



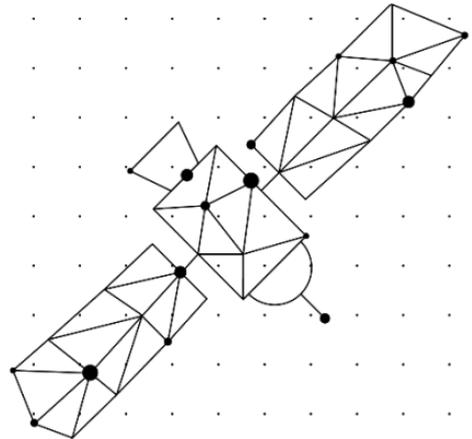
Learning Earth Observation Image Processing with LEOWorks 4.3

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United Nations/Romania International Conference on
Space Solutions for Sustainable Agriculture and
Precision Farming

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- △ ESA Eduspace
- △ LEOWorks Project Objectives and Status
- △ Technical Overview – Architecture
- △ Image Processing and GIS Tools in LEOWorks
- △ Download and Contacts

ESA EDUSPACE

△ LEOWorks is a software product designed and developed for use in educational activities. It is the main tool for demonstrating Earth Observation techniques within the European Earth Observation Web Site for Secondary Schools - EDUSPACE, belonging to the European Space Agency (ESA)

△ More info Resources section on

http://www.esa.int/SPECIALS/Eduspace_EN/SEMHA60P0WF_0.html

LEOWorks 3.0

△LEOWorks 3.0: IDL-based software

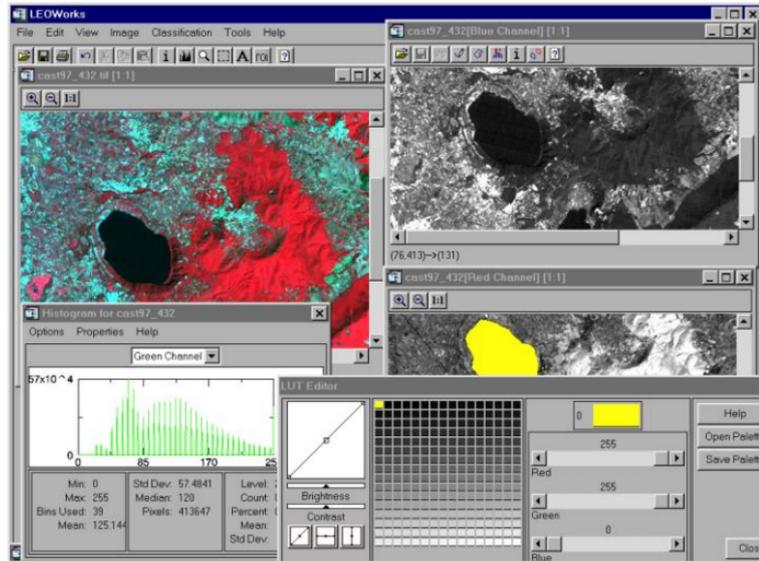
△Extensive tutorial

△Several modules for image manipulation

△GIS functionality: possibility to create GIS layers

△Developed by Florin Serban and Sorin Andrei (ROSA)

△Still available for download on



ESA EDUSPACE website: http://www.esa.int/SPECIALS/Eduspace_EN/SEMHA60P0WF_0.html

LEOWorks 4.3

- △ LEOWorks 4.3 – to continue ESA's educational project developing LEOWorks, main tool for demonstrating Earth Observation techniques inside Eduspace
- △ Make use of advanced geospatial libraries to develop an independent platform and user friendly software application
- △ Open source, Java based, use of BEAM, NEST platform and libraries
- △ New evolution based on ESA SNAP toolboxes.

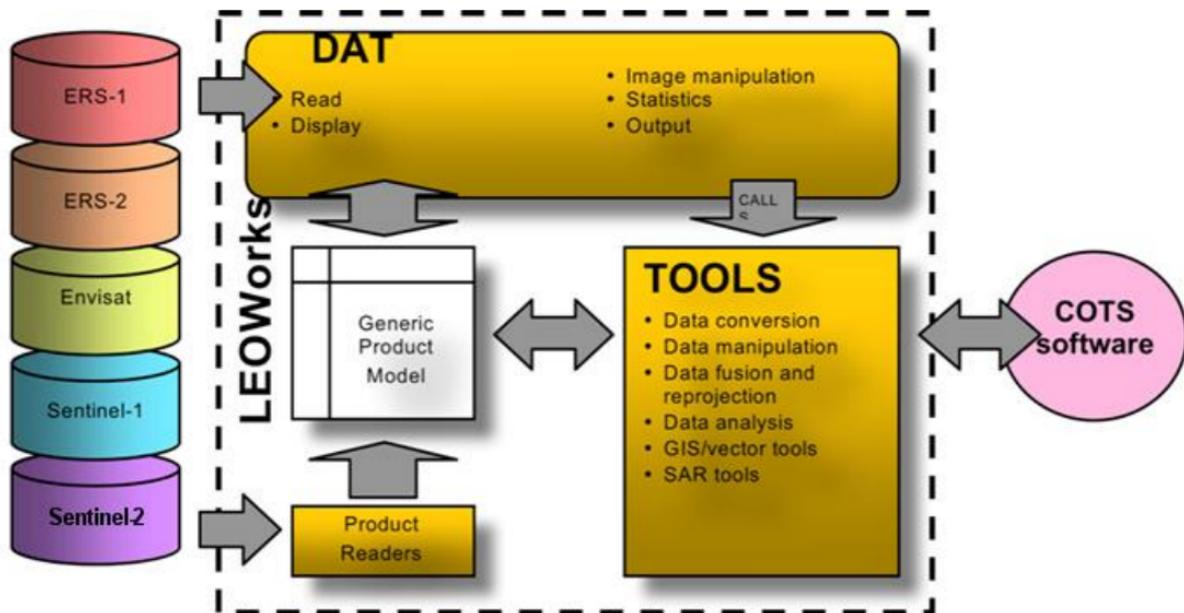


LEOWorks 4.3

△ LEOWorks 4.3 – Evolution from NEST and BEAM to SNAP platform.

