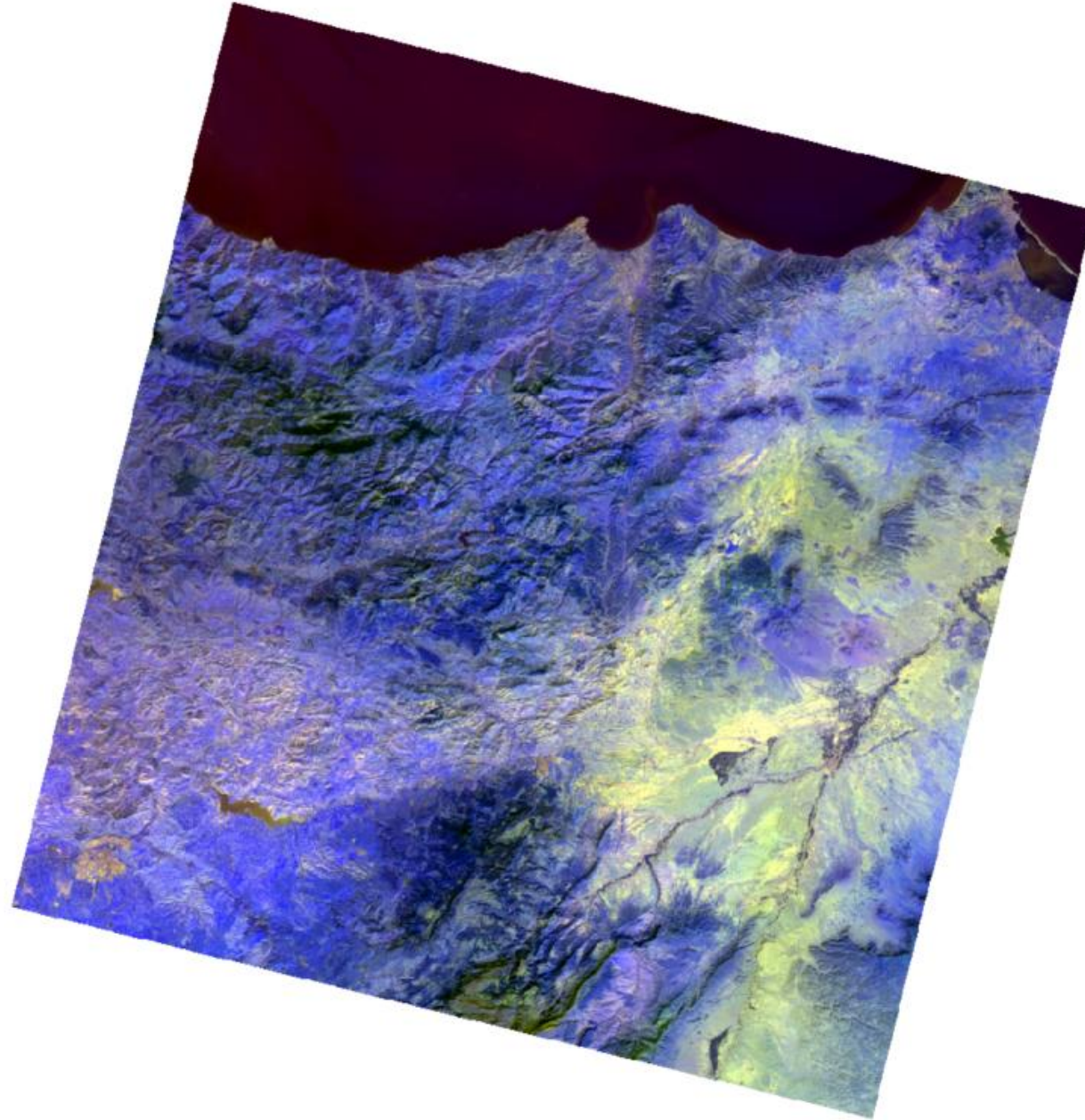
Color infrared (vegetation) R = Bande 5 G = Bande 4 B = Bande 3



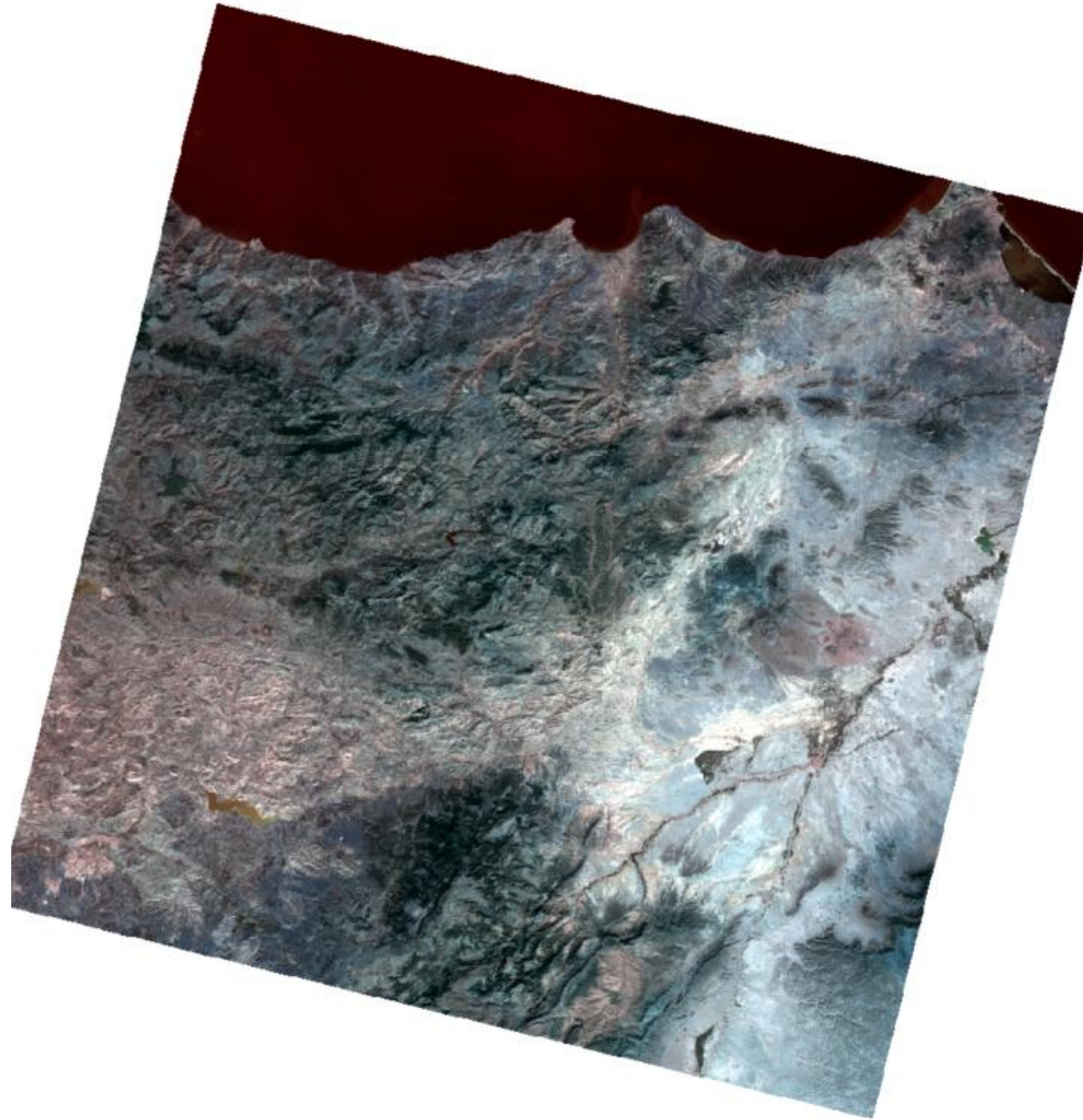
Agriculture R = Bande 6 G = Bande 5 B = Bande 2



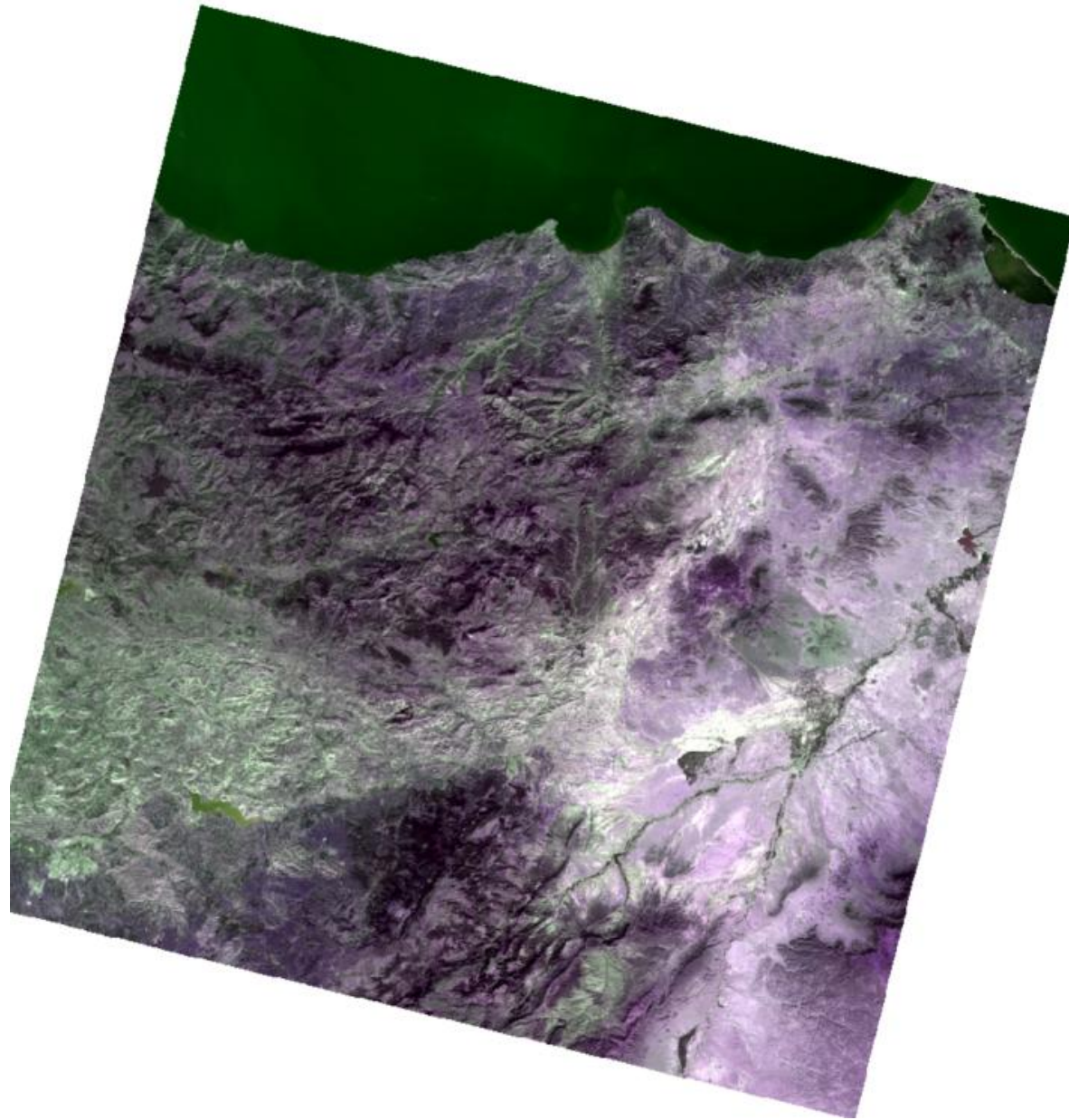
Healthy vegetation R = Bande 5 G = Bande 6 B = Bande 2



