Flood mapping in a desertic context based on Sentinel1 and Sentinel 2

Case of the 2016 Irak flood

Herve YESOU

June 2022

Irka flood case
April 2016 context

Western and southwestern parts of Iran are suffering major flooding following days of heavy rain.

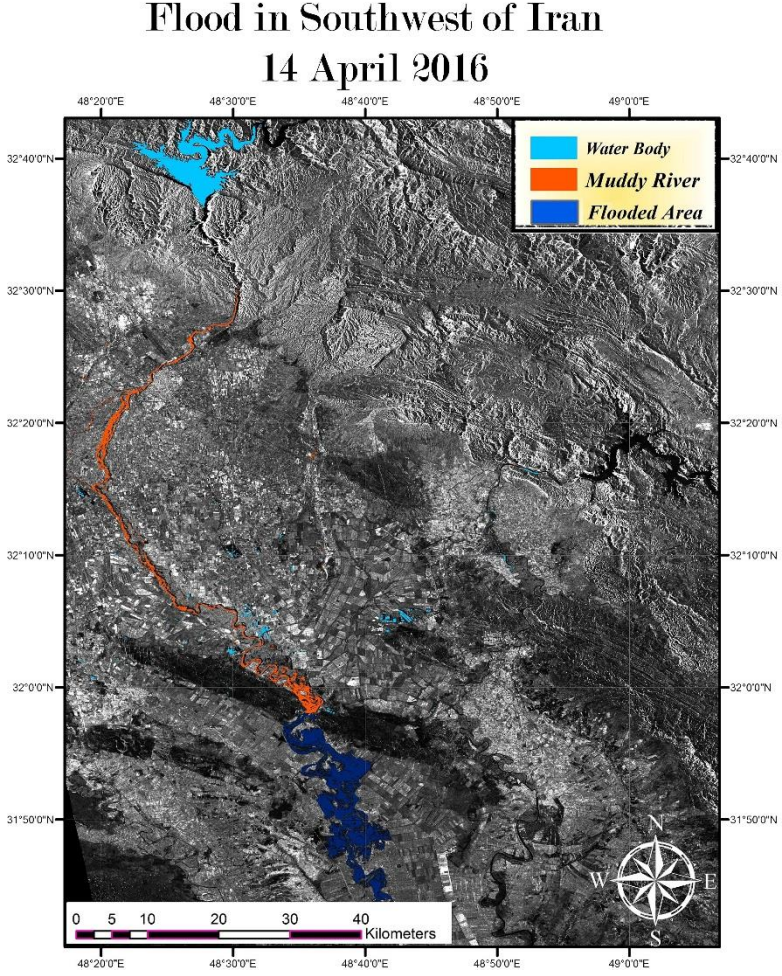
Over 2500 people have been evacuated from several provinces and over a hundred cities are reported to have suffered damage and flooding.

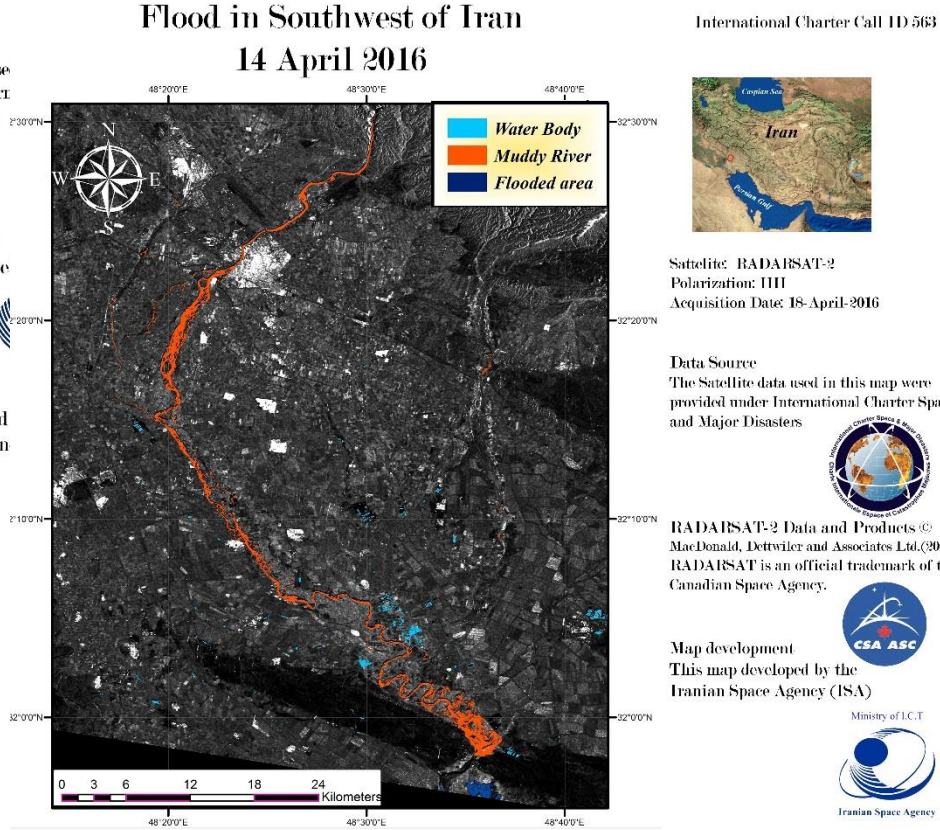
The flooding has struck the provinces of Lorestan, Ilam, Kermanshah, Fars, Khuzestan, Chaharmahal, Bakhtiari and Kurdistan.

The disaster has cut electricity supplies and water to thousands of people, and dams throughout the region are close to their limit as the rain continues to raise water levels ever higher.

Iranian Space Agency trigered the Charter Space and Major disaster

April 2016 context

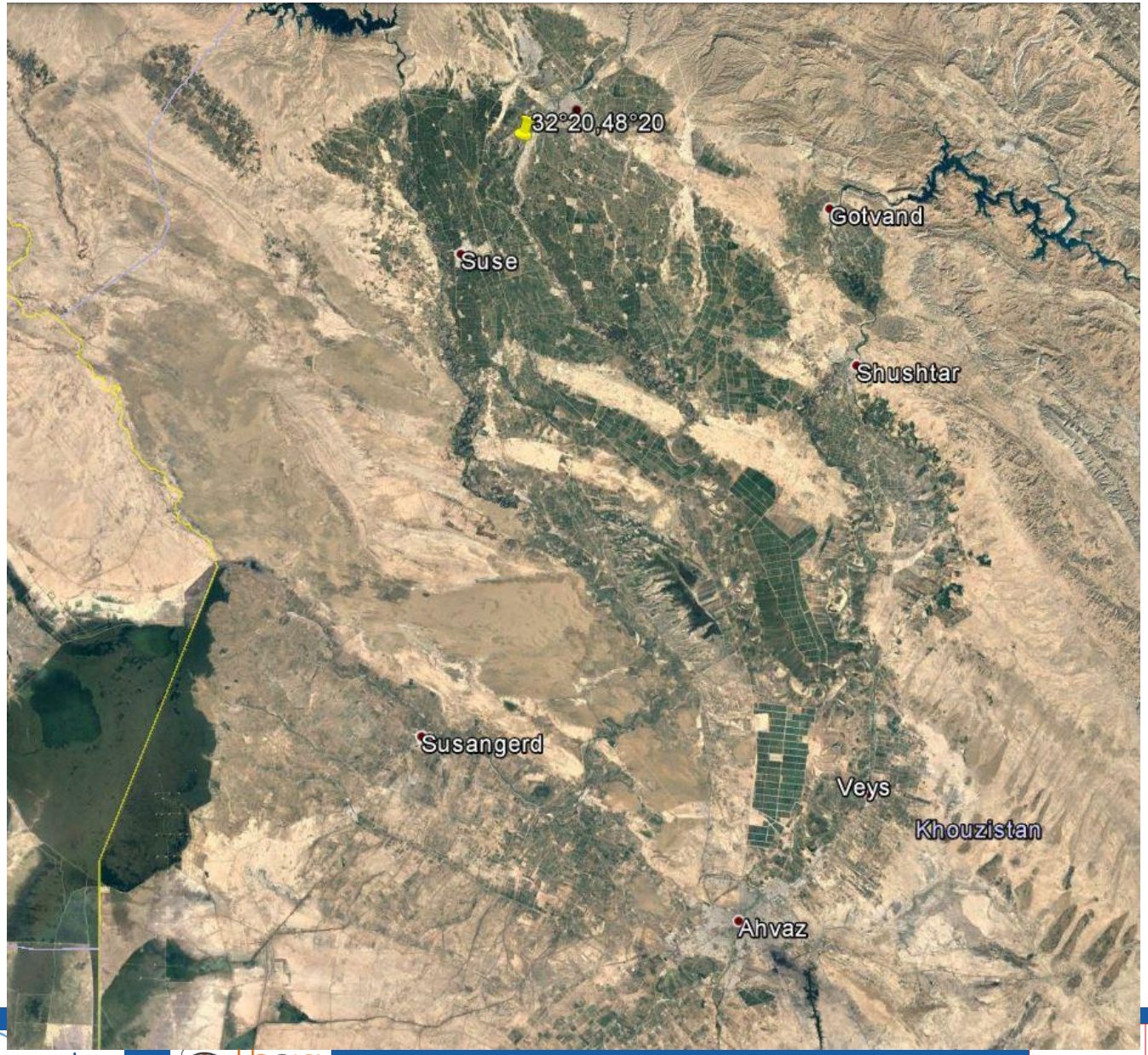




Products generated based on Sentinel1, Radarsat and TerraSAR X 16 and 108 of April 2016

Location of the study area

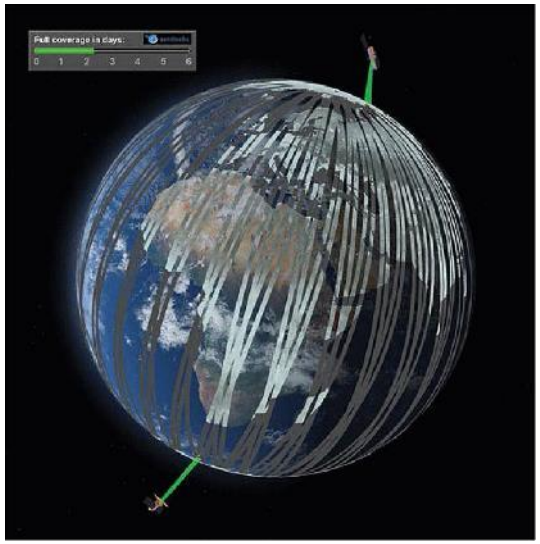
Location of the study area



SENTINEL 1

The Sentinel-1 series : part of the GMES programme
Sentinel1A, 2014 Sentinel1B, 2016

Priority : ensure continuity for C-band data
Improvement of SAR signal (30% better than ENVISAT)