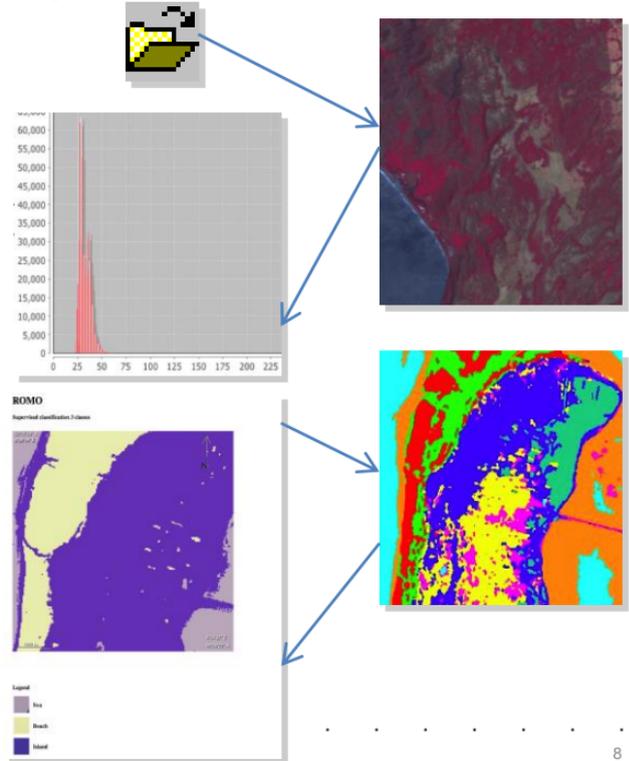


LEOWorks 4.3 - Architecture



LEOWorks 4.3 - Concepts

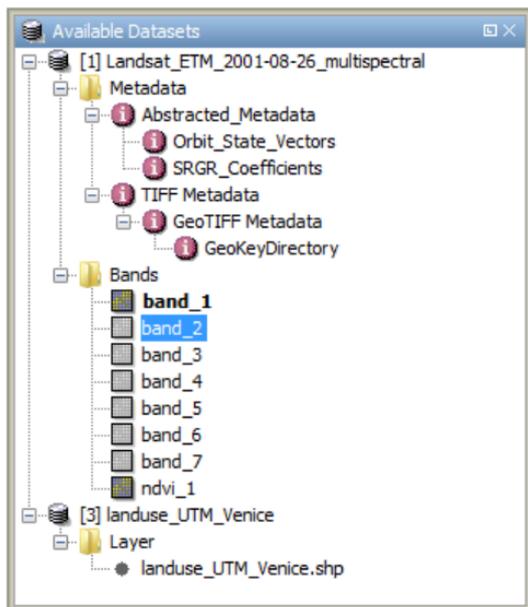
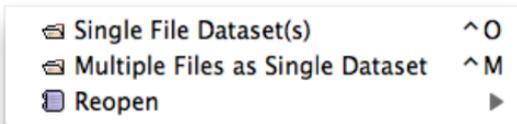
- △ Open files: readers provided for most common EO data products
- △ Display data: gray scale, RGB, color-indexed
- △ Inspect & analyze
- △ Image enhancement and information extraction
- △ Present results – simple maps



LEOWorks 4.3 – Access to data

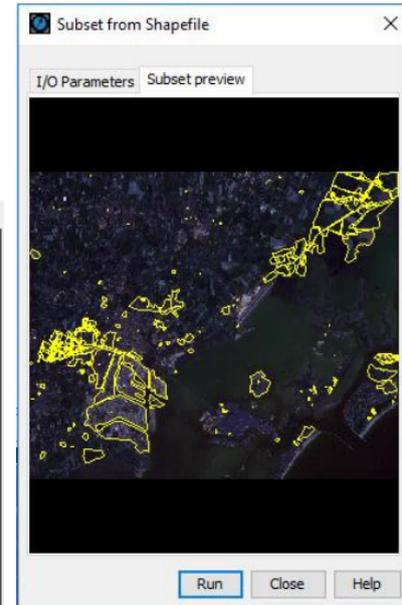
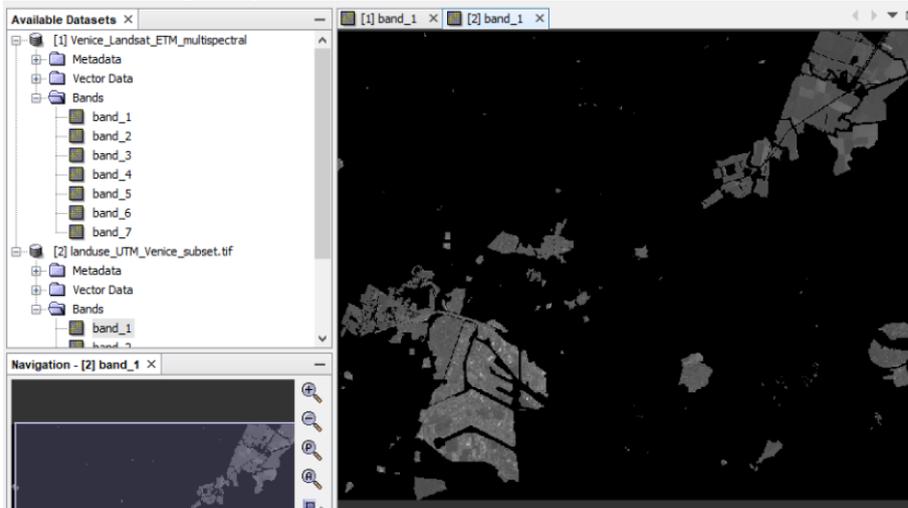
△ Opening files in LEOWorks is a very flexible operation. It is possible to open:

- △ one single file as a single dataset;
 - △ many single files as a single datasets;
 - △ many files as a single dataset;
 - △ reopen a previously open file.
- △ Open files are displayed in Available data window.