Land/Water R = Bande 5 G = Bande 6 B = Bande 4

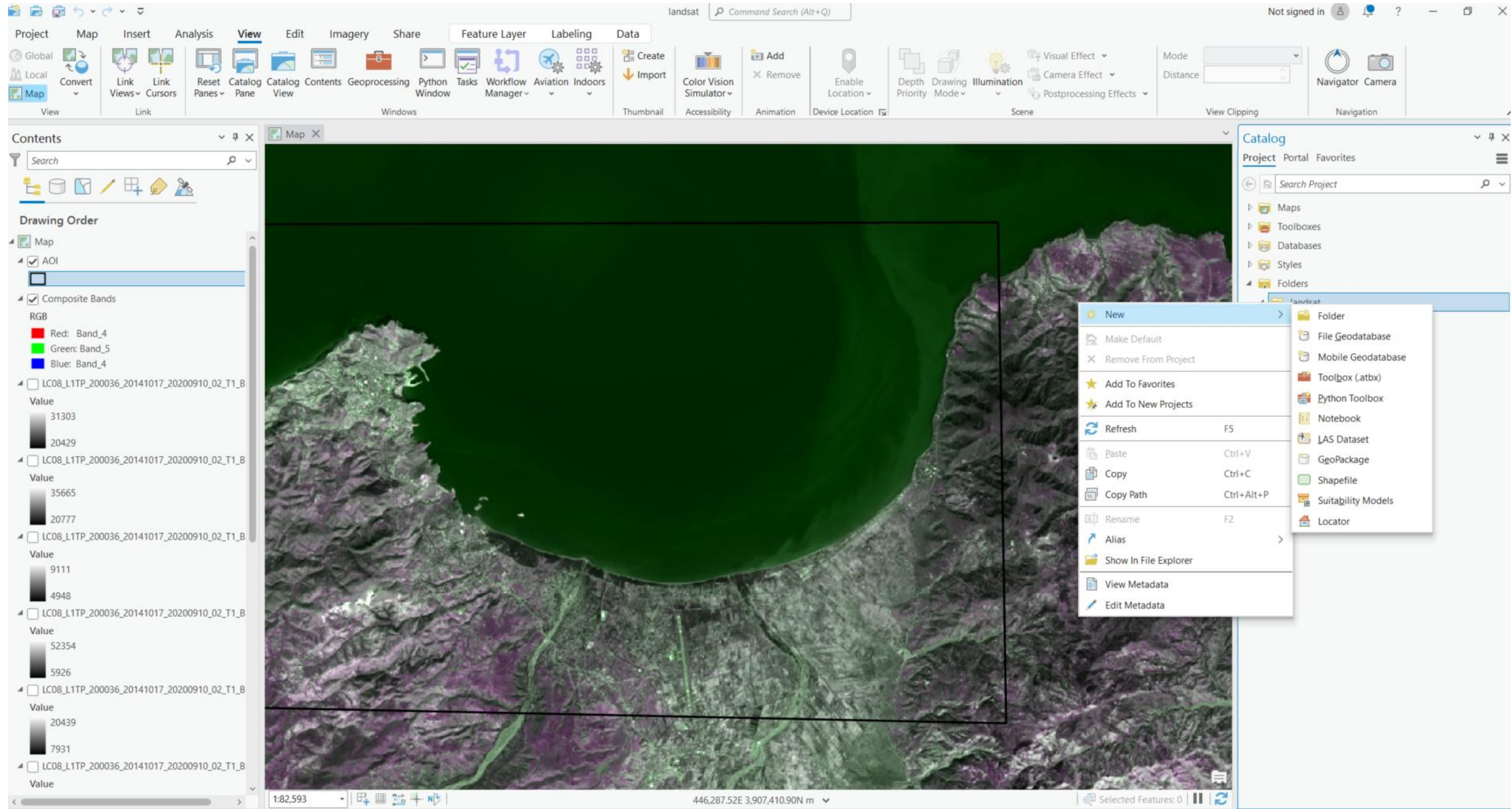


Vegetation analysis R = Bande 6 G = Bande 5 B = Bande 4



Application de la classification supervisée à une image Landsat

Créer un shapefile polygone de la zone d'étude



Extract by Mask de la zone d'étude à partir de l'image Landsat

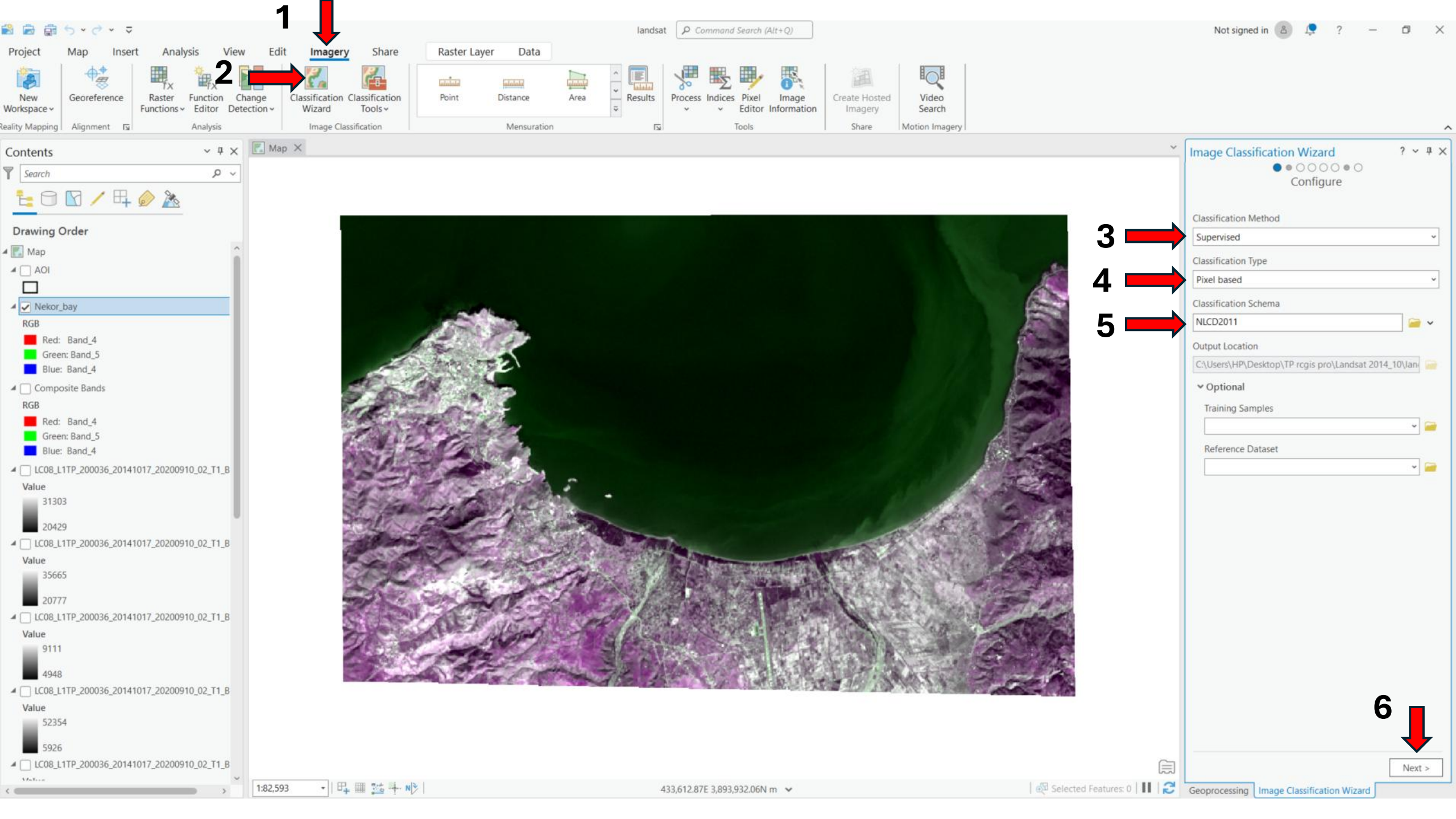
The screenshot displays the QGIS desktop environment. The main map window shows a satellite image of a coastal area with a dark green water body and a purple-toned land area. The 'Contents' panel on the left lists the layers: 'Map', 'AOI', 'Nekor_bay' (selected), and several 'LC08_L1TP' satellite imagery layers. The 'Geoprocessing' panel on the right is open, showing a list of tools under the 'Toolboxes' tab. The 'Extract by Mask' tool is highlighted in blue. The top toolbar includes various icons for project, map, insert, analysis, view, edit, imagery, share, raster layer, and data. The status bar at the bottom indicates 'landsat' and 'Command Search (Alt+Q)'.