Multi mode

- Strip map: 80 km swath , 5m
- Interferometric Wide swath mode IW, 250km, 20 m
- Extra wide EW Swath , 400 km , 25x100 m
- Wave mode, WV, low data rate, 5x20m
- Swath 250 km

Polarisation modes:

- VV or HH in wave mode
- Selectable dual pol for all other mode HH+HV; VV+VH

opernicus
Europe's eyes on Earth

SENTINEL 1

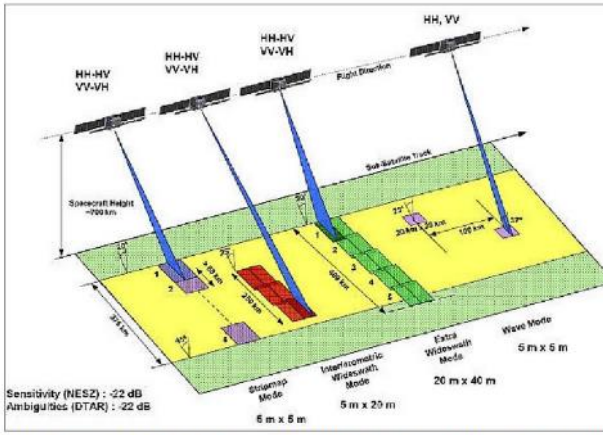
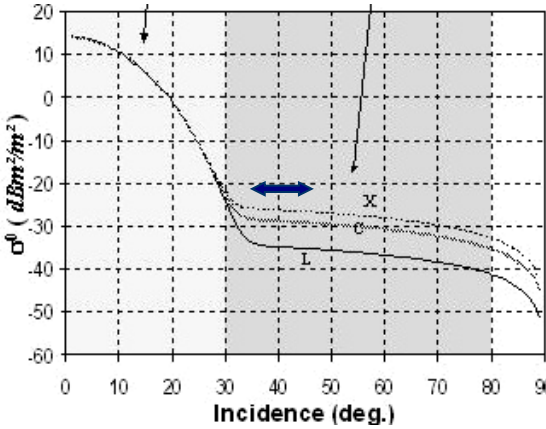
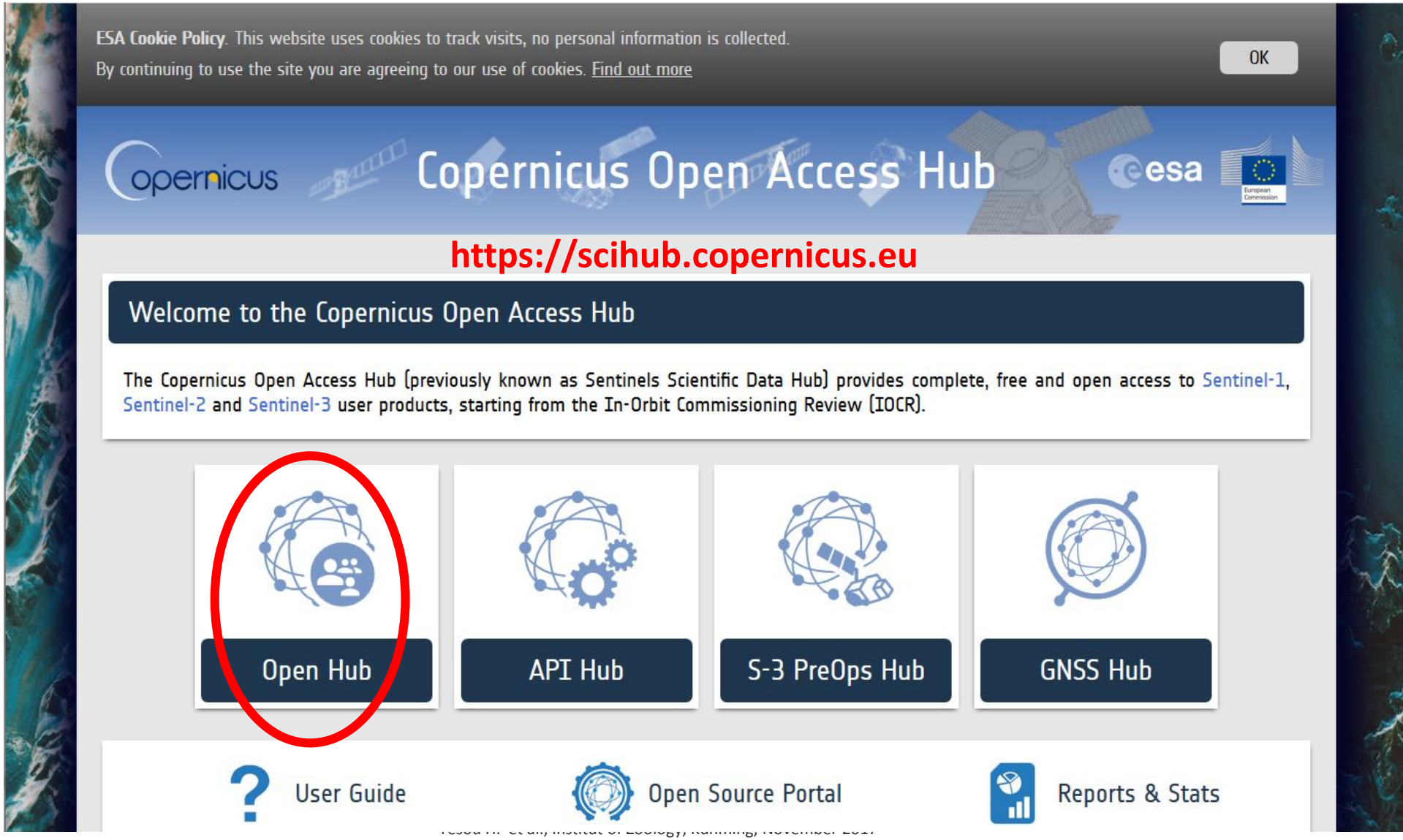


Figure 129: Overview of the Sentinel-1 C-SAR instrument observation scheme and operational support (image credit: ESA)

Acquisition mode	Product type	Resolution class	Resolution (range x azi) (m)	Pixel spacing (range x azi) (m)	No of looks (range x azi)	ENL
SM (Stripmap Mode)	SLC	-	1.7 x 4.3 to 3.6 x 4.9	1.5 x 3.6 to 3.1 x 4.1	1 x 1	1
	GRD	FR	9 x 9	4 x 4	2 x 2	3.9
		HR	23 x 23	10 x 10	6 x 6	34.4
		MR	84 x 84	40 x 40	22 x 22	464.7
IW (Interferometric Wide Swath)	SLC	-	2.7 x 22 to 3.5 x 22	2.3 x 17.4 to 3 x 17.4	1	1
	GRD	HR	20 x 22	10 x 10	5 x 1	4.9
		MR	88 x 89	40 x 40	22 x 5	105.7
EW (Extra Wide Swath)	SLC	-	7.9 x 42 to 14.4 x 43	5.9 x 34.7 to 12.5 x 34.7	1 x 1	1
	GRD	HR	50 x 50	25 x 25	3 x 1	3
		MR	93 x 87	40 x 40	6 x 2	12
WV (Water Vapor)	SLC	-	2.0 x 4.8 and 3.1 x 4.8	1.7 x 4.1 and 2.7 x 4.1	1 x 1	1
	GRD	MR	52 x 51	25 x 25	13 x 13	139.7



Data access: Sentinel 1



Flood event mapping exploiting

SENTINEL 1 SAR data

&

SENTINEL 2 optical image

Dr Herve YESOU ICube – SERTIT

Case of the April 2016 flood in Western, Iran

Date selection

Between 13 and 17 April 2016, heavy rains in Iran's western and southwestern provinces have resulted in flash floods that killed three people.

In total, 16 provinces in the country including Lorestan, Ilam, Fars, Kermanshah, Khuzestan, Chaharmahal-Bakhtiyari, Hamedan, Esfahan, Khorasan Shomali, Khorasan Razavi, Kurdestan, Alborz, Yazd, Zanjan, Kohgiluyeh-Boyer Ahmad and Azarbaijan Sharghi were hit by heavy torrential rains and major flooding whilst three provinces of Ilam, Lorestan and Khuzestan are badly damaged

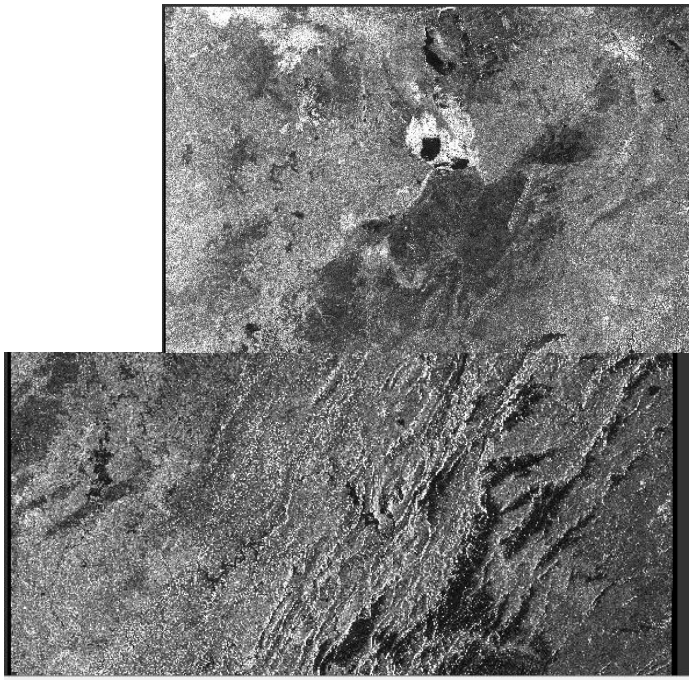
=> Strating date for searching crisis images : 13 of April 2016

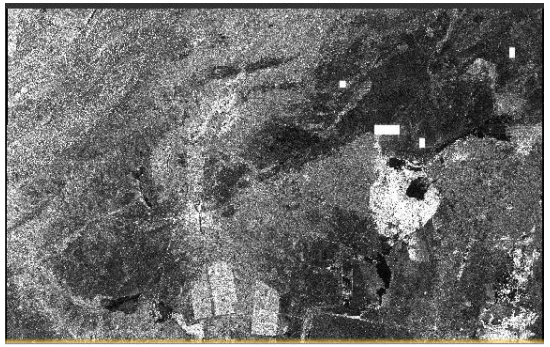
S1 selected images for practical

- Sentinel1 Prevent
- 20160328….. 14F
- 20160328 … 20F

- Sentinel1 crisis et post event
- 20160416

- 20160429





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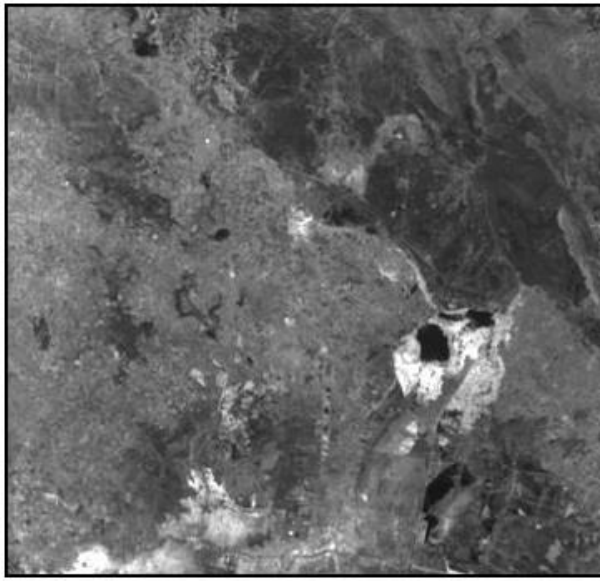
Footprint