LEOWorks 4.3 – Access to data

- When opening files, either Raster data or GIS vector data, it is possible to subset and or resize the content in a selected file or in a group of files;



LEOWorks 4.3 – Inspecting data

- △ Data inspection tools are available under the Inspect menu
- △ Each tool is activated when clicking on data items in the Available Data window
- △ Feature info and feature attribute table - available for GIS vector data

- Information
- Pixel info
- Feature info
- Statistics
- Spectrum
- Profile Plot

Object and Attribute Table

Attribute field values: view only

TE7_	JUDETE7_ID	JUDET	COD	MUNICIPIU	SHAPE_area	SH
1	Botosani	BT		Botosani	5.017208...	49
2	Satu Mare	SM		Satu Mare	4.424846...	46
3	Maramures	MM		Baia Mare	6.284916...	55
32	Suceava	SV		Suceava	8.633331...	58
5	Bihor	BH		Oradea	7.468850...	58
6	IASI	IS		IASI	5.465361...	63
7	Bistrita-N...	BN		Bistrita	5.313327...	41
33	Salaj	SJ		Zalau	3.851034...	39
8	Cluj	CJ		Cluj Napoca	6.764028...	64
34	Neamt	NT		Piatra Nea...	5.872872...	51
10	Mures	MS		Targu Mur...	6.753975...	55
11	Harghita	HR		Miercurea...	6.560871...	54

Attribute field... Visible

Feature ident... Visible

Theme type Visible

OBJECTID Visible

AREA Visible

PERIMETER Visible

Statistics computed for the field PERIMET

Count : 42

Min : 84100.023

Max : 708079.25

Mean : 490930.23578571423

Feature Info

Attribute name	Attribute value
Geometry	MultiPolygon
OBJECTID	32
AREA	0.0
PERIMETER	399257.188
JUDETE7_	33
JUDETE7_ID	38
JUDET	Gorj
COD	GJ
MUNICIPIU	Targu Jiu
SHAPE_area	5.54160488756E9
SHAPE_len	399257.202955

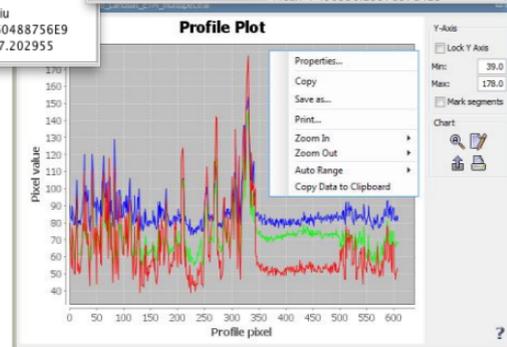
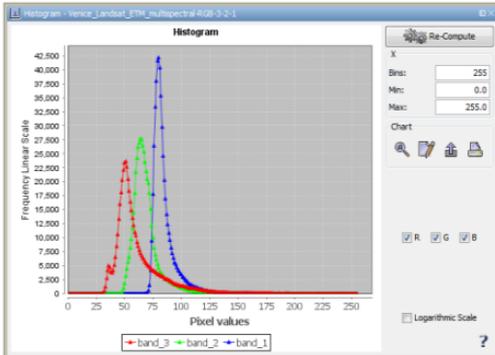
Pixel Info View

Geo-location

Coordinate	Value	Unit
Image-X	64	pixel
Image-Y	102	pixel
Longitude	8°29'25" E	
Latitude	55°10'21" N	
Map-X	467615.0	m
Map-Y	6114319.2	m

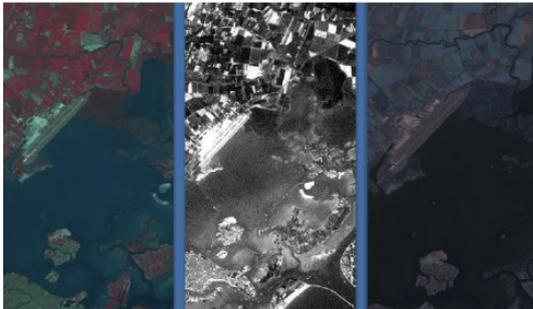
Bands

Band	Original	Displayed
band_1	132	132



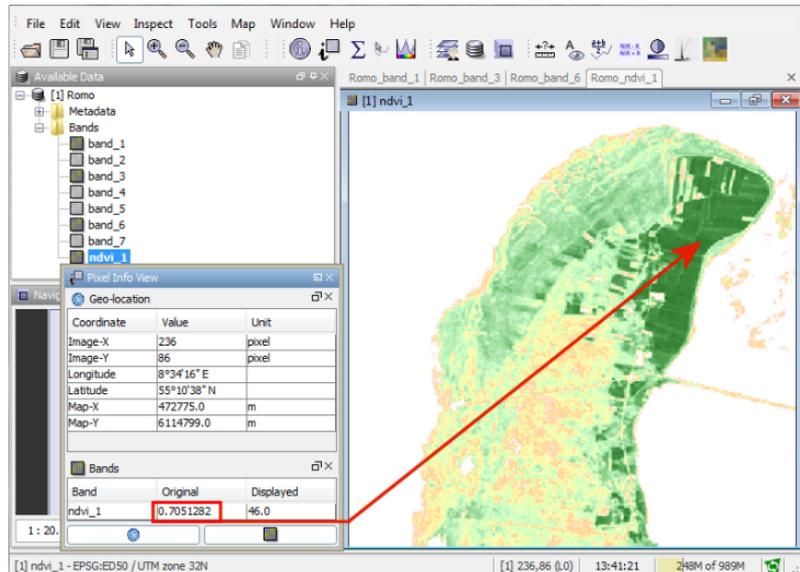
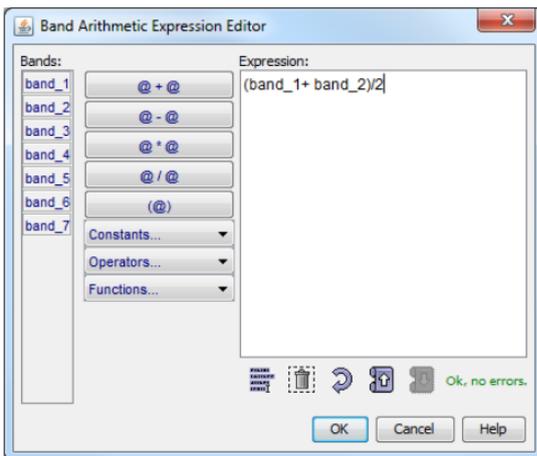
LEOWorks 4.3 – Image processing