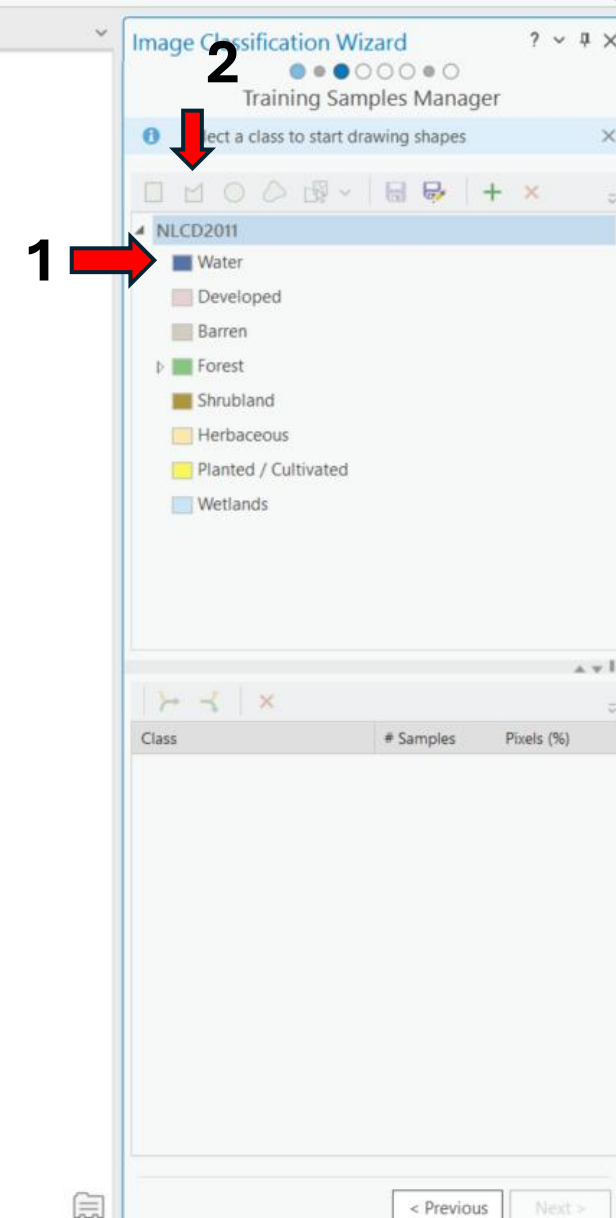
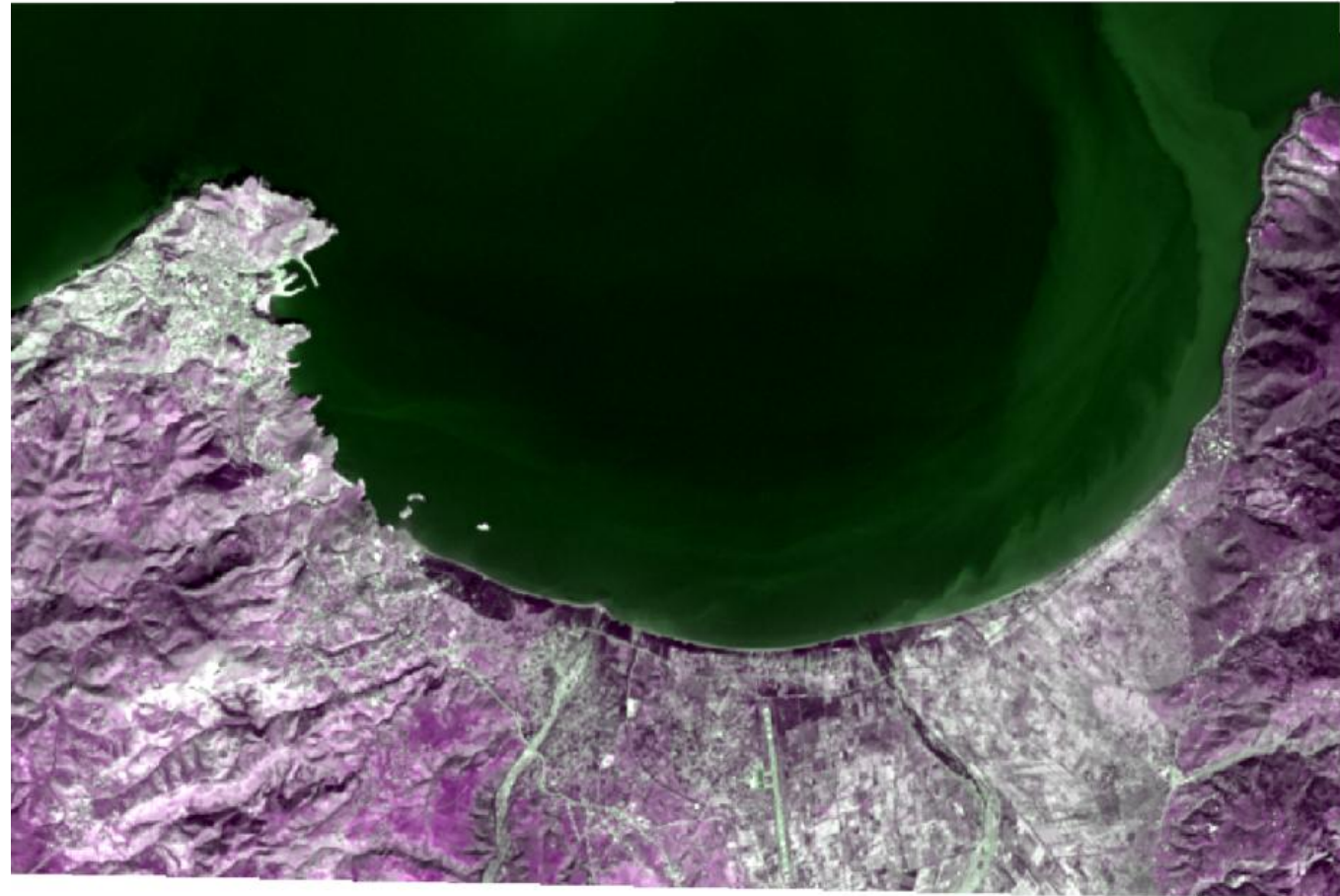
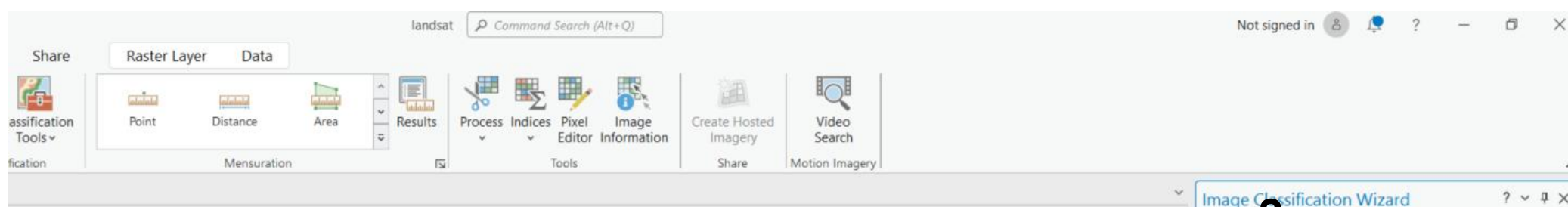
Contents Panel:

- Map
- AOI
- ☒ Nekor_bay
 - RGB
 - Red: Band_4
 - Green: Band_5
 - Blue: Band_4
- Composite Bands
 - RGB
 - Red: Band_4
 - Green: Band_5
 - Blue: Band_4
- LC08_L1TP_200036_20141017_20200910_02_T1_B
 - Value
 - 31303
 - 20429
- LC08_L1TP_200036_20141017_20200910_02_T1_B
 - Value
 - 35665
 - 20777
- LC08_L1TP_200036_20141017_20200910_02_T1_B
 - Value
 - 9111
 - 4948
- LC08_L1TP_200036_20141017_20200910_02_T1_B
 - Value
 - 52354
 - 5926
- LC08_L1TP_200036_20141017_20200910_02_T1_B

Geoprocessing Panel:

- Find Tools
- Favorites
- Toolboxes
 - Indoor Positioning Tools
 - Indoors Tools
 - Intelligence Tools
 - Linear Referencing Tools
 - Location Referencing Tools
 - Maritime Tools
 - Multidimension Tools
 - Network Analyst Tools
 - Network Diagram Tools
 - Parcel Tools
 - Public Transit Tools
 - Server Tools
 - Space Time Pattern Mining Tools
 - ☒ Spatial Analyst Tools
 - Conditional
 - Density
 - Distance
 - ☒ Extraction
 - Extract by Attributes
 - Extract by Circle
 - Extract by Mask**
 - Extract by Points
 - Extract by Polygon
 - Extract by Rectangle
 - Extract Multi Values to Points
 - Extract Values to Points
 - Sample
 - Generalization
 - Groundwater