Quicklook



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ier: S1A_IW_GRDH_1SSV_20160328T145052_20160328T145117_010571_00FB78_14F0

ment: SAR-C

IW

te: Sentinel-1

316.77 MB

Sentinel1 28 March 2016

Inspector

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- measurement
- preview
- support
- S1A_IW_GRDH_1SSV_20160328T145052_20160328T145117_01
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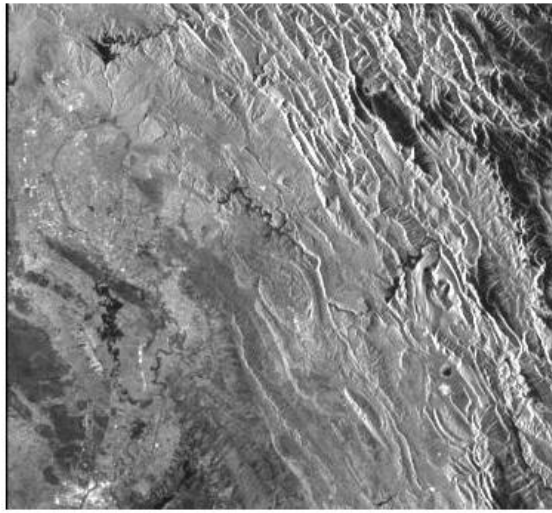
Quicklook



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Instrument: SAR-C

Mode: IW

Satellite: Sentinel-1

Size: 822.58 MB

Inspector

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Sentinel1 16 April 2016

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Footprint

Inspector

Attributes

Sentinel1 29 April 2016

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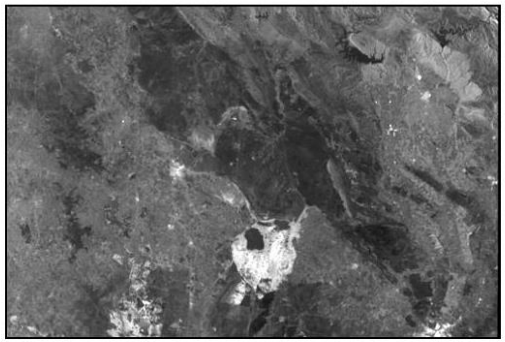
Footprint

Quicklook



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Instrument: SAR-C

Mode: IW

Satellite: Sentinel-1

Size: 817.66 MB

Inspector

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- annotation
- measurement
- preview
- support
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Sentinel1 15 Mai2016

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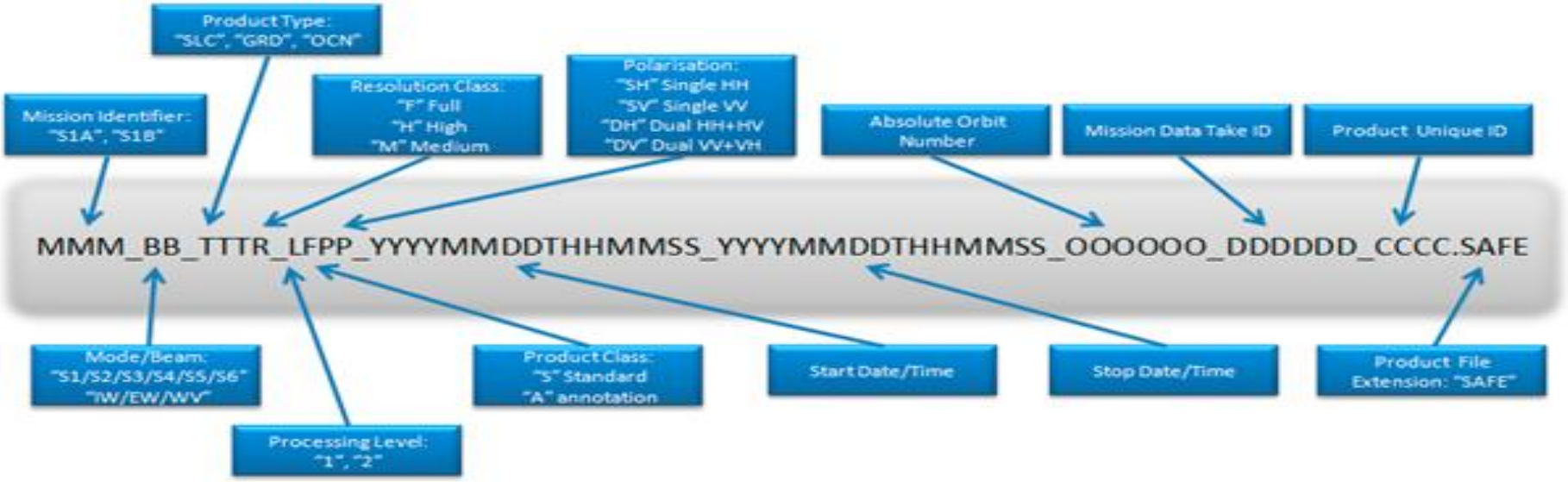

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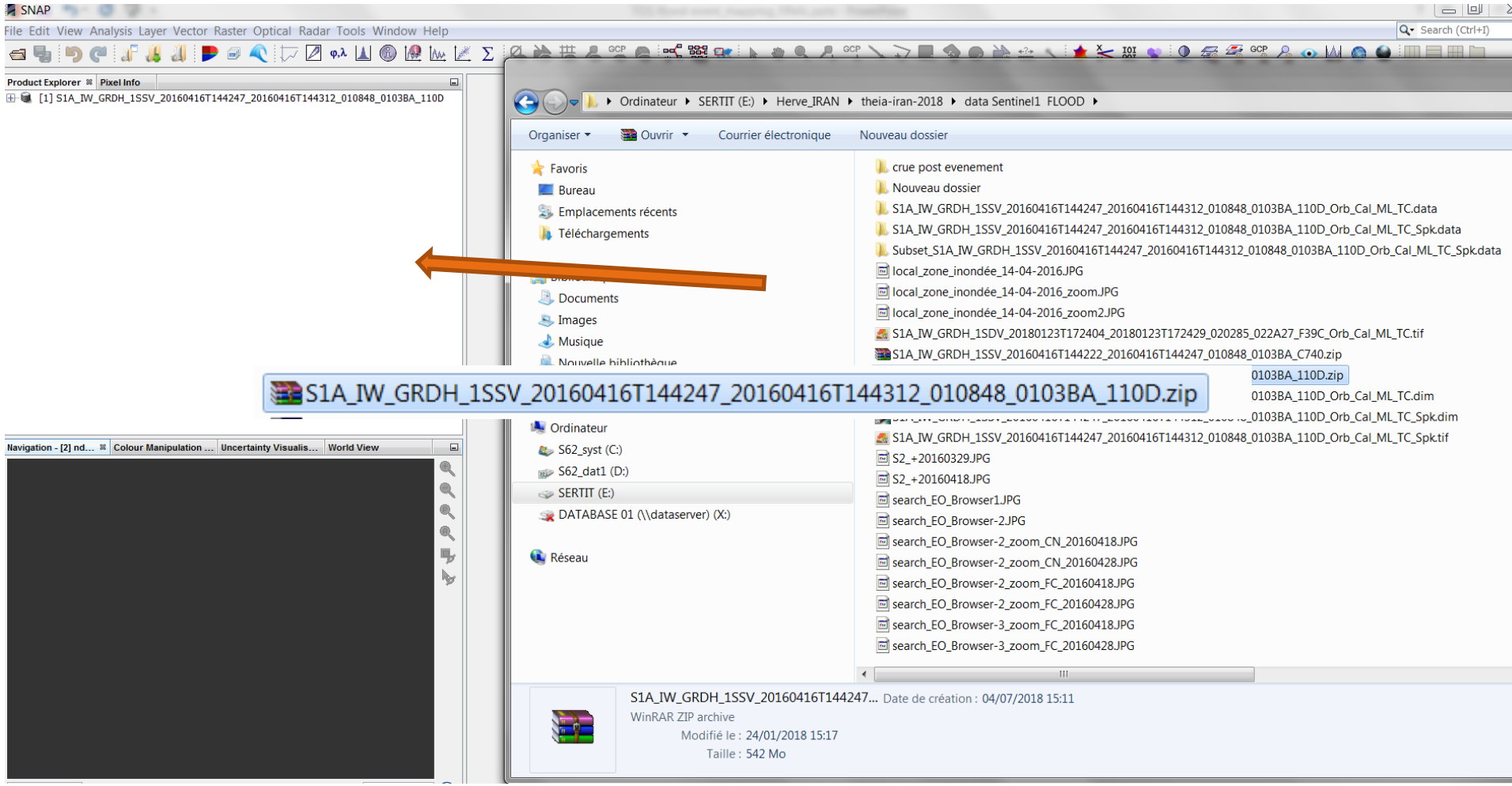
Sometime too long name to be transfered !!! Use the rar files