- △ Radiometric and geometric image processing
- △ Contrast manipulation
- △ Image filtering
- △ Geometric transformation: scale, rotate, translate
- △ Pan-sharpening based on RGB-HIS transform



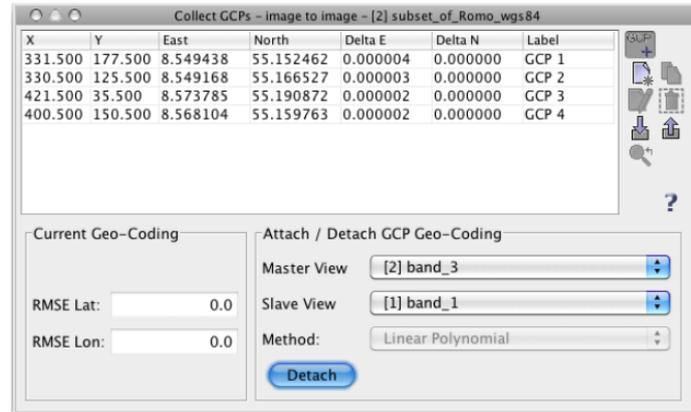
LEOWorks 4.3 – Image arithmetic

- △ Dedicated function for computing NDVI and applying a predefined color palette
- △ Advanced Band Arithmetic tool allows editing complex formula



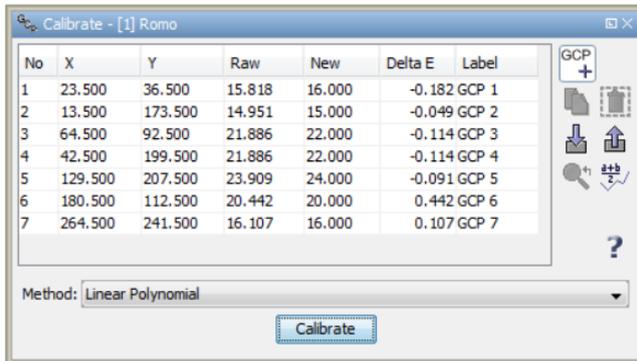
LEOWorks 4.3 – Attach coordinates to pixels

- △ The registration procedures implemented in LEOWorks allows you to compute and attach geographic coordinates to every pixel in a satellite image
 - △ In Image to Map registration, the GCPs are selected exclusively by inspecting the image and choosing features that are also visible on a map in such a way their geographic or map coordinates can be accurately indicated
 - △ In Image to Image registration, the GCPs needed to compute the geocoding for a non-geocoded image are defined based on a geocoded image
- △ Re-projection is possible for both vector and raster data



LEOWorks 4.3 – Radiometric calibration

- △ The calibration window gives you access to the tools allowing you to radiometrically calibrate a band of an image by selecting points for which filed values are known.

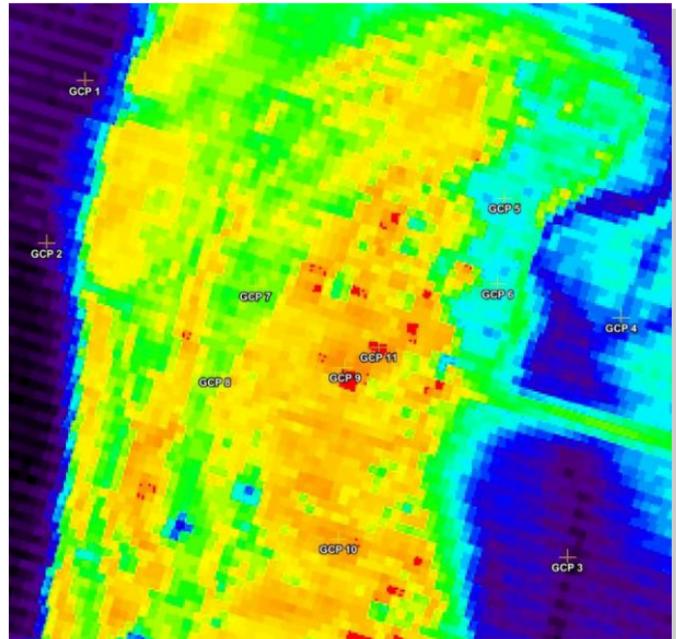


Calibrate - [1] Romo

No	X	Y	Raw	New	Delta E	Label
1	23.500	36.500	15.818	16.000	-0.182	GCP 1
2	13.500	173.500	14.951	15.000	-0.049	GCP 2
3	64.500	92.500	21.886	22.000	-0.114	GCP 3
4	42.500	199.500	21.886	22.000	-0.114	GCP 4
5	129.500	207.500	23.909	24.000	-0.091	GCP 5
6	180.500	112.500	20.442	20.000	0.442	GCP 6
7	264.500	241.500	16.107	16.000	0.107	GCP 7

Method: Linear Polynomial

Calibrate



LEOWorks 4.3 – Image classification

- Unsupervised (k-means) and supervised methods available (Min Distance, Parallelepiped, Max Likelihood).
- Complete set of tools for defining, inspecting and refining training fields.
- Legend editing and classified image statistics are available.