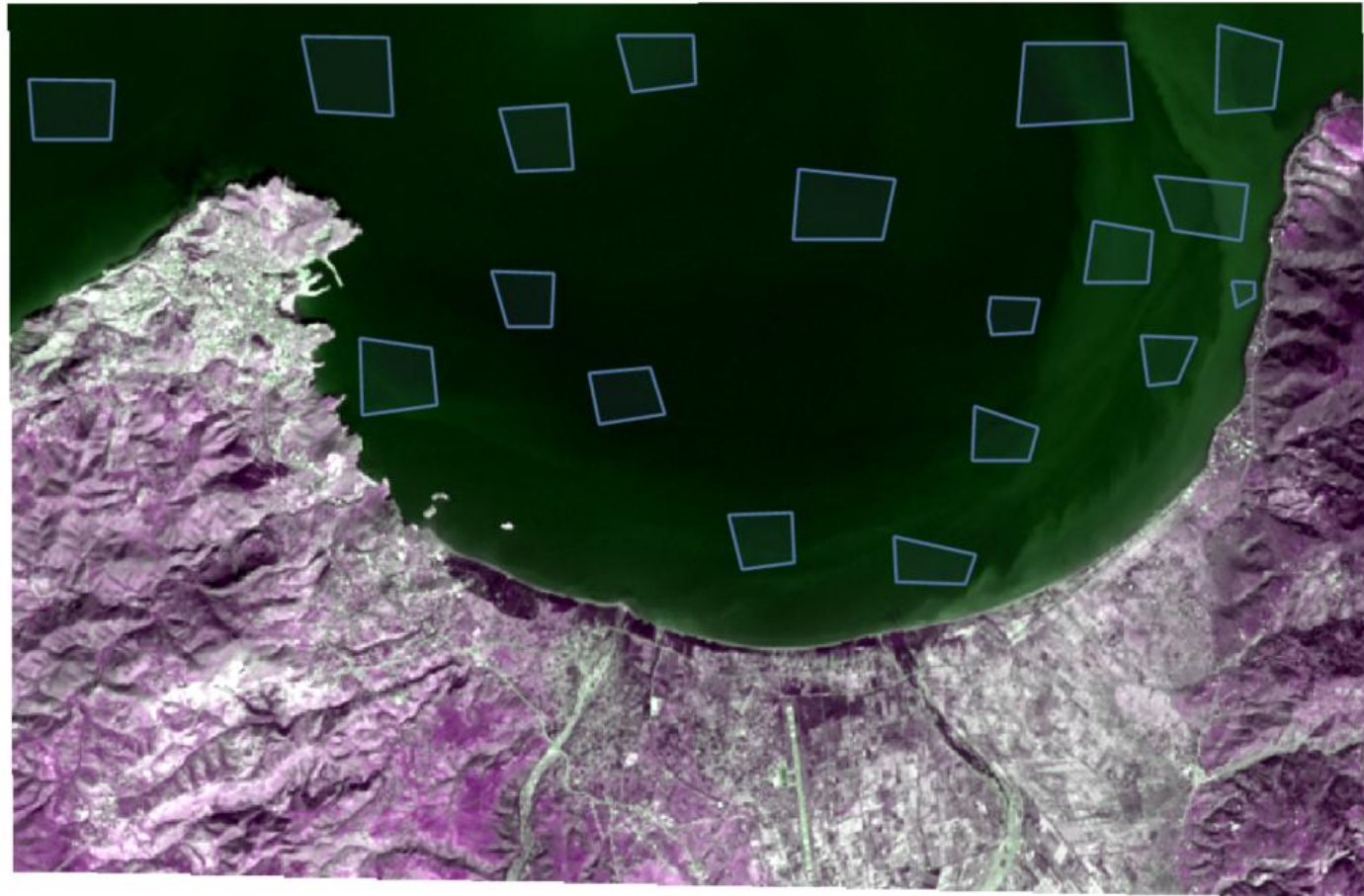


Image Classification Wizard

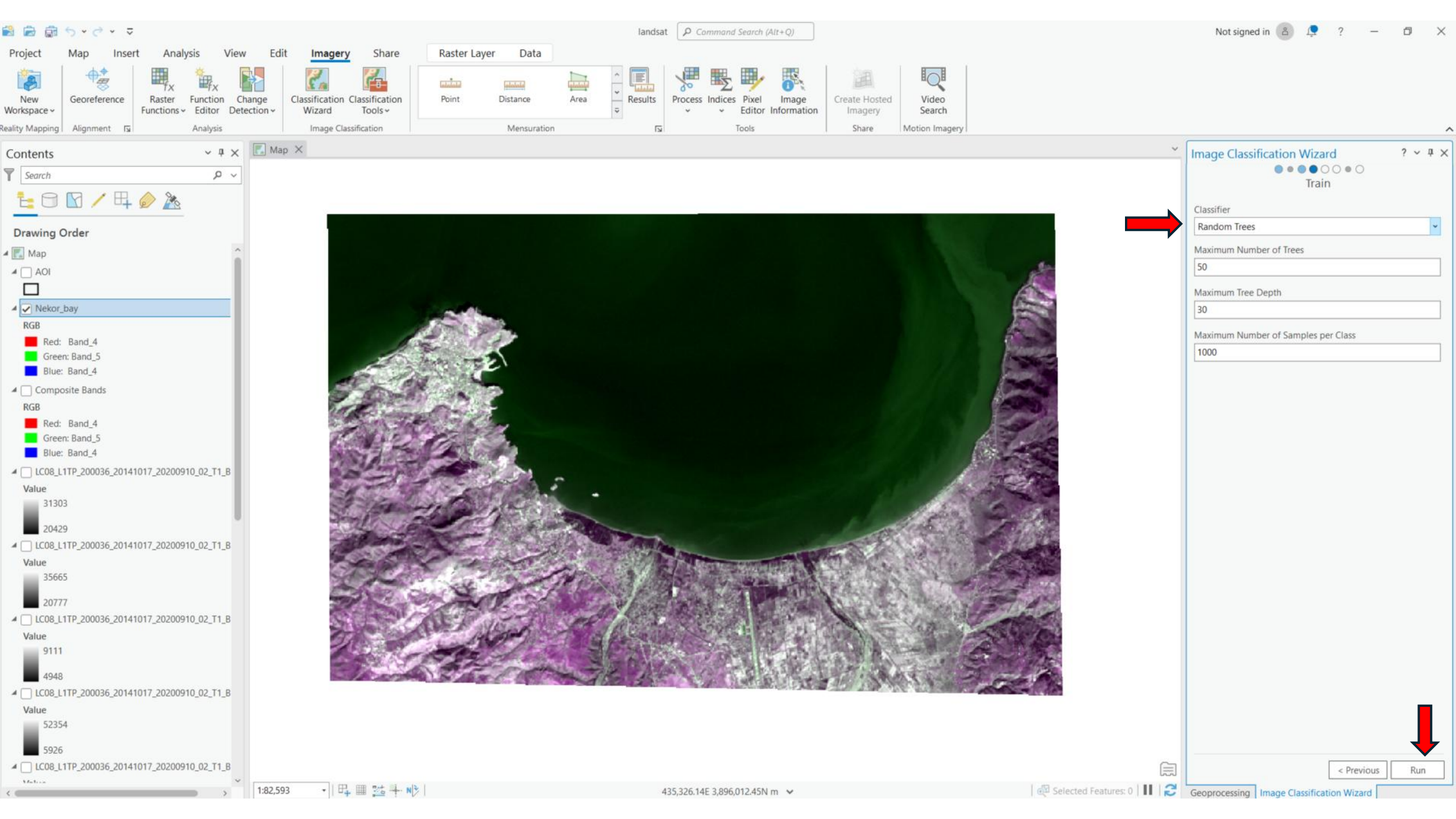
Training Samples Manager

NLCD2011

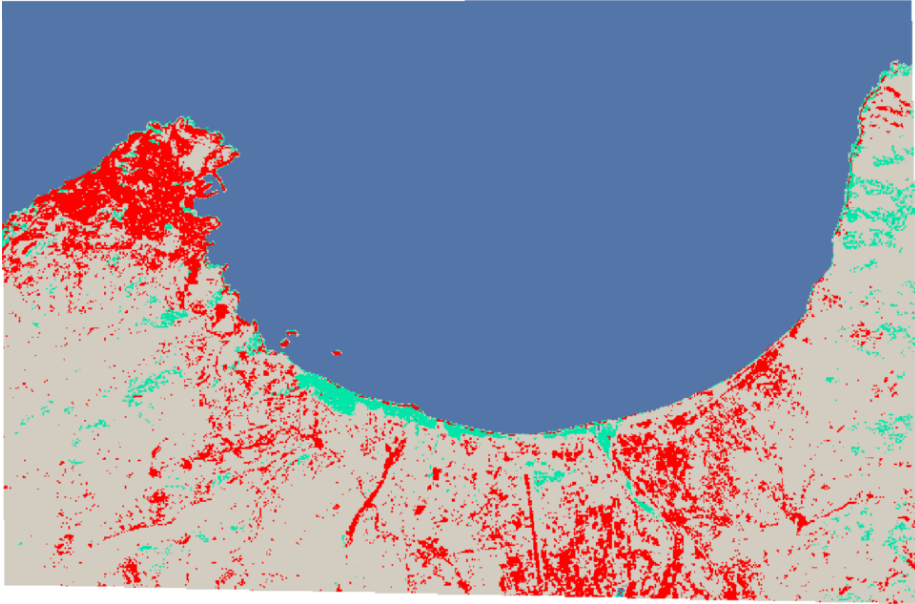
- Water
- Developed
- Barren
- Forest
- Shrubland
- Herbaceous
- Planted / Cultivated
- Wetlands

Class	# Samples	Pixels (%)
Water	1	2.34
Water	1	4.99
Water	1	4.11
Water	1	4.59
Water	1	5.75
Water	1	6.94
Water	1	5.34
Water	1	6.72
Water	1	12.30
Water	1	6.29
Water	1	0.61
Water	1	2.87
Water	1	3.86
Water	1	4.39