Other downloading site

- https://www.asf.alaska.edu/

SNAP: read image: drag on the rar file



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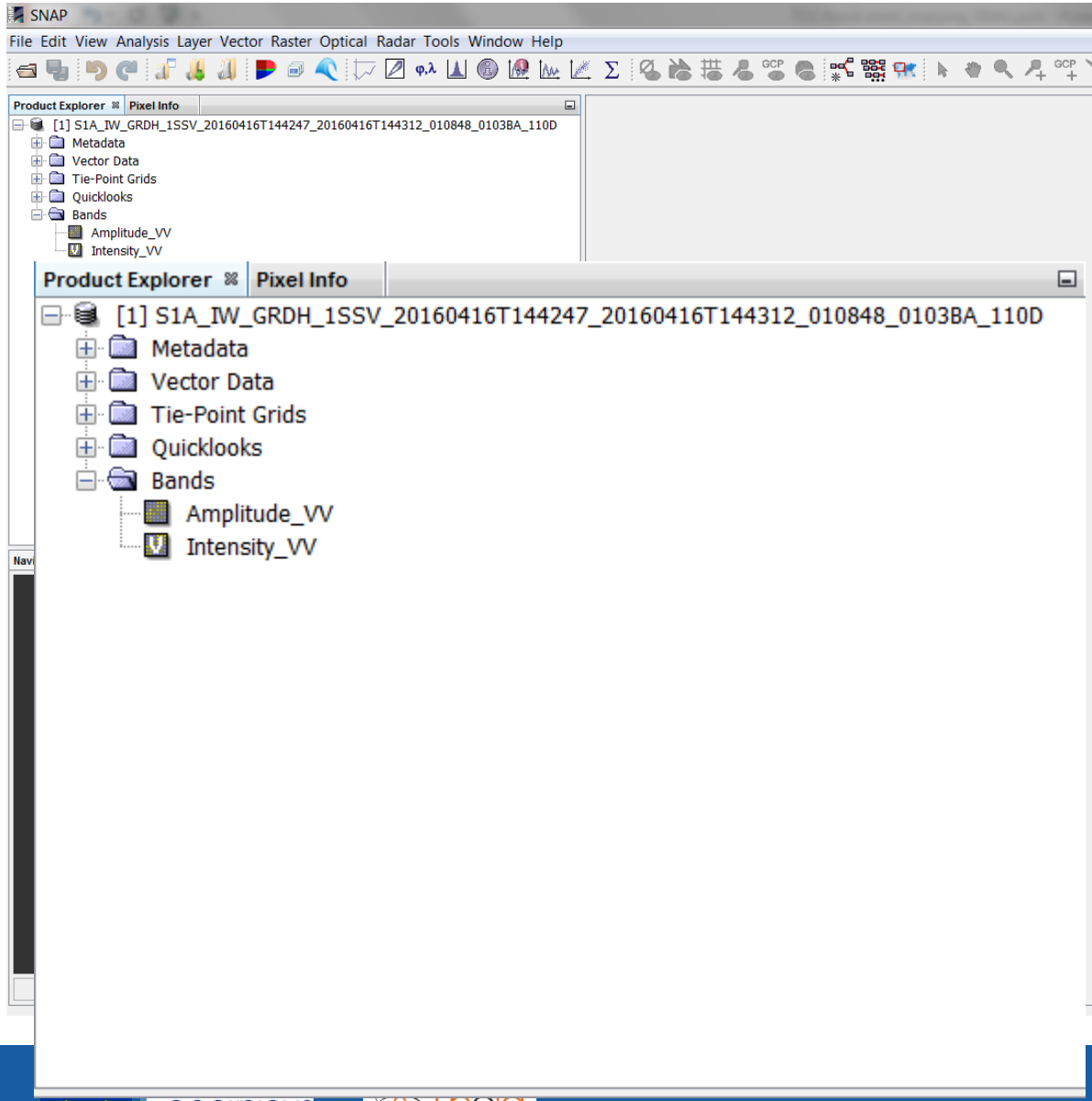
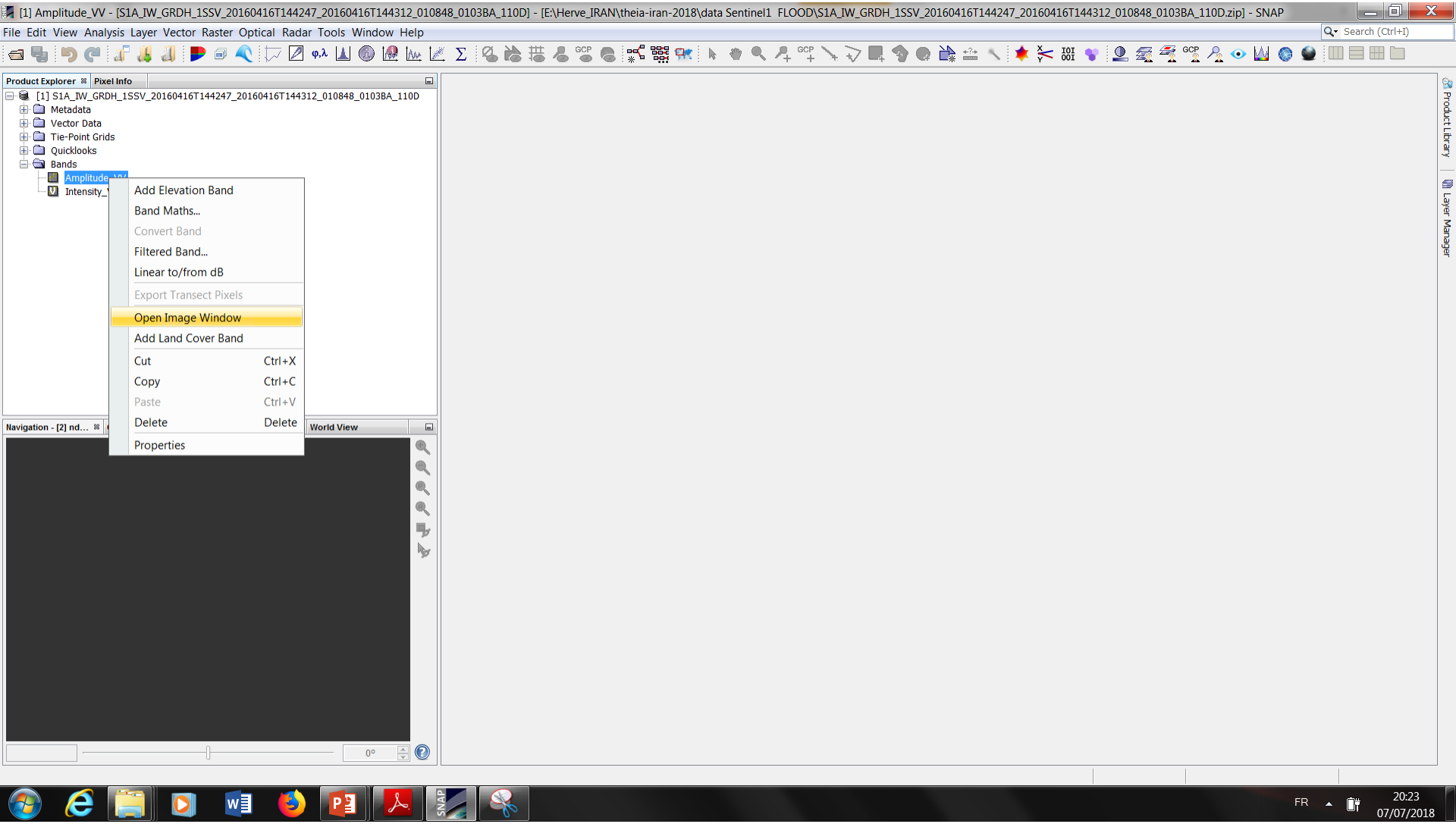


two bands: Amplitude and Intensity. (The Intensity band is a virtual one. It is the square of the amplitude). Double click on either Amplitude or Intensity to view the image

SNAP: read image



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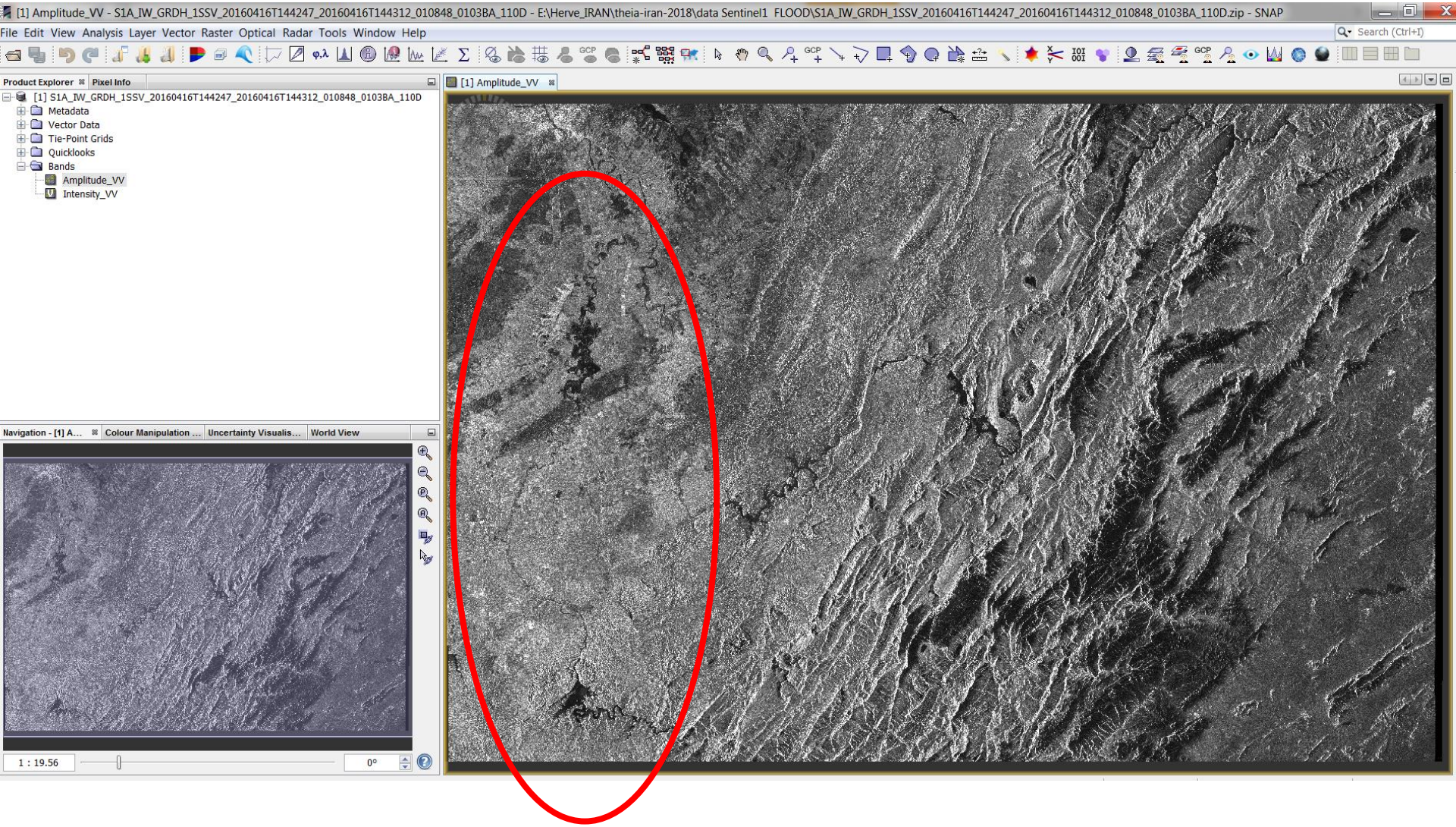