Class	Colour	Pixel Value
Unclassified	Yellow	232, 237, 174
class_1	Dark Blue	98, 46, 179
class_2	Light Blue	186, 166, 187
class_3	Dark Green	8, 56, 151
class_4	Light Green	10, 235, 165
class_5	Medium Green	42, 147, 63
class_6	Dark Purple	124, 7, 240
class_7	Medium Purple	108, 26, 160
class_8	Light Purple	220, 254, 108
class_9	Magenta	172, 2, 111
class_10	Pink	189, 144, 247
class_11	Light Green	116, 211, 155
class_12	Medium Green	58, 245, 54
class_13	Dark Green	27, 163, 103
class_14	Dark Purple	112, 74, 246

Unsupervised Classification

I/O Parameters Processing Parameters

Number of classes: 14

Number of iterations: 30

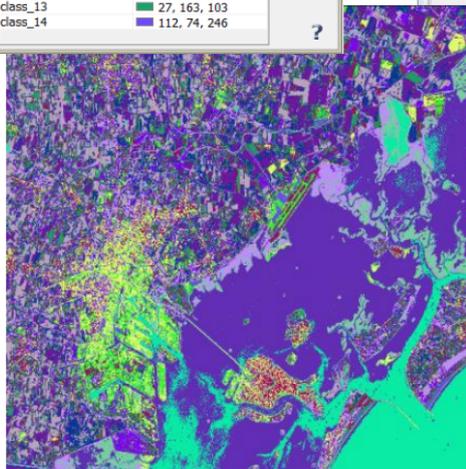
Random seed: 31415

Source band names:

- band_1
- band_2
- band_3
- band_4
- band_5
- band_6
- band_7
- band_1_calib

Run Close Help

Class	Pixel Value	Frequenc...	No. of Pl...	Area(sq m)
Unclassified	0	0	0	0
class_1	1	21,206	109,870	98,883,000
class_2	2	11,639	60,303	54,272,700
class_3	3	9,236	47,850	43,065,000
class_4	4	9,16	47,456	42,710,400
class_5	5	7,7	39,892	35,902,800
class_6	6	7,49	38,805	34,924,500
class_7	7	7,143	37,007	33,306,300
class_8	8	5,648	29,263	26,336,700
class_9	9	5,584	28,933	26,039,700
class_10	10	4,497	23,300	20,970,000
class_11	11	4,176	21,638	19,474,200
class_12	12	2,903	15,043	13,538,700
class_13	13	2,757	14,282	12,853,800
class_14	14	0,861	4,463	4,016,700
Total		100	518,105	466,294,500



LEOWorks 4.3 – Image classification

- Supervised Classification - Complete set of tools for defining, inspecting and refining training fields.

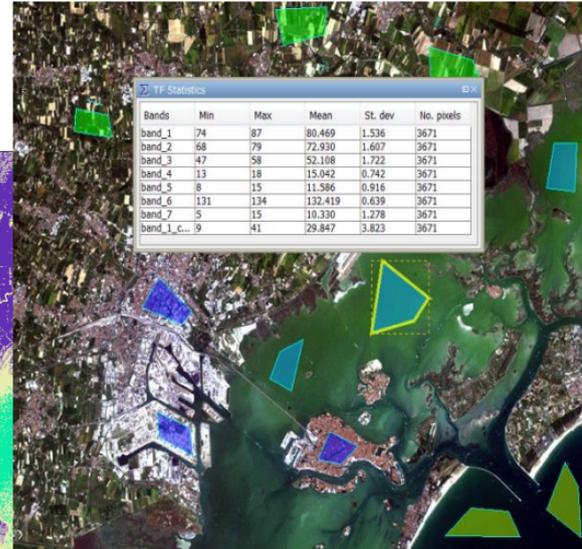
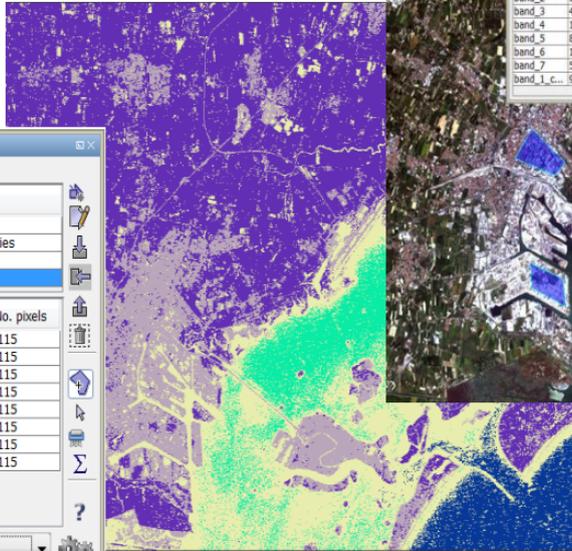
Classification

Existing classes / training fields

Name	Description
Agriculture	arable fields
Urban	buildings and industrial facilities
Sea Deep	
Sea Shallow	

Bands	Min	Max	Mean	St. dev	No. pixels
band_1	72	87	79.889	1.899	7115
band_2	63	79	71.062	2.723	7115
band_3	43	58	51.123	2.240	7115
band_4	13	18	15.080	0.727	7115
band_5	8	16	11.597	0.928	7115
band_6	130	134	132.501	0.658	7115
band_7	5	15	10.309	1.259	7115
band_1_c...	0	41	28.214	5.133	7115