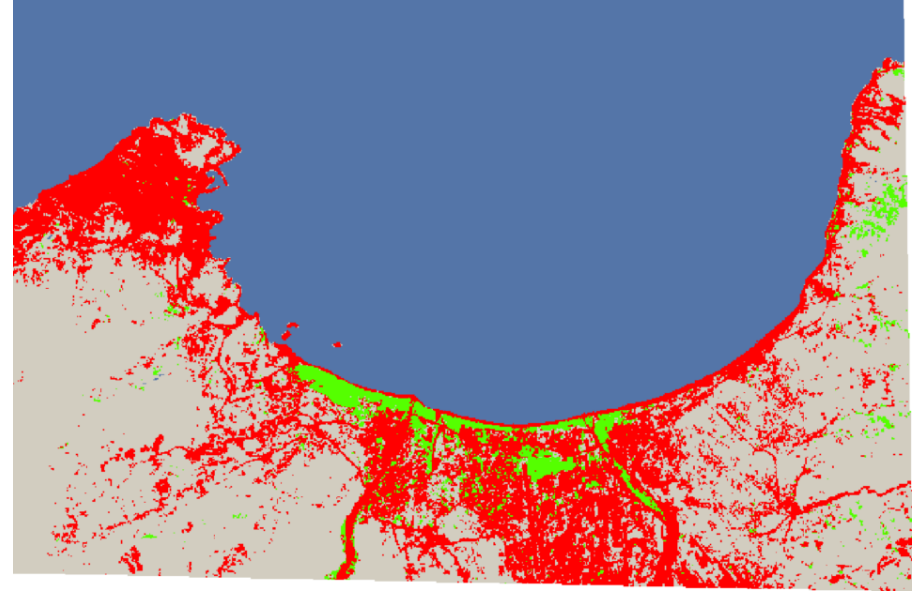
< PreviousNext >



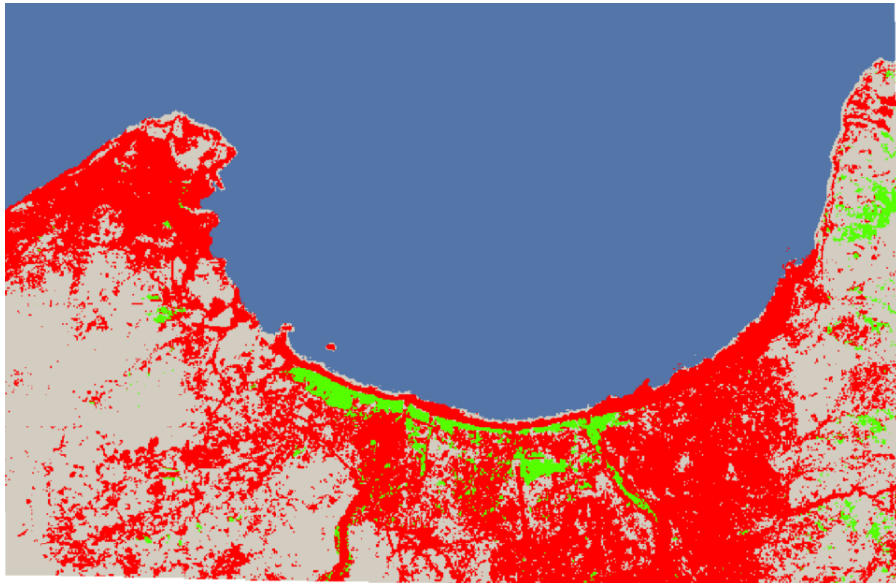
Random Trees



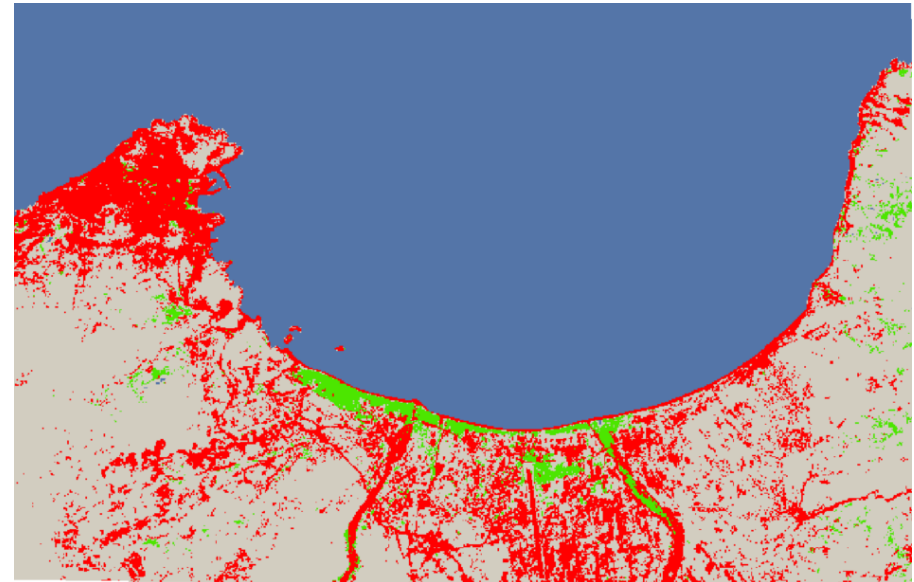
Support Vector Machine



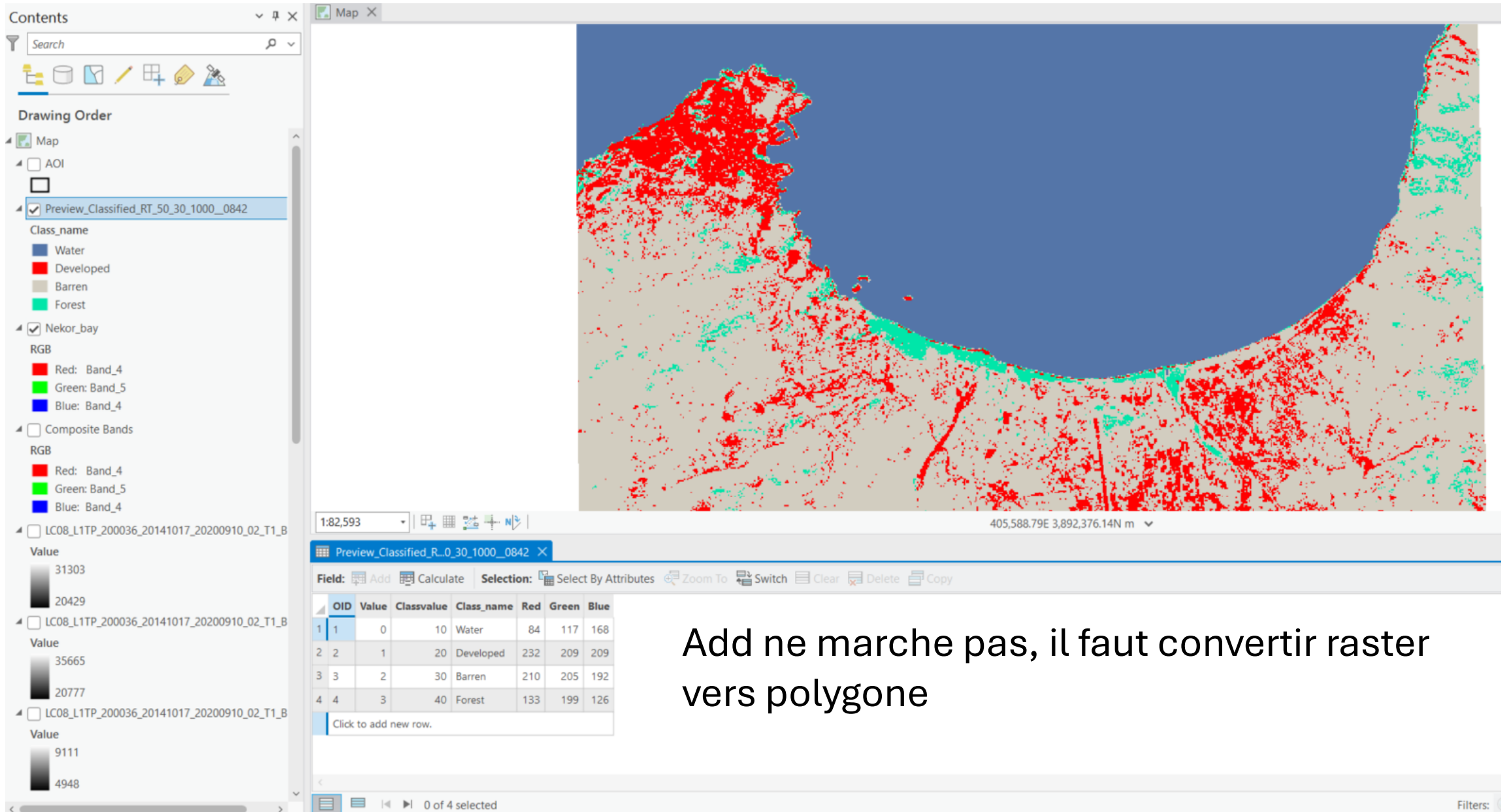
Maximum Likelihood



K – Nearest Neighbor



Calcul de la surface de chaque classe



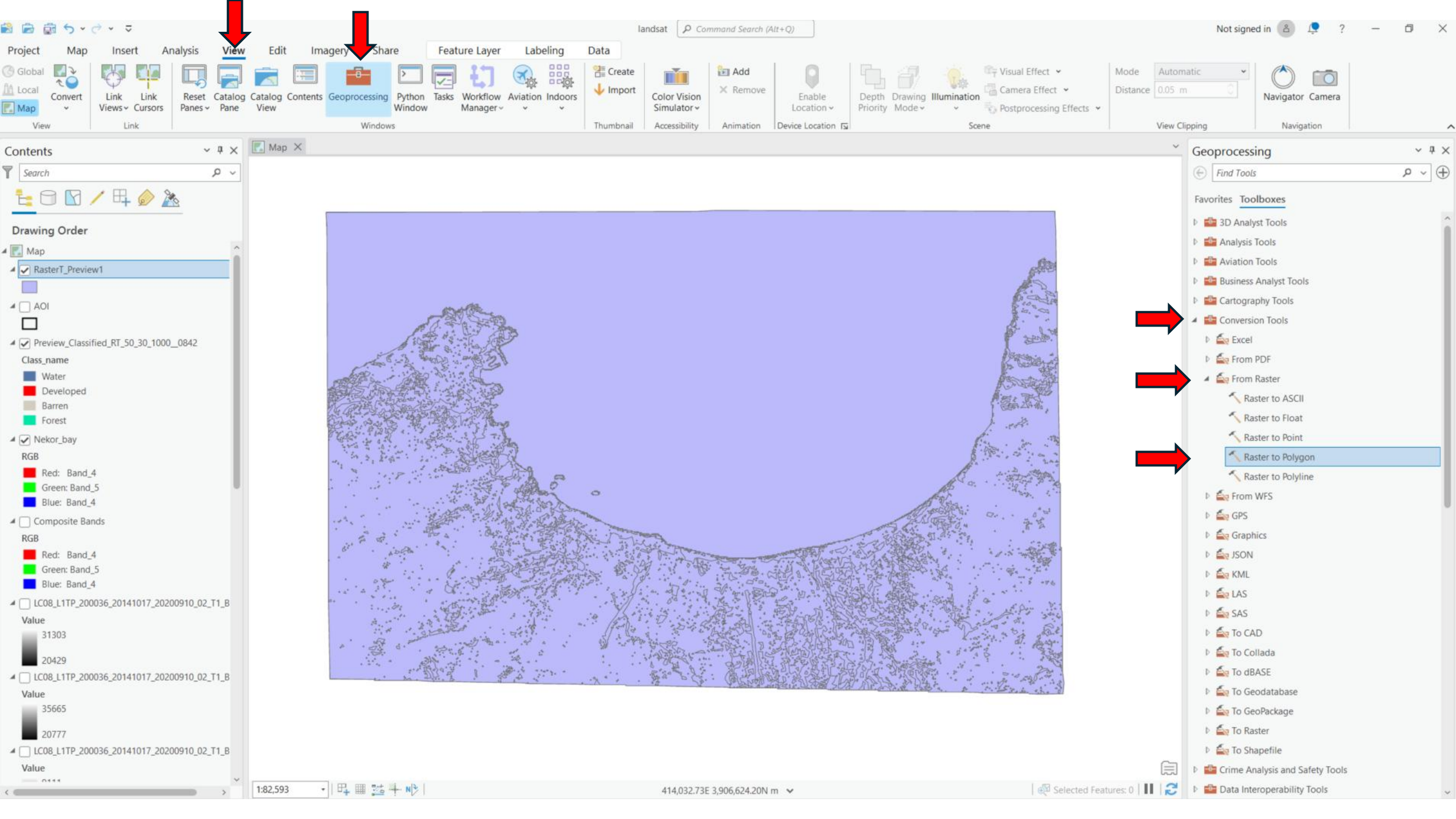
The screenshot displays the QGIS software interface. On the left, the 'Contents' panel shows the layer stack. The 'Map' layer is active, and the 'Preview_Classified_RT_50_30_1000_0842' layer is selected. Below it, the 'Nekor_bay' layer is also visible. The 'Class_name' legend indicates four classes: Water (blue), Developed (red), Barren (grey), and Forest (green). The 'Nekor_bay' layer is set to 'RGB' with 'Red: Band_4', 'Green: Band_5', and 'Blue: Band_4'. The 'Map' layer is also set to 'RGB' with the same band assignments. The 'Map' panel shows a map of a coastal area with a large blue body of water (Nekor Bay) and surrounding land areas colored red, grey, and green. The map scale is 1:82,593, and the coordinates are 405,588.79E 3,892,376.14N m.

Below the map, the 'Preview_Classified_R_0_30_1000_0842' layer's attribute table is displayed. The table has columns for 'OID', 'Value', 'Classvalue', 'Class_name', 'Red', 'Green', and 'Blue'. The data is as follows:

OID	Value	Classvalue	Class_name	Red	Green	Blue
1	1	0	Water	84	117	168
2	2	1	Developed	232	209	209
3	3	2	Barren	210	205	192
4	4	3	Forest	133	199	126

At the bottom of the attribute table, there is a button that says 'Click to add new row.' The status bar at the bottom indicates '0 of 4 selected'.

Add ne marche pas, il faut convertir raster vers polygone



Contents

Search

Drawing Order

- Map
 - ☒ RasterT_Preview1
 - ☐ AOI
 - ☐ Preview_Classified_RT_50_30_1000_0842
 - Class_name
 - Water
 - Developed
 - Barren
 - Forest
 - ☐ Nekor_bay
 - RGB
 - Red: Band_4
 - Green: Band_5
 - Blue: Band_4
 - ☐ Composite Bands
 - RGB
 - Red: Band_4
 - Green: Band_5
 - Blue: Band_4
 - ☐ LC08_L1TP_200036_20141017_20200910_02_T1_B
 - Value
 - 31303
 - 20429
 - ☐ LC08_L1TP_200036_20141017_20200910_02_T1_B
 - Value
 - 35665
 - 20777
 - ☐ LC08_L1TP_200036_20141017_20200910_02_T1_B

Map

1:82,593

RasterT_Preview1

Field: Add Calculate Selection: Select By Attributes Zoom To

	OBJECTID *	Shape *	Id	gridcode	Shape_Length	Shape_Area	Class_name
1	1	Polygon	1	3	112.494865	576.34964	Barren
2	2	Polygon	2	4	120	900	Forest
3	3	Polygon	3	3	112.494012	576.342773	Barren
4	4	Polygon	4	3	120	900	Barren
5	5	Polygon	5	4	120	900	Forest
6	6	Polygon	6	3	120	900	Barren
7	7	Polygon	7	4	120	900	Forest
8	8	Polygon	8	3	360	5400	Barren
9	9	Polygon	9	4	112.494865	576.34964	Forest
10	10	Polygon	10	4	120	900	Forest
11	11	Polygon	11	3	120	900	Barren
12	12	Polygon	12	4	120	900	Forest

Il faut rassembler les polygones qui ont la même classe

Geoprocessing

dissolve

Dissolve (Data Management Tools)
Aggregates features based on specified attributes.

Dissolve Network (Network Analyst Tools)
Creates a network dataset that minimizes the number of line features required to correctly model the input netwo...

Dissolve Boundaries (GeoAnalytics Desktop Tools)
Finds polygons that intersect or have the same field values and merges them to form a single polygon.