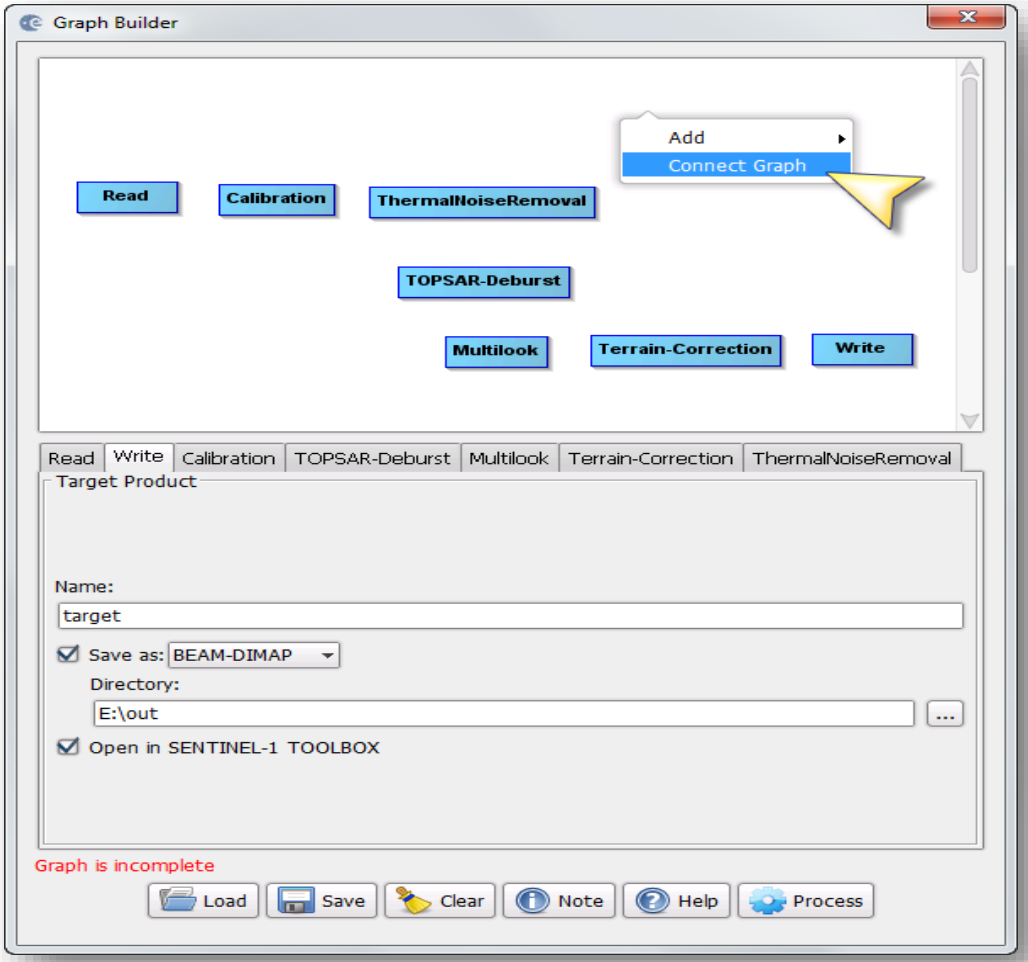
Ascending => invert geometry N/S

Preprocessing steps:Calculation of geocoded backscatter coefficients (sigma0).

SNAP Graph Building

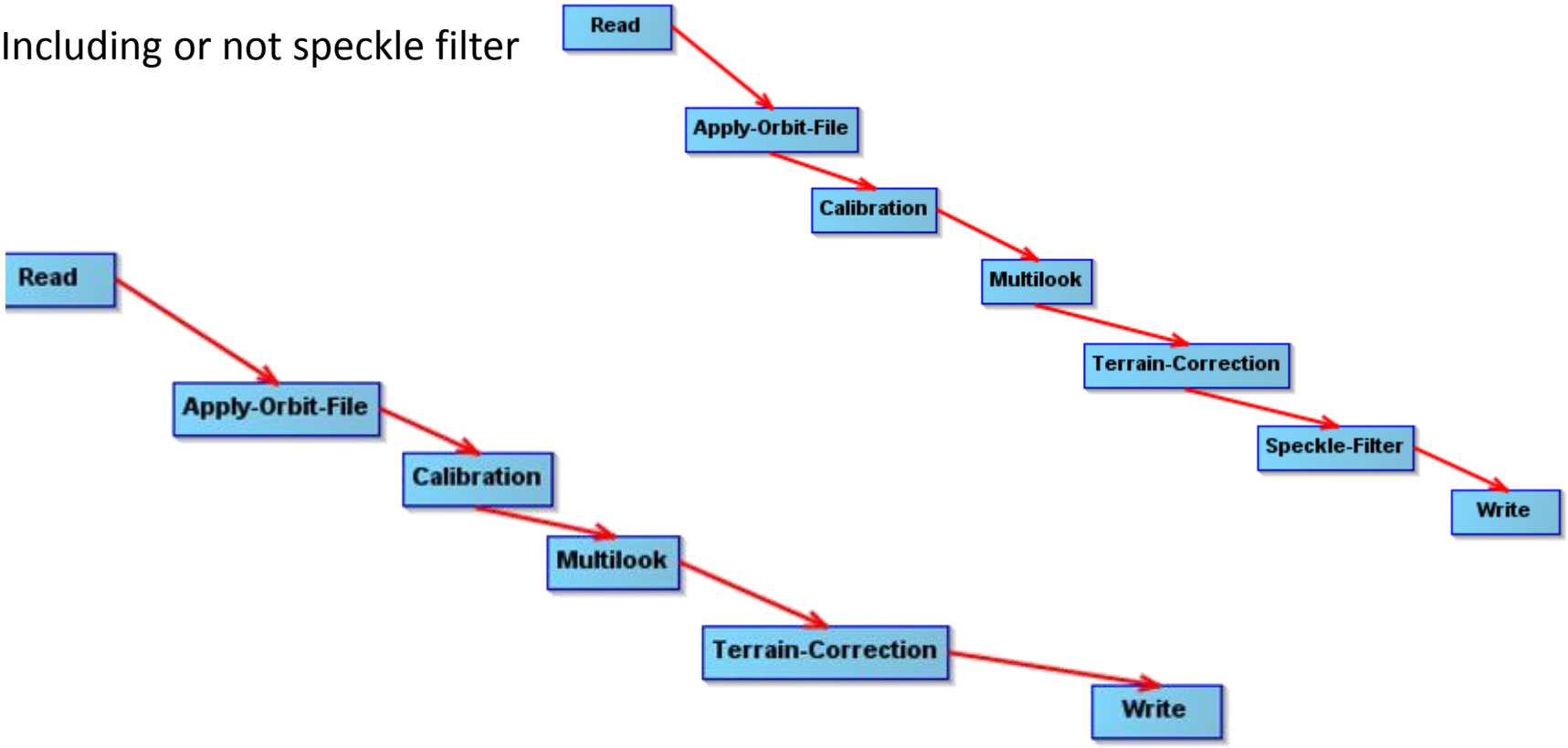
Right click to add operators from the context menu:

- Calibration
- Thermal Noise Removal
- Deburst & Merge
- Multilook
- Range Doppler Terrain Correction
- Connect the graph



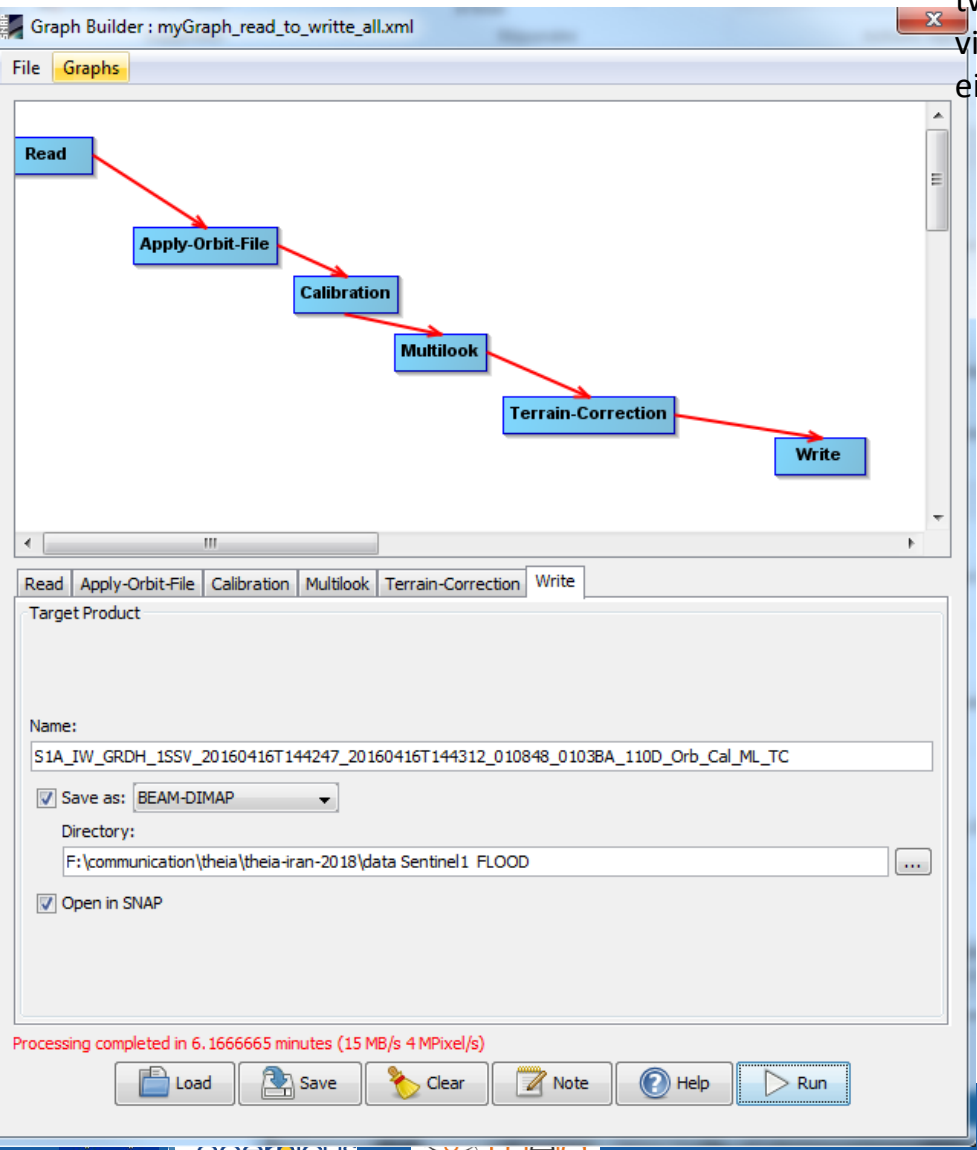
Preprocessing steps:Calculation of geocoded backscatter coefficients (sigma0).