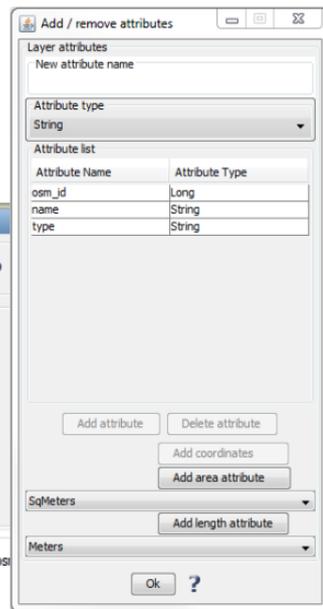
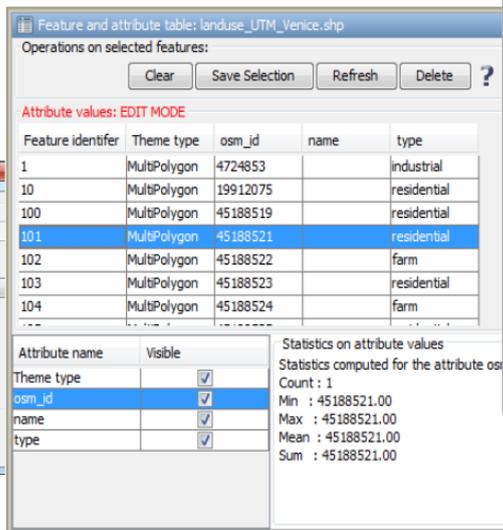
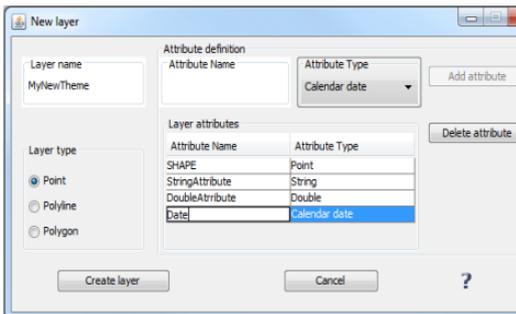
Classification method: Maximum likelihood



LEOWorks 4.3 – GIS tool

^ GIS tools allowing to:

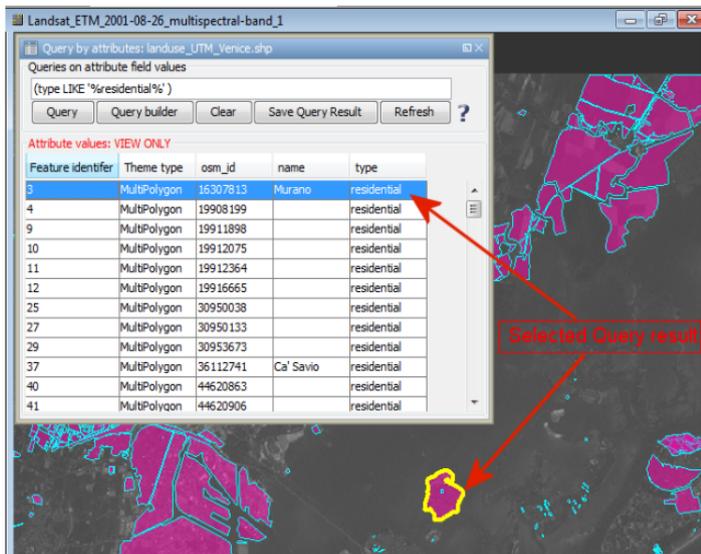
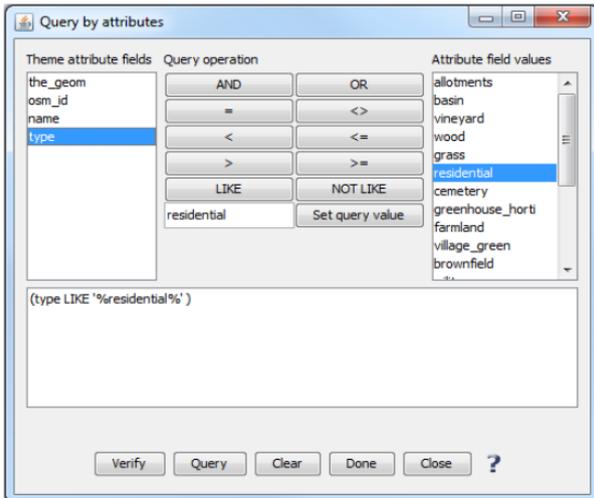
- ^ Edit existing data (geometry and attributes)
- ^ Create new data
- ^ Select and export features



LEOWorks 4.3 – GIS tool

△ GIS tools allowing to:

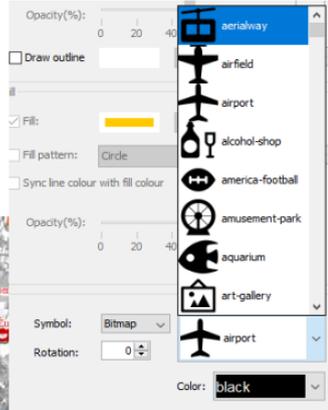
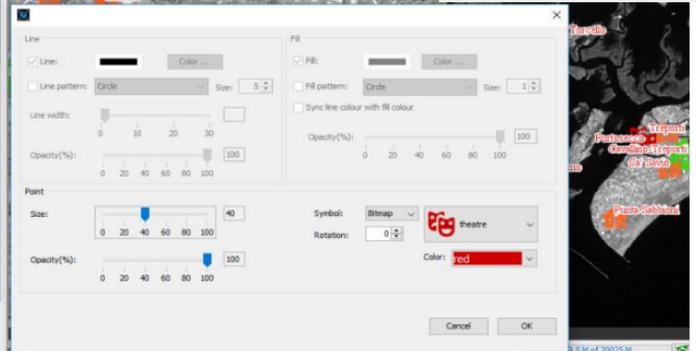
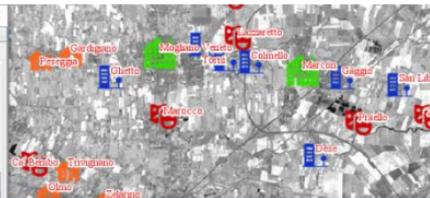
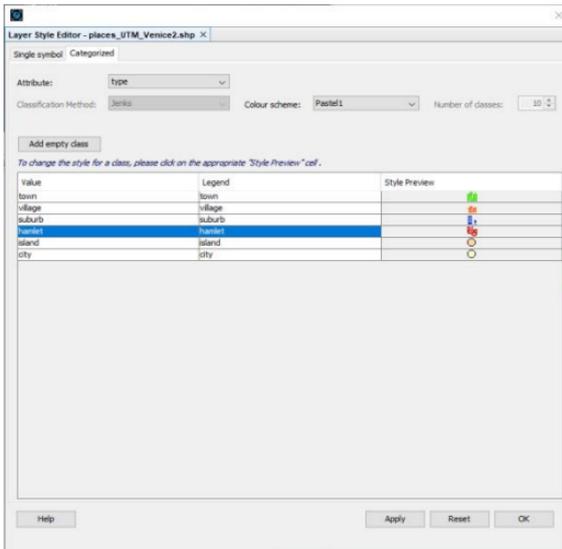
△ Query and query builder