Dissolve Route Events (Linear Referencing Tools)
Removes redundant information from event tables or separates event tables having more than one descripti...

Geoprocessing

←

Dissolve

+

The Pairwise Dissolve tool provides enhanced functionality or performance.

×

Parameters

Environments

?

Input Features

RasterT_Preview1

▼

Output Feature Class

RasterT_Preview1_Dissolve

▼

Dissolve Fields

▼

gridcode

▼

Class_name

▼

▼

Statistics Fields

Field

▼

Statistic Type

▼

☒ Create multipart features

☐ Unsplit lines



1:82,593

RasterT_Preview1

RasterT_Preview1_Dissolve

Field:

Add

Calculate

Selection:

Select By Attributes

Zoom To

	OBJECTID *	Shape *	gridcode	Class_name	Shape_Length	Shape_Area
1	1	Polygon	1	Water	80266.334399	147049064.378891
2	2	Polygon	2	Developed	952752.382463	22283518.131947
3	3	Polygon	3	Barren	1200565.649754	110412811.063684
4	4	Polygon	4	Forest	296118.949795	5227038.739469
Click to add new row.						

Puis clic sur run

Avant de calculer la surface de chaque classe, il faut confirmer que l'unité linière est mètre.

Contents

Search

1

Clic droit

Map

✓ RasterT_Preview1_Dissolve

Copy

Remove

Group

Attribute Table

Data Engineering

Add Error Layers

Data Design

Create Chart

New Report

Joins and Relates

Zoom To Layer

Zoom To Make Visible

Selection

Label

Labeling Properties...

Convert Labels

Symbology

Disable Pop-ups

Configure Pop-ups

Data

Sharing

View Metadata

Edit Metadata

Properties

2

Properties

Show the properties for the selected layers.

3

4

5

Layer Properties: RasterT_Preview1_Dissolve

General

Metadata

Source

Elevation

Selection

Display

Cache

Definition Query

Time

Floors

Range

Indexes

Joins

Relates

Vertical Units

meter

> Extent

> Spatial Reference

Projected Coordinate System	WGS 1984 UTM Zone 30N
Projection	Transverse Mercator
WKID	32630
Authority	EPSG
Linear Unit	Meters (1.0)
False Easting	500000.0
False Northing	0.0
Central Meridian	-3.0
Scale Factor	0.9996
Latitude Of Origin	0.0

OK

Cancel

Contents

Search

Drawing Order

Map

RasterT_Preview1

RasterT_Preview1

AOI

Preview_Classified

Class_name

- Water
- Developed
- Barren
- Forest

Nekor_bay

RGB

- Red: Band_4
- Green: Band_5
- Blue: Band_4

Composite Bands

RGB

- Red: Band_4
- Green: Band_5
- Blue: Band_4

LC08_L1TP_20003

Value

31303

20429

LC08_L1TP_20003

Value

35665

20777

Copy

Remove

Group

Attribute Table Ctrl+T

Data Engineering Ctrl+Shift+D

Add Error Layers

Data Design

Create Chart

New Report

Joins and Relates

Zoom To Layer

Zoom To Make Visible

Selection

Label

Labeling Properties...

Convert Labels

Symbology

Disable Pop-ups

Configure Pop-ups

Data

Sharing

View Metadata

Edit Metadata

Properties

Export Features

Export Table

Rematch Add

Set Data Source

Map

RasterT_Preview1_Dissolve

Calculate

Selection: Select By Attributes

Shape *	gridcode	Class_name	Shape_Length	Shape_Area
Water	1	Water	80266.334399	14704906
Developed	2	Developed	952752.382463	2228351
Barren	3	Barren	1200565.649754	11041281
Forest	4	Forest	296118.949795	522703

Dans le cas l'unité est n'est pas mètre

Changer la projection

Export Features

Parameters Environment

Output Coordinates

Output Coordinate System

Geographic Transformations

Processing Extent

Extent Default

Geodatabase

Output CONFIG Keyword

Auto Commit 1000

Maintain Attachments

Geodatabase Advanced

Preserve Global IDs

Fields

Maintain fully qualified field names

Transfer field domain descriptions

XY Values

Output XY Domain Same As Input

OK

RasterT_Preview1_Dissolve

Field: Add Calculate Selection: Select By Attributes Zoom To

OBJECTID * **Add Field**

Add a new field in this table.

	OBJECTID	Shape_Length	Shape_Area
1	1	266.334399	147049064.378891
2	2	Polygon	2 Developed 952752.382463 22283518.131947
3	3	Polygon	3 Barren 1200565.649754 110412811.063684
4	4	Polygon	4 Forest 296118.949795 5227038.739469

Click to add new row.

Calculate Geometry

This tool modifies the Input Features

Parameters Environments

Input Features: RasterT_Preview1_Dissolve

Geometry Attributes

Field (Existing or New): surface_km Property: Area

Area Unit: Square Kilometers

Coordinate System: WGS_1984_UTM_Zone_30N

Sort Ascending
Sort Descending
Custom Sort
Hide Field
Freeze/Unfreeze Field
Calculate Field
Calculate Geometry
Statistics
Summarize
Fields

Fields View
Show the fields view for the current table.

RasterT_Preview1_Dissolve *Fields: RasterT_Preview1_Dissolve

Current Layer: RasterT_Preview1_Dissolve

Visible	Read Only	Field Name	Alias	Data Type	Allow NULL
☒	☒	OBJECTID	OBJECTID	Object ID	☐
☒	☐	Shape	Shape	Geometry	☒
☒	☐	gridcode	gridcode	Long	☒
☒	☐	Class_name	Class_name	Text	☒
☒	☒	Shape_Length	Shape_Length	Double	☒
☒	☒	Shape_Area	Shape_Area	Double	☒
☒	☐	surface_km		Double	☒

RasterT_Preview1_Dissolve

Field: Add Calculate Selection: Select By Attributes Zoom To Switch

	OBJECTID *	Shape *	gridcode	Class_name	Shape_Length	Shape_Area	surface_km
1	1	Polygon	1	Water	80266.334399	147049064.378891	<Null>
2	2	Polygon	2	Developed	952752.382463	22283518.131947	<Null>
3	3	Polygon	3	Barren	1200565.649754	110412811.063684	<Null>
4	4	Polygon	4	Forest	296118.949795	5227038.739469	<Null>

Click to add new row.

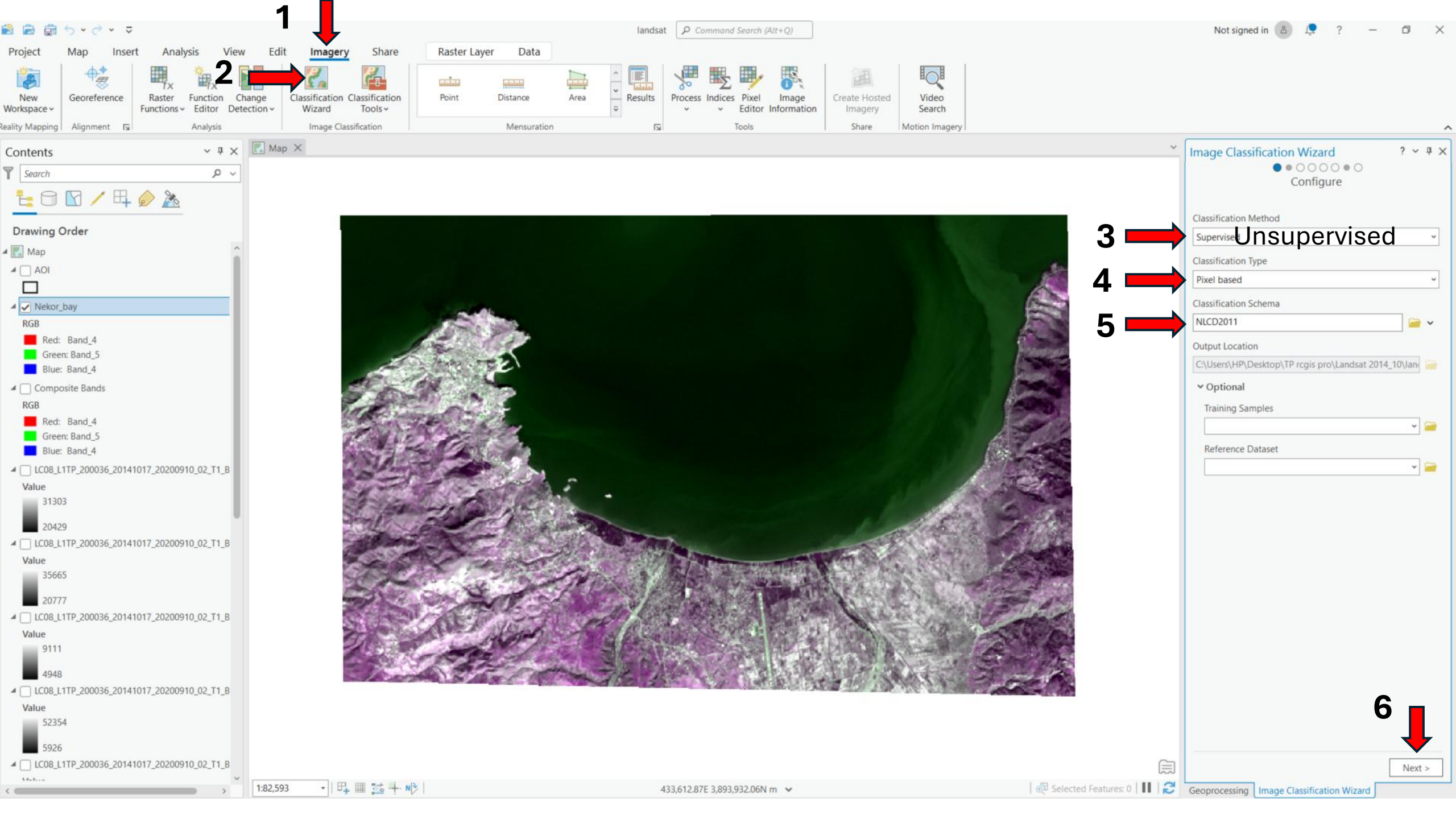
RasterT_Preview1_Dissolve

Field: Add Calculate Selection: Select By Attributes Zoom To Switch

	OBJECTID *	Shape *	gridcode	Class_name	Shape_Length	Shape_Area	surface_km
1	1	Polygon	1	Water	80266.334399	147049064.378891	147.049064
2	2	Polygon	2	Developed	952752.382463	22283518.131947	22.283518
3	3	Polygon	3	Barren	1200565.649754	110412811.063684	110.412811
4	4	Polygon	4	Forest	296118.949795	5227038.739469	5.227039

Click to add new row

Application de la classification non supervisée à une image Landsat



1

2

3

4

5

6

Unsupervised

Next >

Image Classification Wizard

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Train

i

Press the "L" key to toggle transparency of the preview layer.