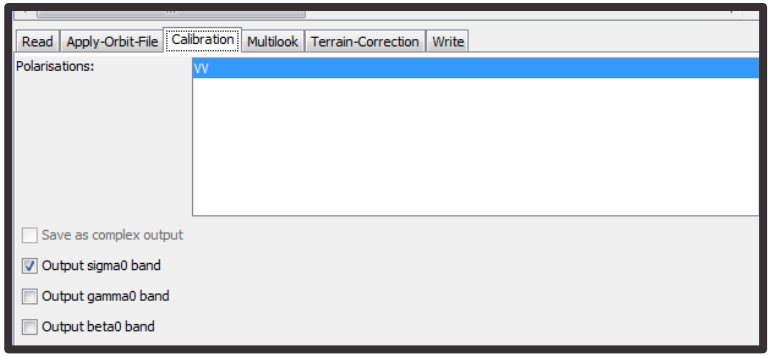
Including or not speckle filter



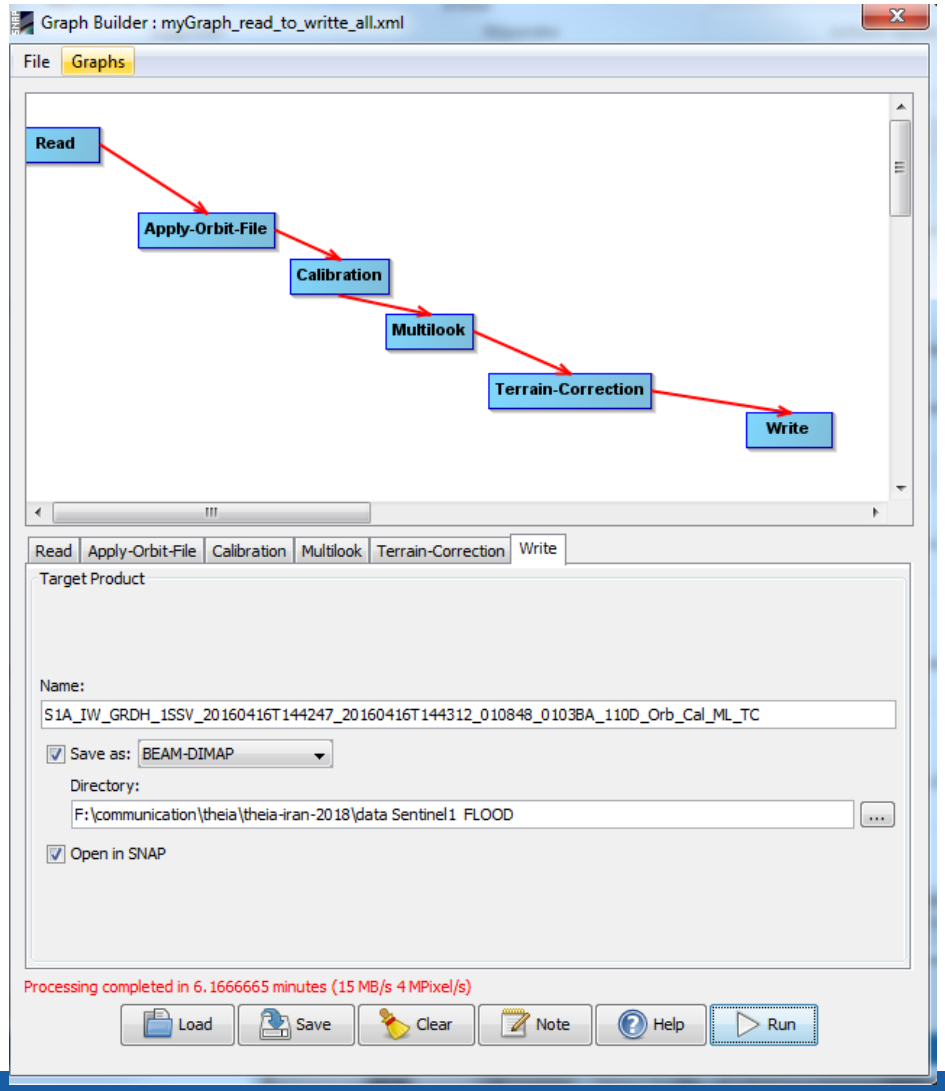
Preprocessing steps:Calculation of geocoded backscatter coefficients (sigma0).

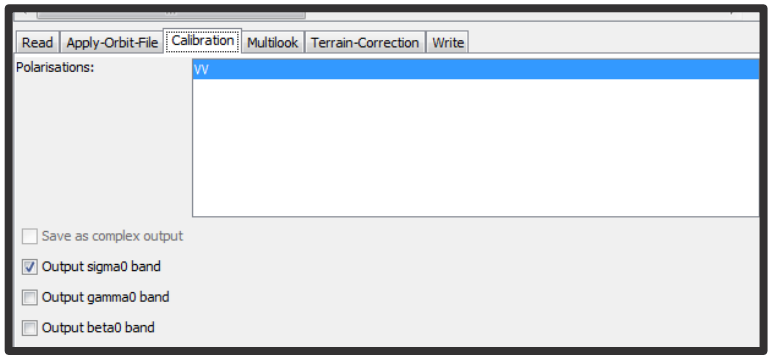
two bands: Amplitude and Intensity. (The Intensity band is a virtual one. It is the square of the amplitude). Double click on either Amplitude or Intensity to view the image

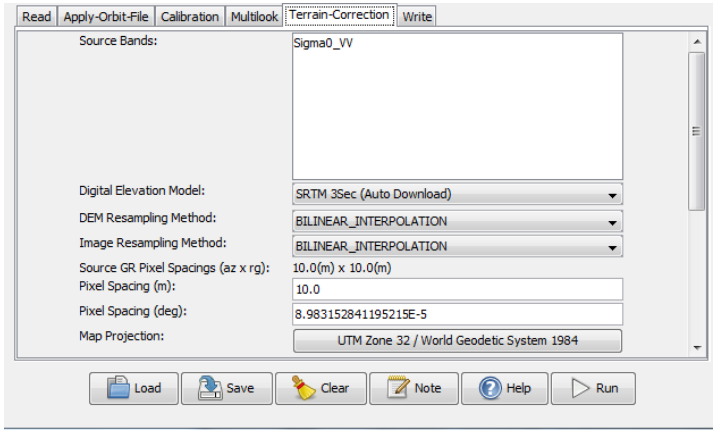




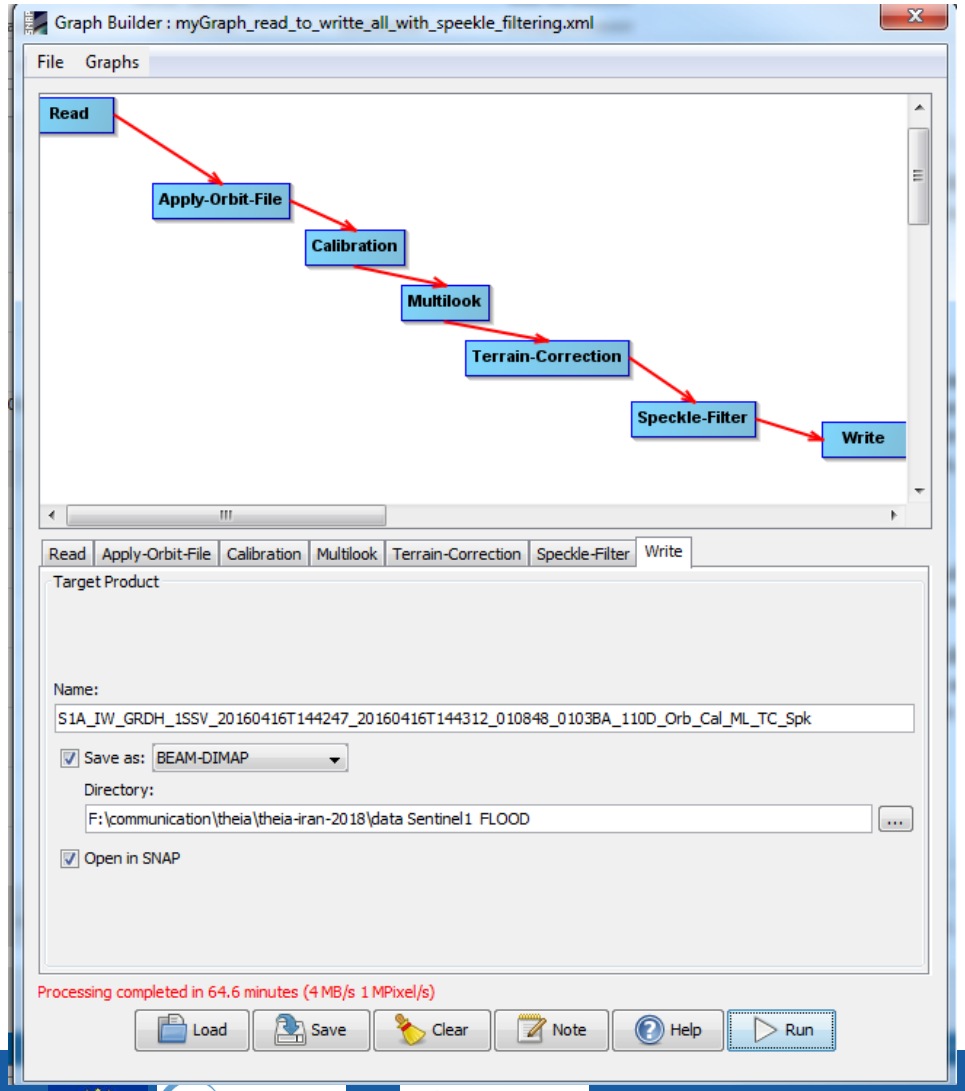
Preprocessing steps:Calculation of geocoded backscatter coefficients (sigma0).