LEOWorks 4.3 – GIS tool

GIS tools allowing to:

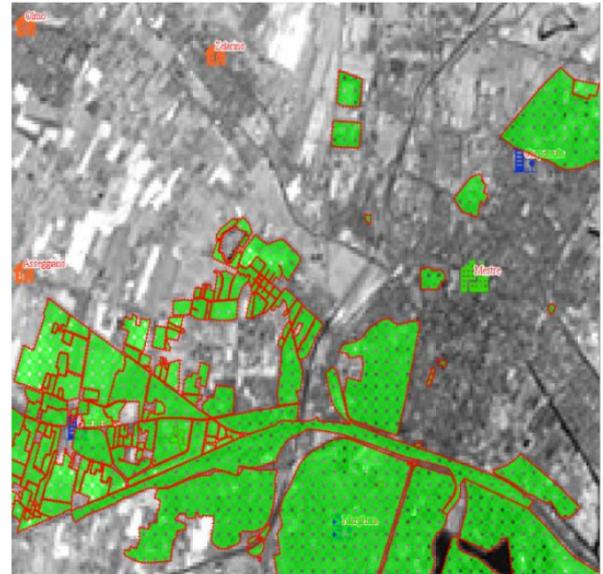
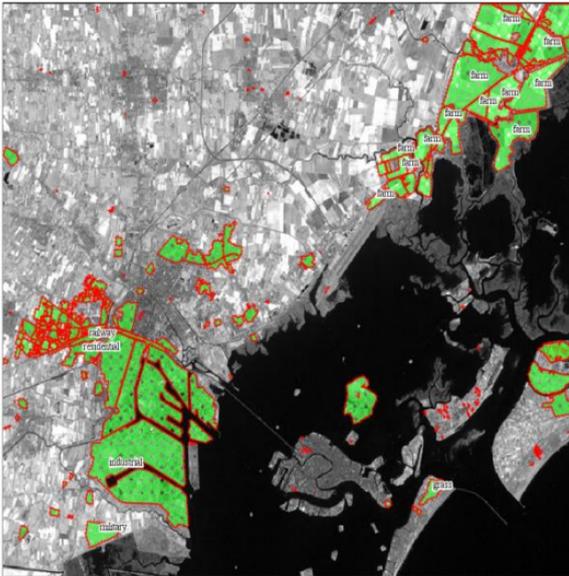
Changing the symbols for point layers



LEOWorks 4.3 – GIS tool

△ GIS tools allowing to:

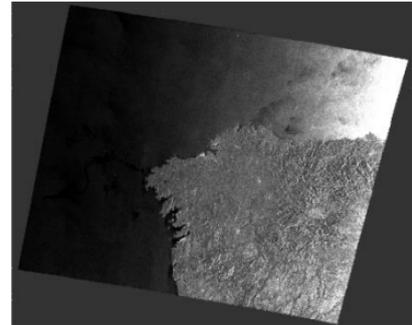
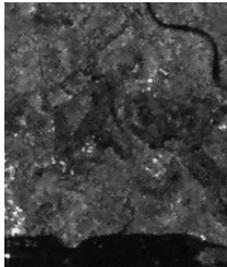
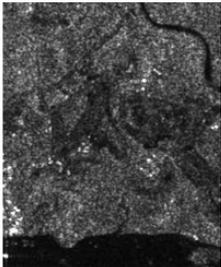
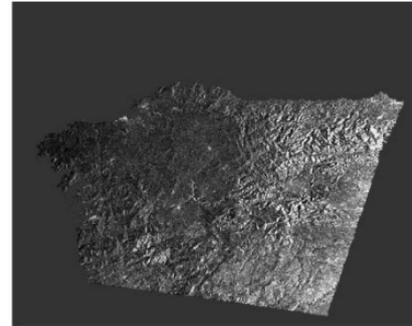
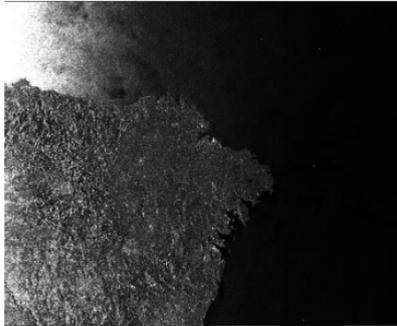
△ Creating graduated and/or proportional symbols for GIS layers



LEOWorks 4.3 – Radar (SAR) tools

△ SAR tools allowing to do operations like:

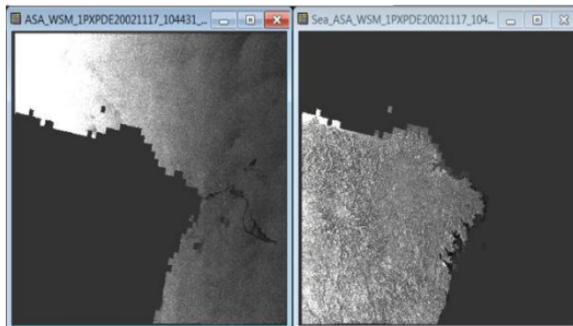
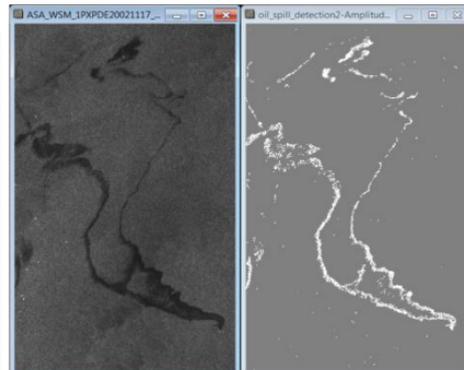
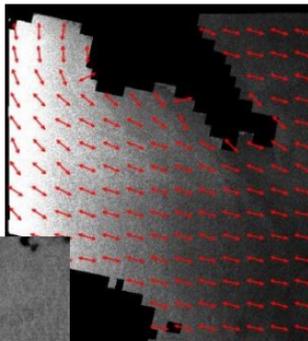
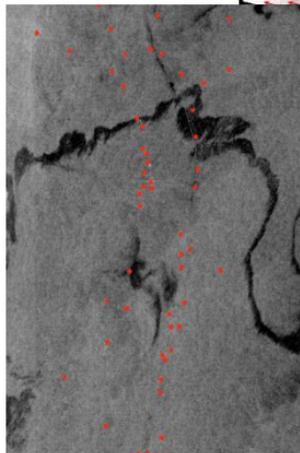
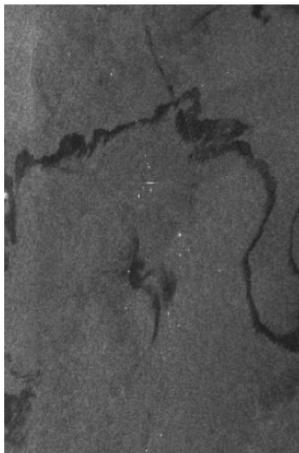
- △ Radiometric calibration
- △ Geometric correction
- △ Speckle filtering
- △ Resampling
- △ Multilooking
- △ Ocean Tools
- △ S1 - deburst



LEOWorks 4.3 – Radar (SAR) tools

△ SAR tools:

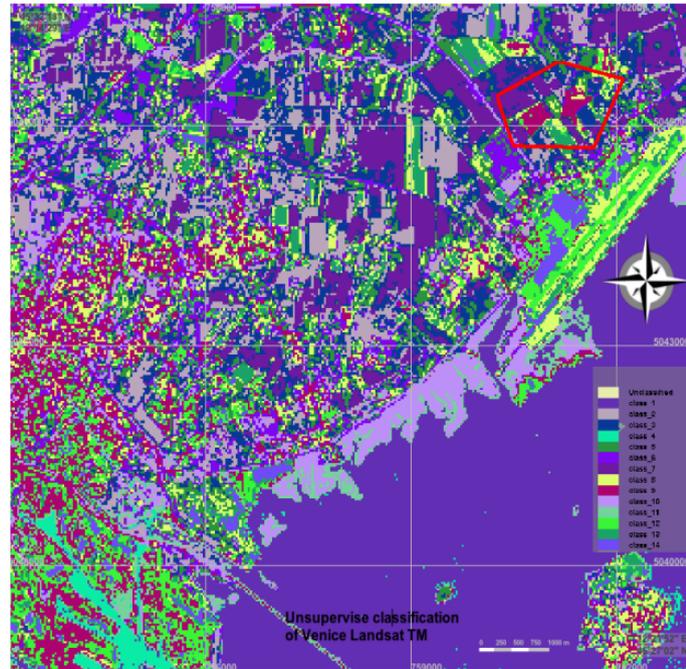
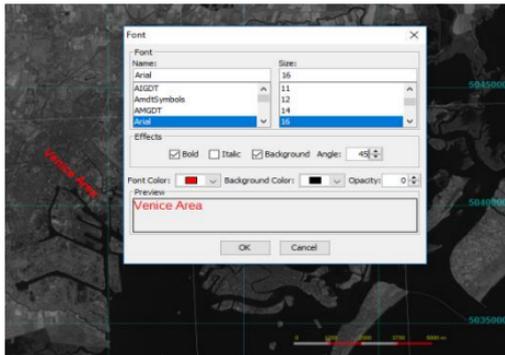
△ Ocean Tools



LEOWorks 4.3 – Map tool

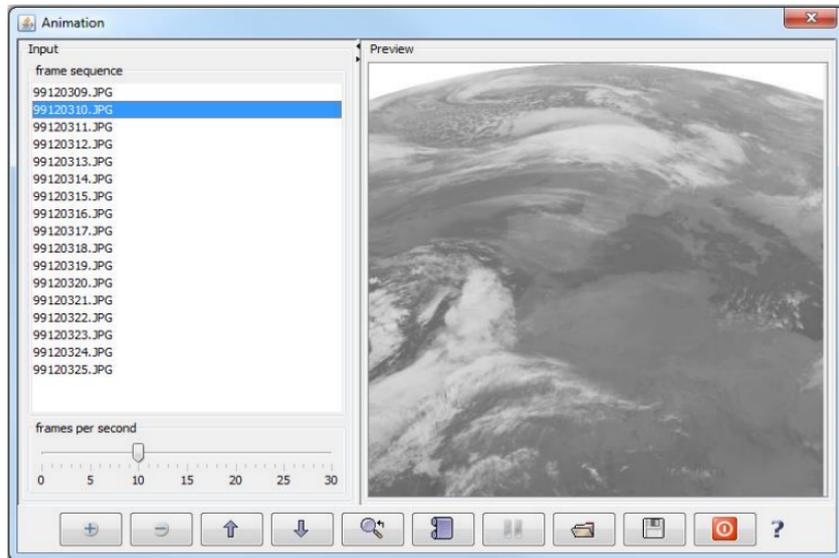
MAP tool allowing to:

- Create a new map composition
- Add different types of elements to the map
- Print or export the map as PDF or JPEG
- Show or hide the map grid or the map composer ruler



LEOWorks 4.3 – Other tools

- ↗ Spatial and spectral subset
- ↗ Image Stack
- ↗ Mosaic
- ↗ Data conversion
- ↗ Orthorectification
- ↗ Reprojection
- ↗ Animation
- ↗ & more to come
- ↗ & more to discover ...



LEOWorks 4.3 – Download and Contacts

△ For download: <http://leoworks.terrasigna.com>

△ And:

http://www.esa.int/SPECIALS/Eduspace_EN/SEMHA60P0WF_0.html

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Thank you for attention