✕

Classifier

ISO Cluster

▼

Maximum Number of Classes

9

Maximum Number of Iterations

20

Maximum Number of Cluster Merges per Iteration

5

Maximum Merge Distance

0.5

Minimum Samples Per Cluster

20

Skip Factor

10

< Previous

Run

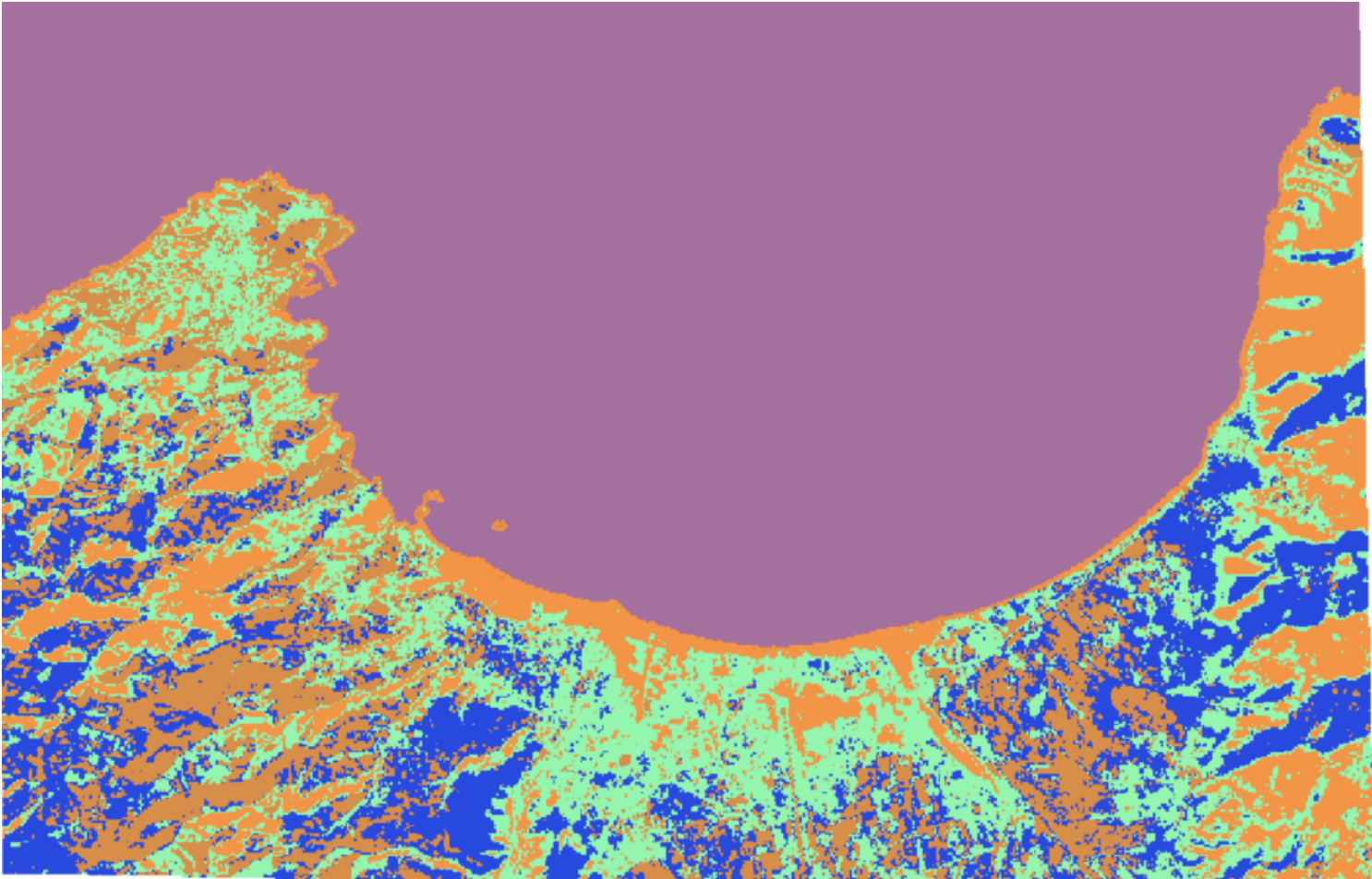


Image Classification Wizard

Assign Classes

2 ↓

1 Select class

↓

- Water
- Developed
- Barren
- Forest
- Shrubland
- Herbaceous
- Planted / Cultivated
- Wetlands

Old Class	New Class
0	Forest
1	
2	Developed
3	
4	Water

< Previous Next >



Image Classification Wizard

Assign Classes

NLCD2011

- Water
- Developed
- Barren
- Forest
- Shrubland
- Herbaceous
- Planted / Cultivated
- Wetlands

Old Class	New Class
0	Forest
1	Barren
2	Developed
3	Shrubland
4	Water

< Previous Next >



Image Classification Wizard

Reclassifier

Press the "L" key to toggle transparency of the preview layer.

Edit Type

- Reclassify an object
- Reclassify within a region

Remap Classes

Current Class: Any

New Class: Water

Edits Log

Type	Use	Old Class	New Class
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Final Classified Dataset

Reclassified_202509011131249441257

< Previous Run

☒ Reclassified_202509011131249441257

Class_name

Water

Developed

Barren

Forest

Shrubland



calcul d'indices de végétation NDVI

L'indice NDVI

L'indice NDVI (Normalized Difference Vegetation Index ou Indice de Végétation par Différence Normalisée) est un indicateur utilisé principalement en télédétection pour évaluer la végétation à partir d'images satellites ou de drones.

Formule du NDVI :

$$NDVI = \frac{(NIR - RED)}{(NIR + RED)}$$

➡

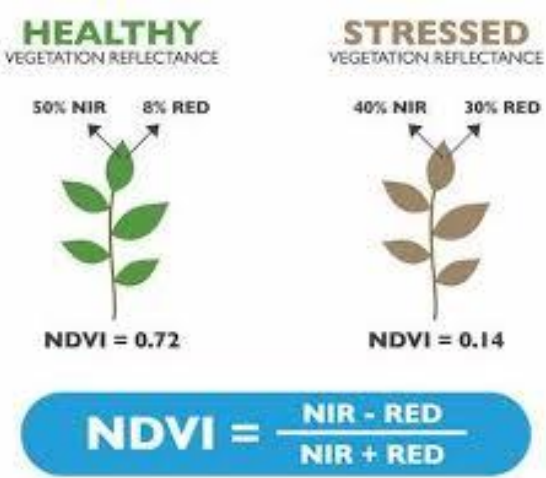
$$NDVI = \frac{\text{Bande5} - \text{bande 4}}{\text{Bande5} + \text{bande 4}}$$

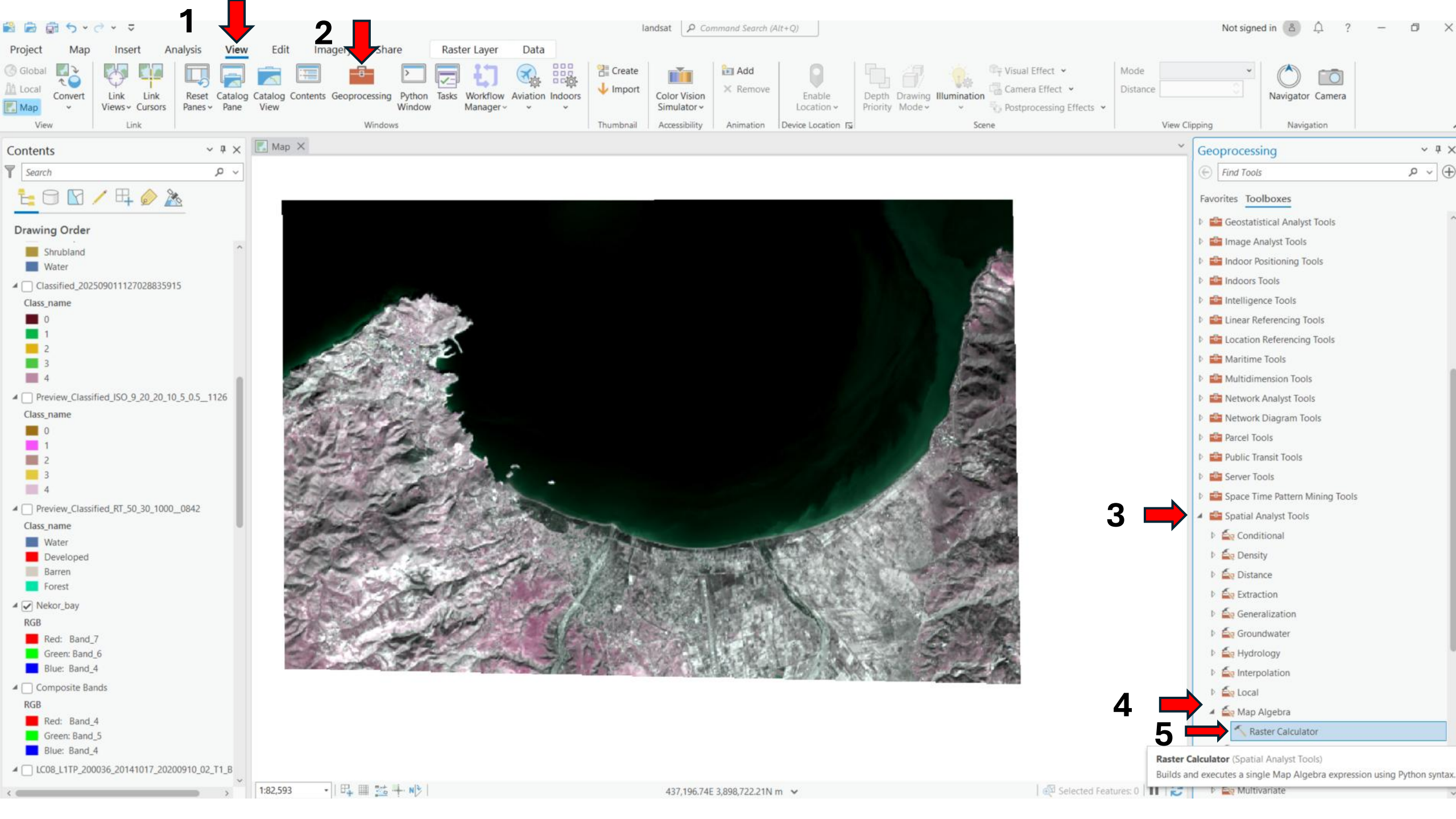
NIR : Réflectance dans le proche infrarouge (Near InfraRed)