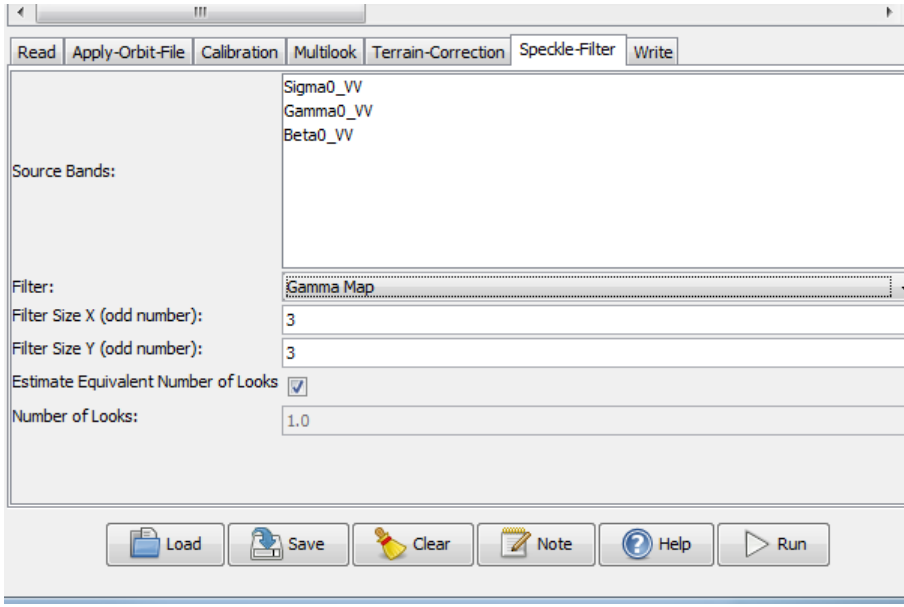




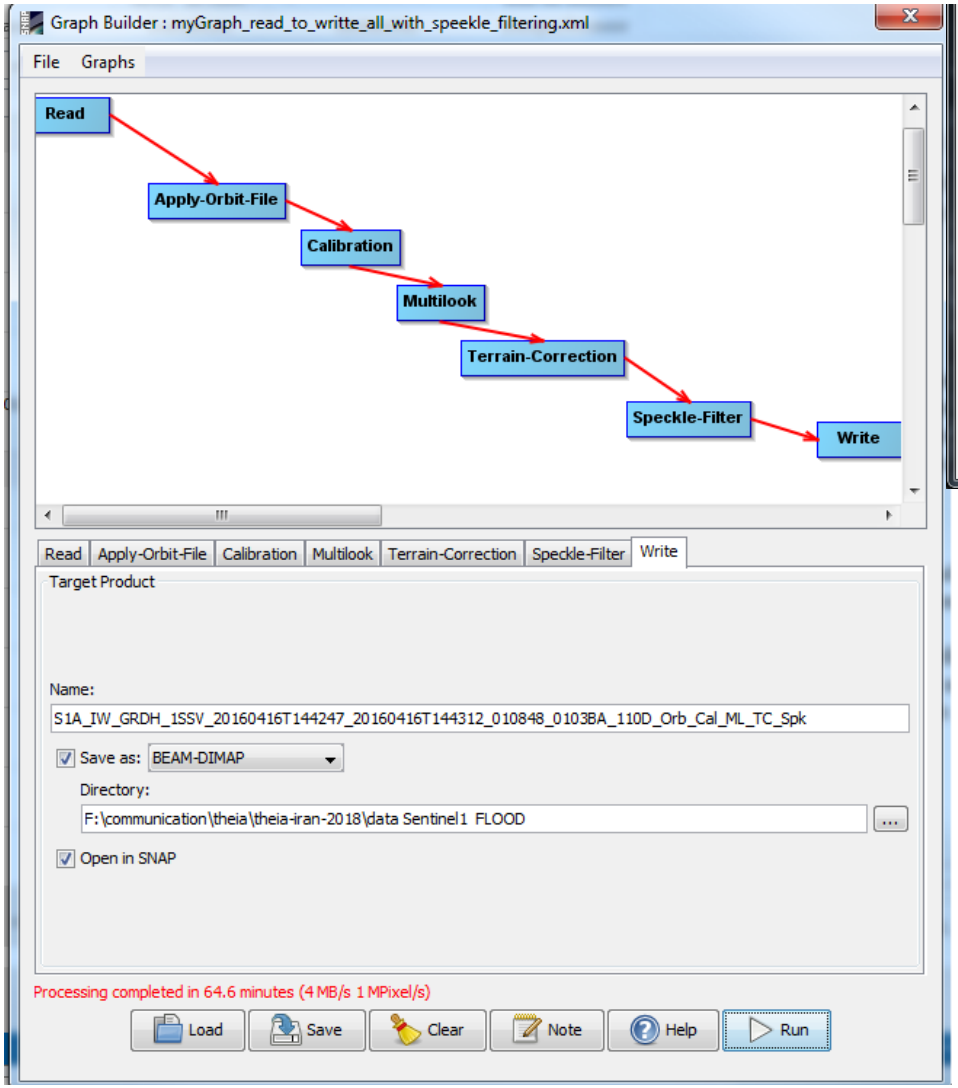


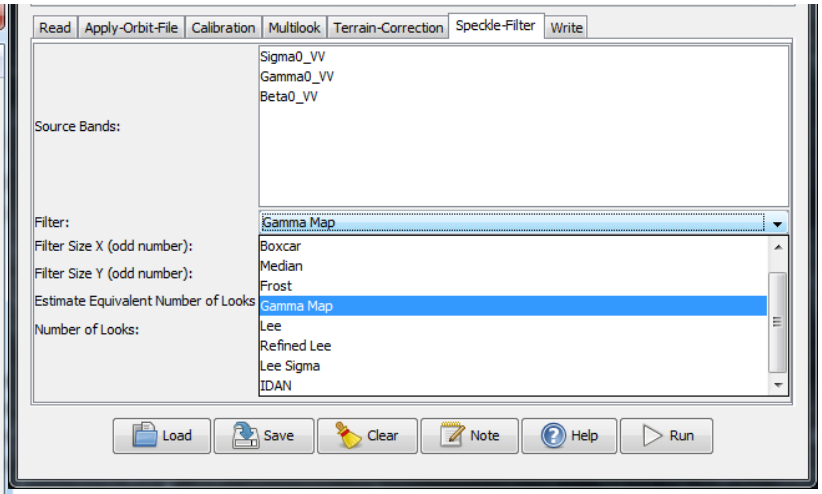
Preprocessing steps:Calculation of geocoded backscatter coefficients (sigma0).

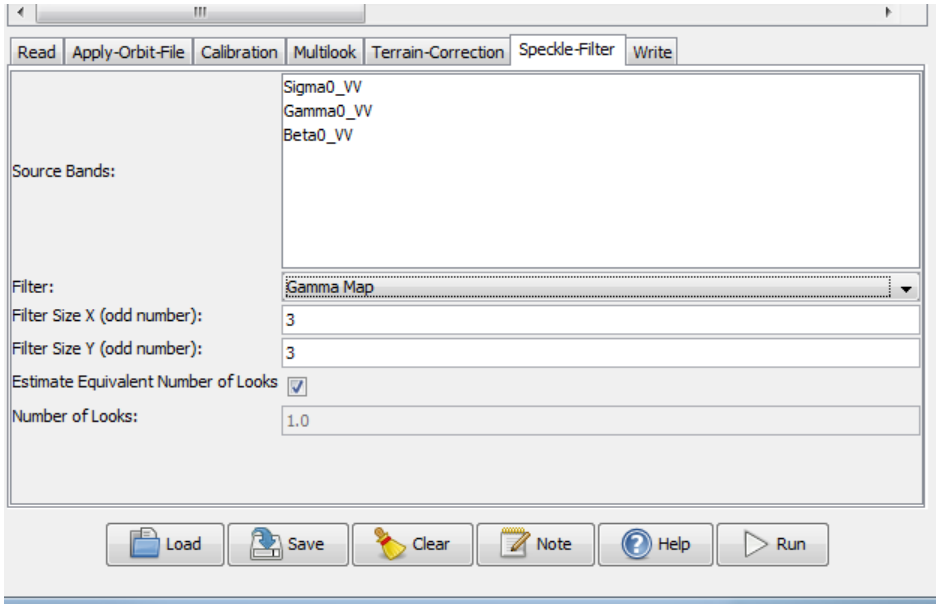




Preprocessing steps:Calculation of geocoded backscatter coefficients (sigma0).