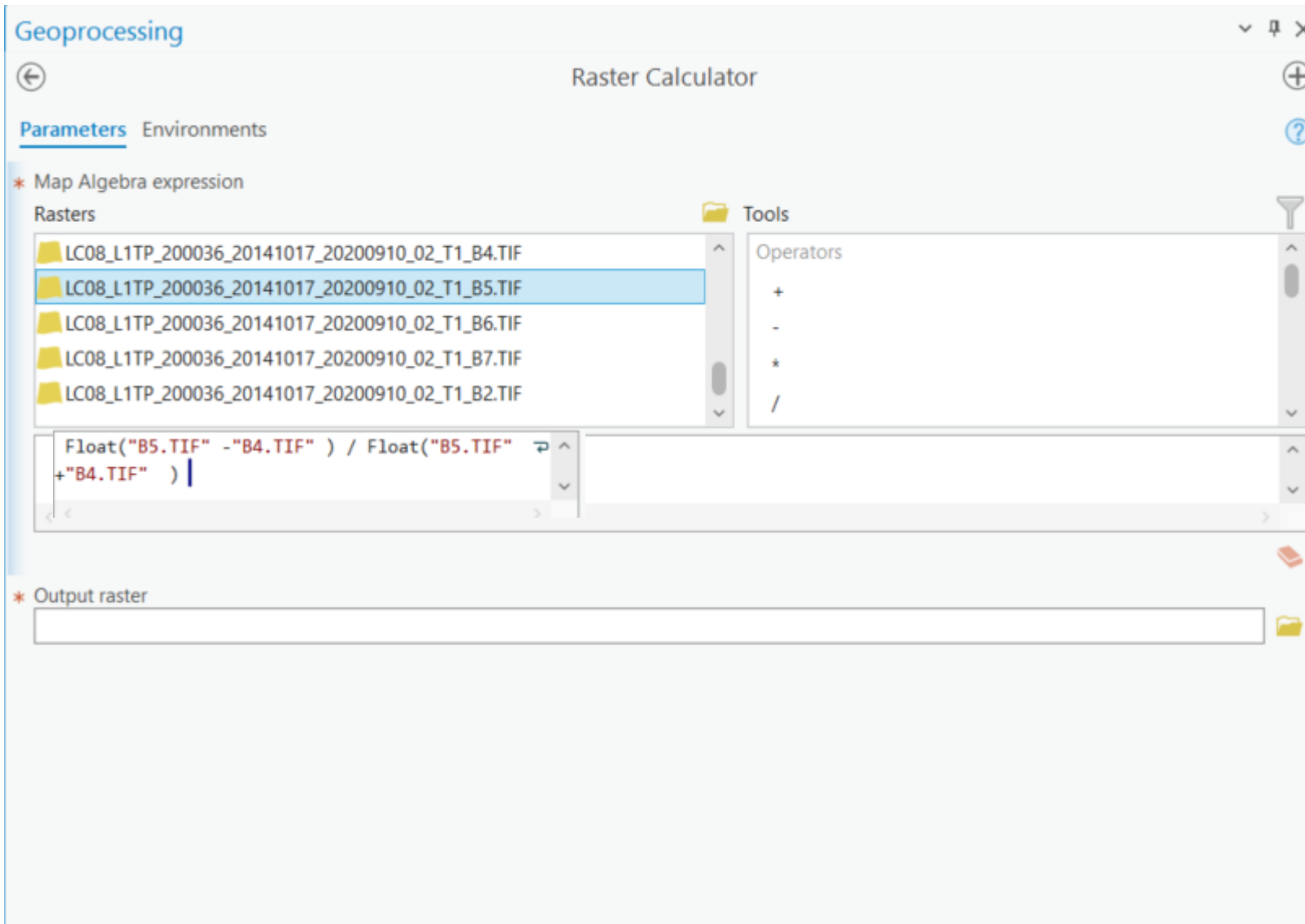
RED : Réflectance dans le rouge (bande visible)

Les valeurs du NDVI sont comprises entre -1 et 1

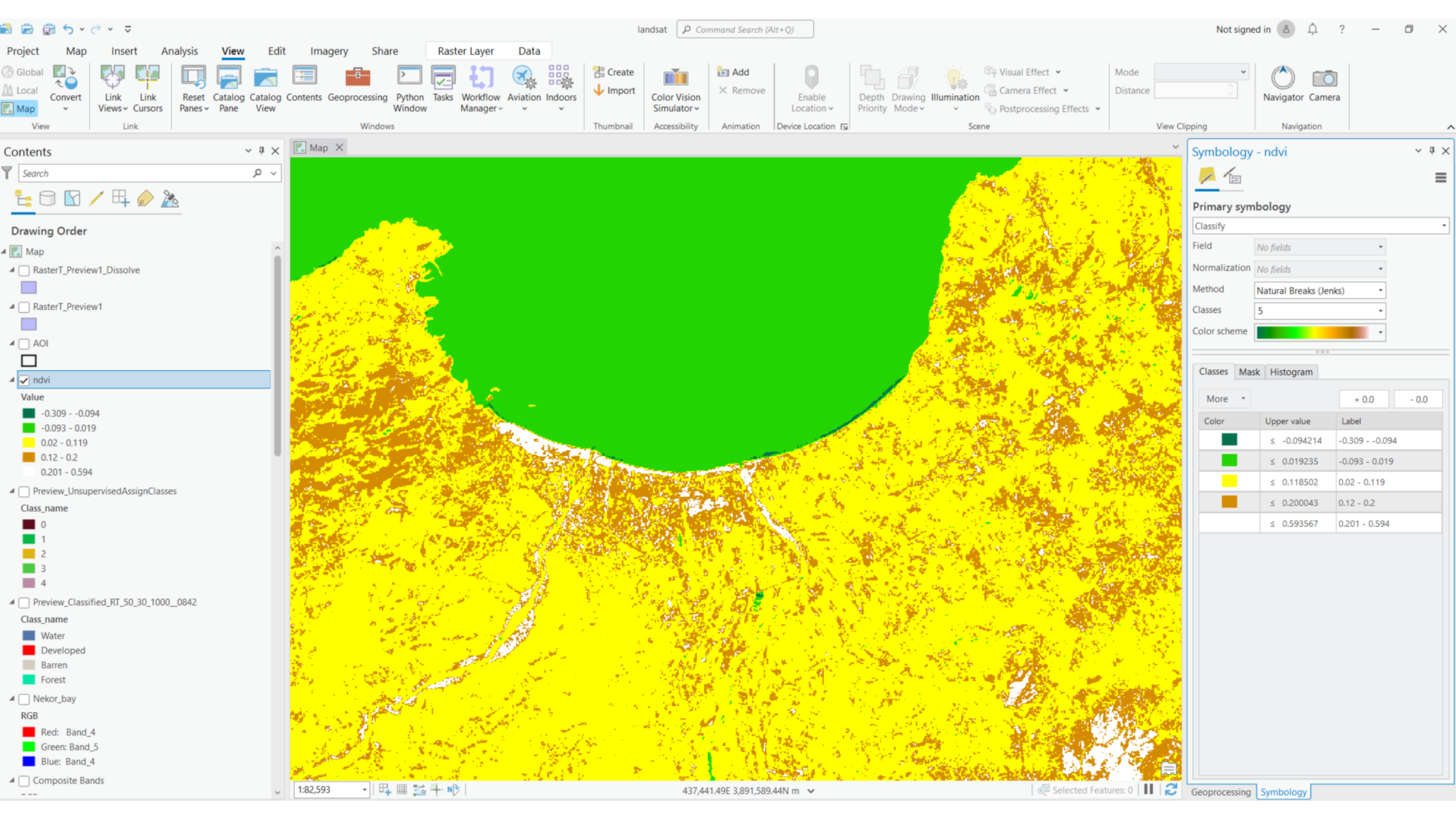
NDVI	Signification
-1 à 0	Eau, nuages, neige, surfaces artificielles
~ 0	Sol nu, zones urbaines
0.2 à 0.5	Végétation clairsemée (prairie, arbustes)
0.5 à 0.8+	Végétation dense (forêt, cultures saines)







$$\text{NDVI} = \frac{\text{Float (" B5" - "B4")}}{\text{Float (" B5" + "B4")}}$$



Symbology - ndvi

Primary symbology

Classify

Field: No fields

Normalization: No fields

Method: Natural Breaks (Jenks)

Classes: 5

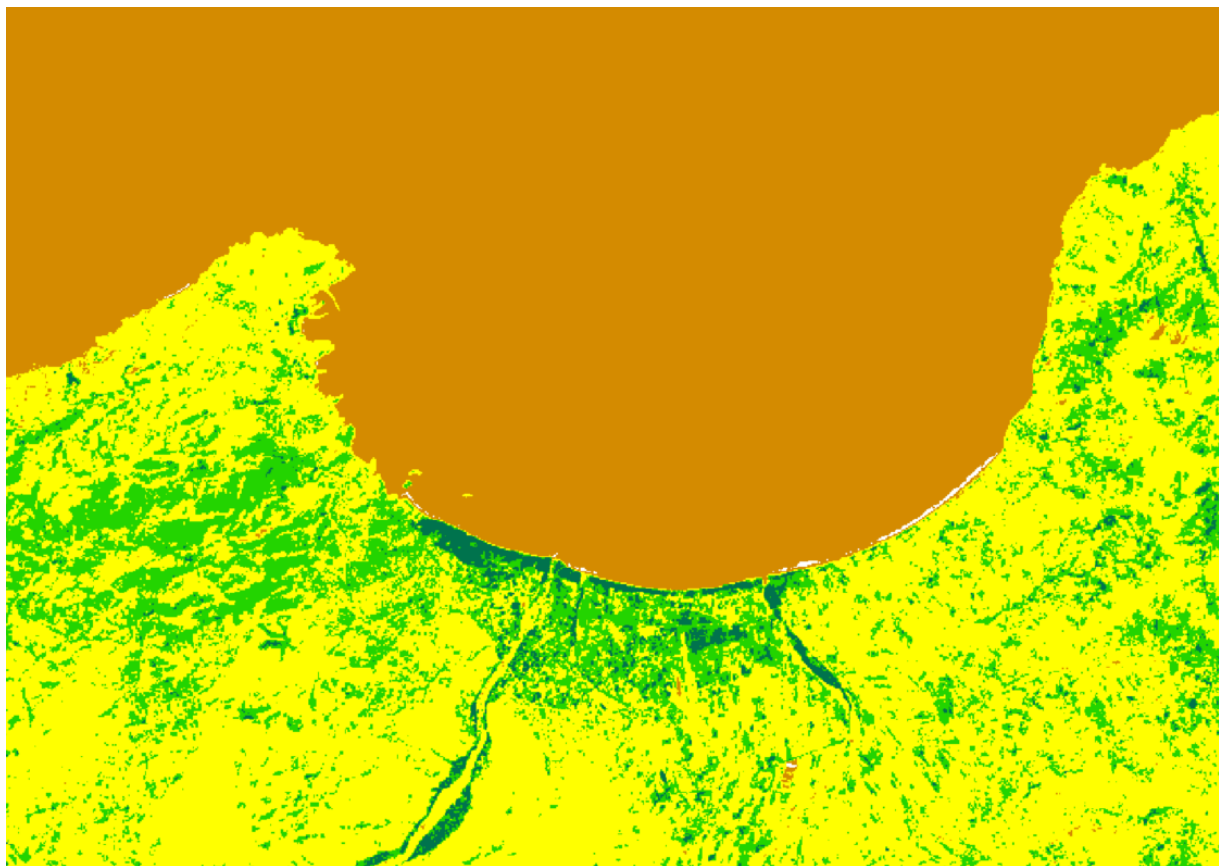
Color scheme: [Color bar]

Classes Mask Histogram

More

- Show excluded values
- Show statistics
- Reverse symbol order
- Reverse values

		Label
		-0.309 - -0.094
		-0.093 - 0.019
		0.02 - 0.119
	≤ 0.200043	0.12 - 0.2
	≤ 0.593567	0.201 - 0.594



Travail à faire :

**Estimation de la Température de la
Surface de la Terre par Télédétection**