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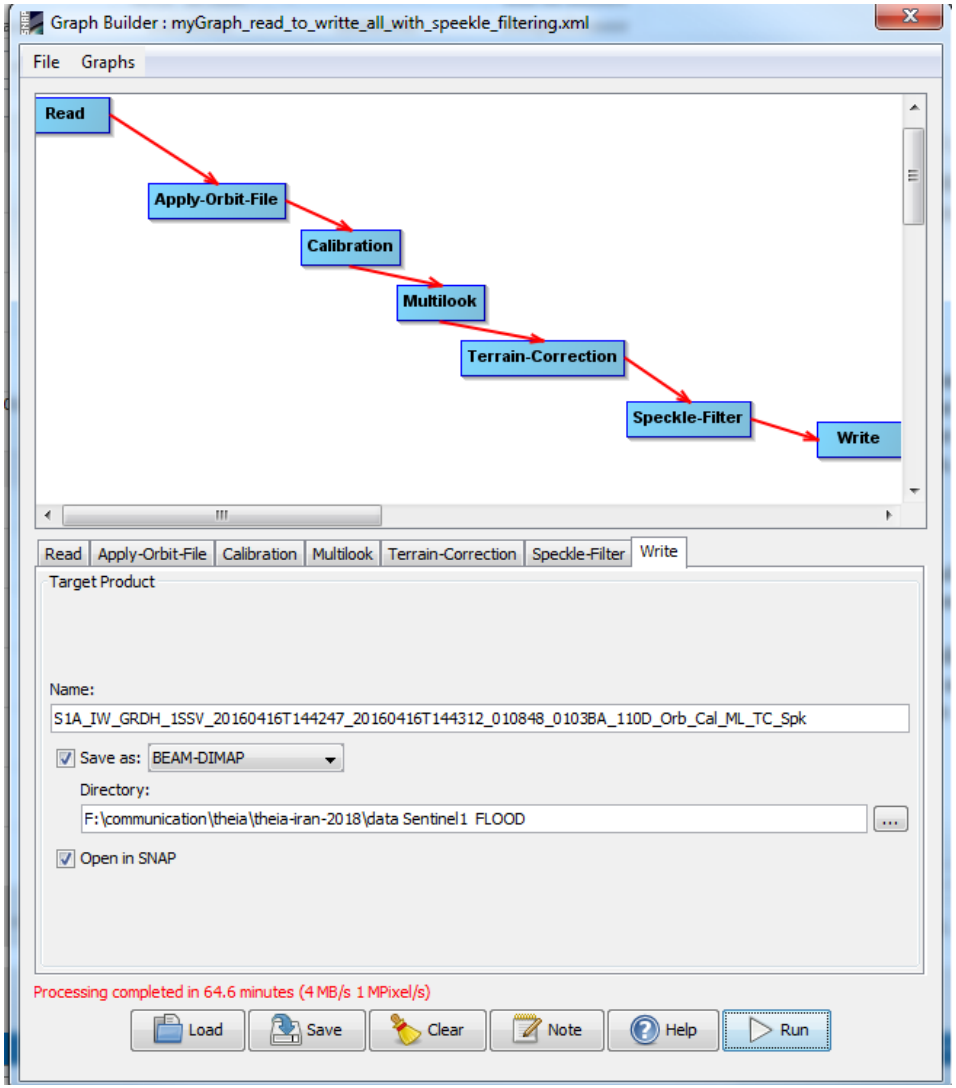
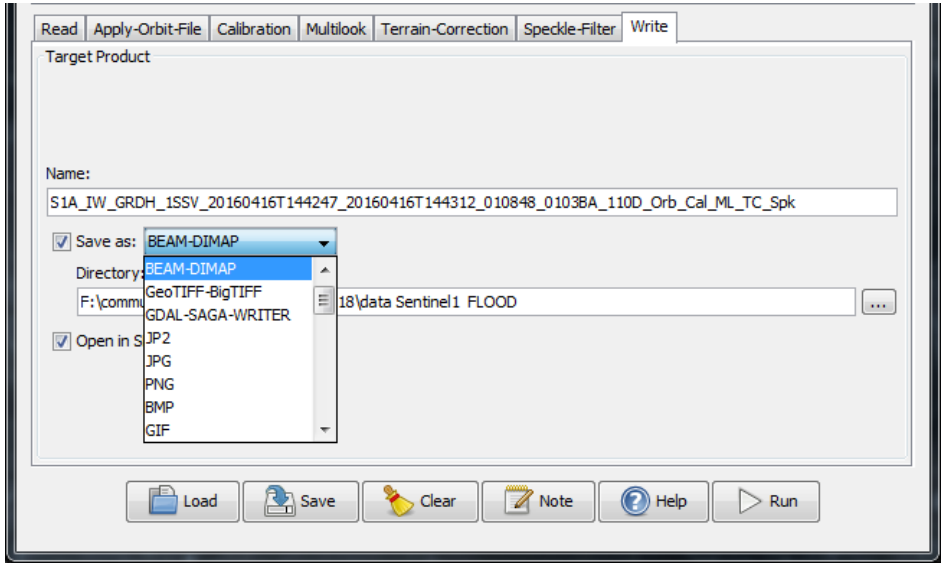
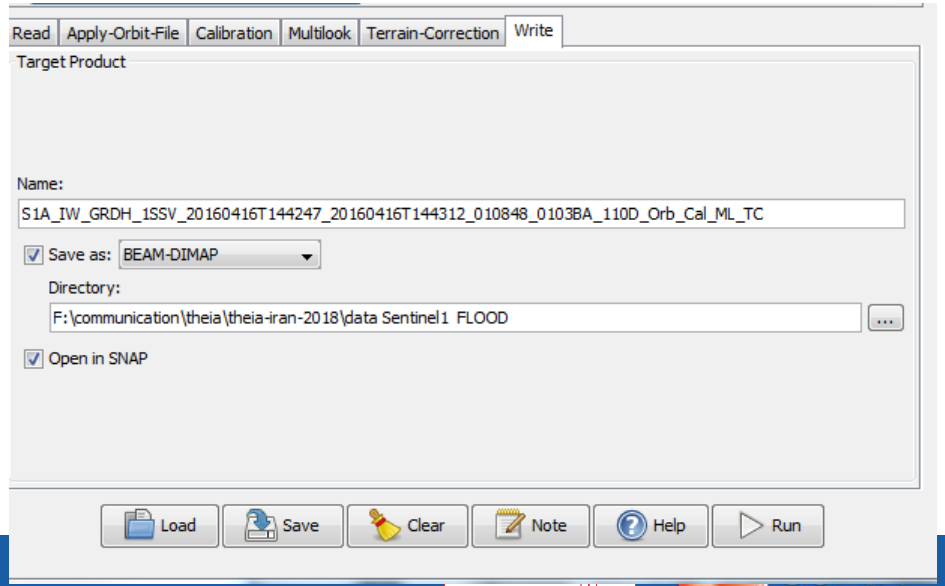
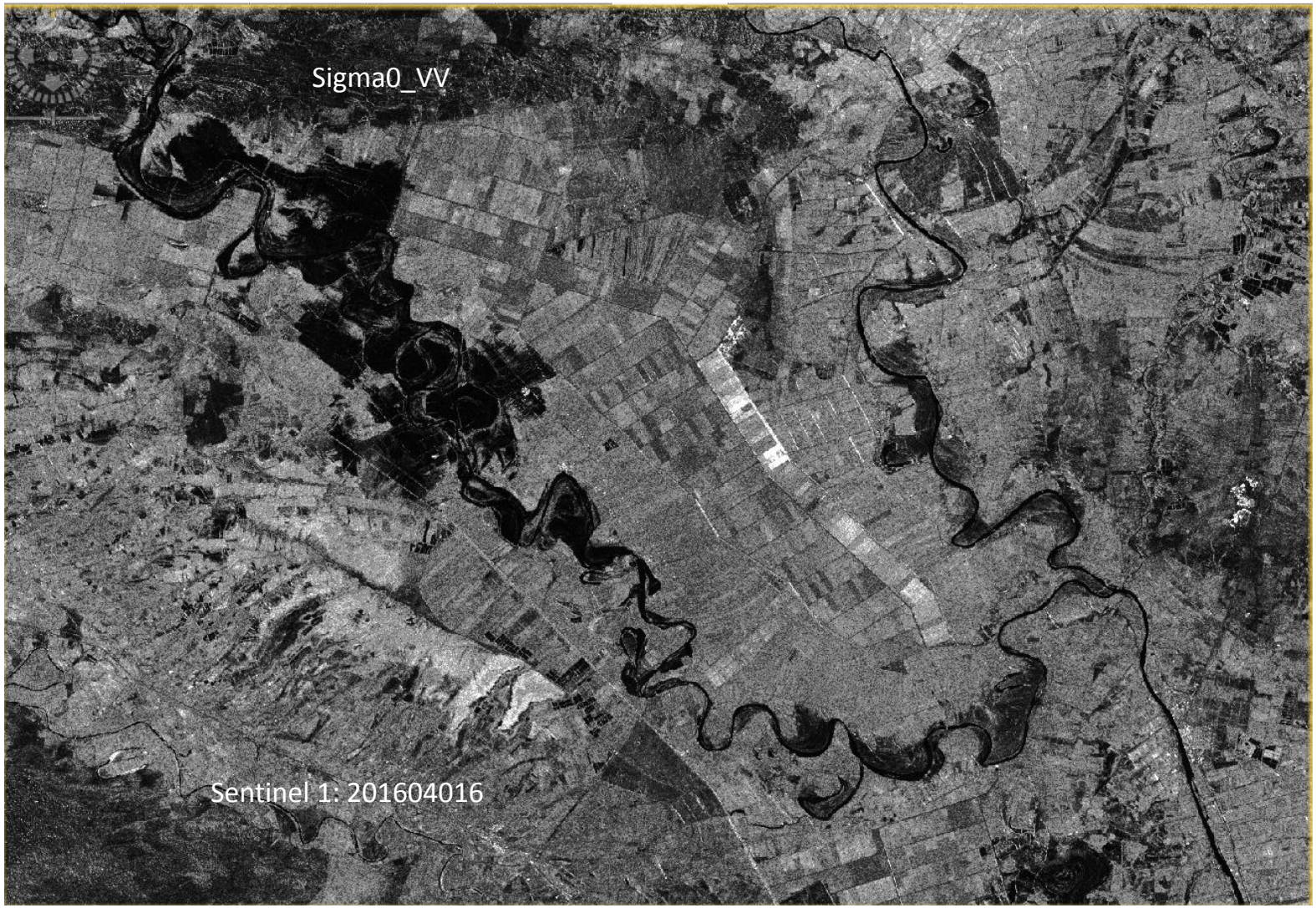






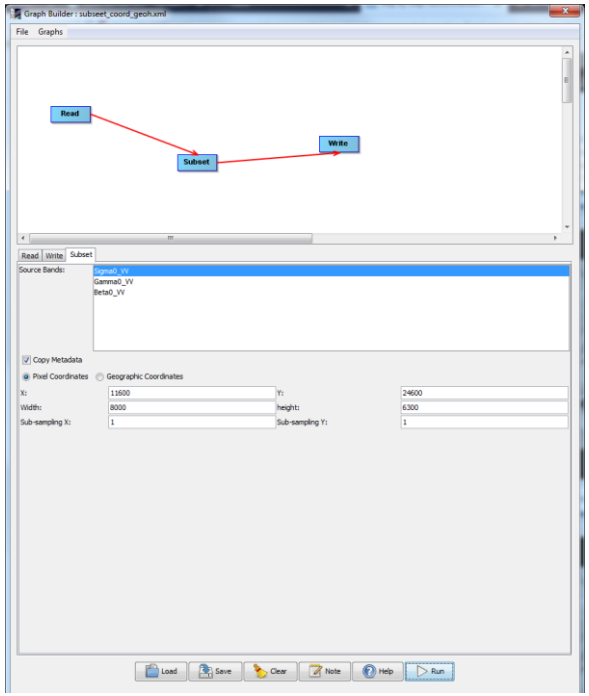

Beta0_VV

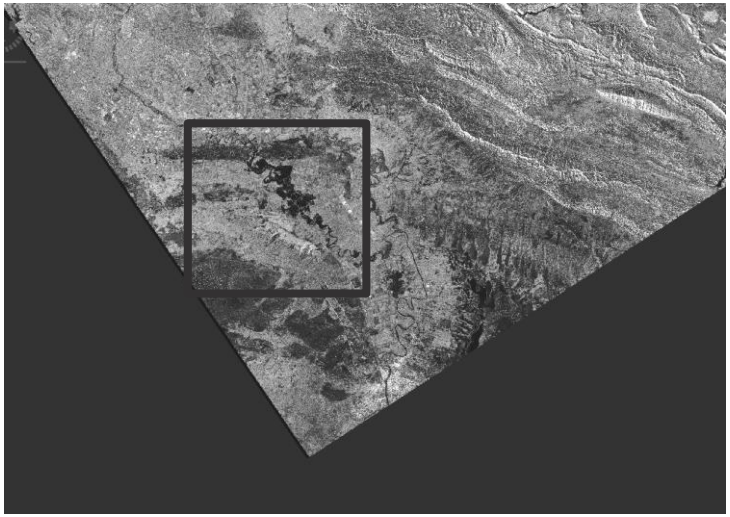

Gamma0_VV

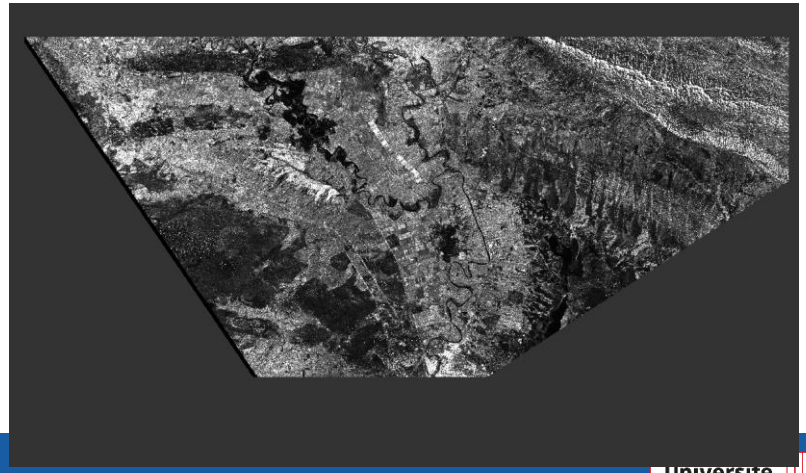

Sigma0_VV
Sentinel 1: 201604016

Landscape analysis:

- Subset
- Coordonnes fichiers
- 11600-24600
- 8000



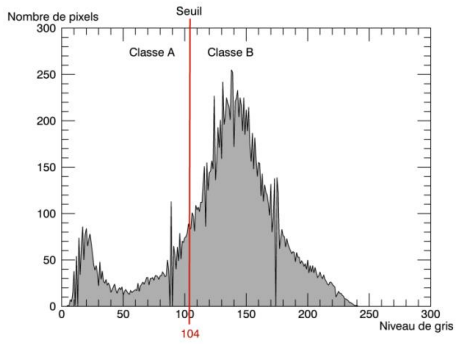


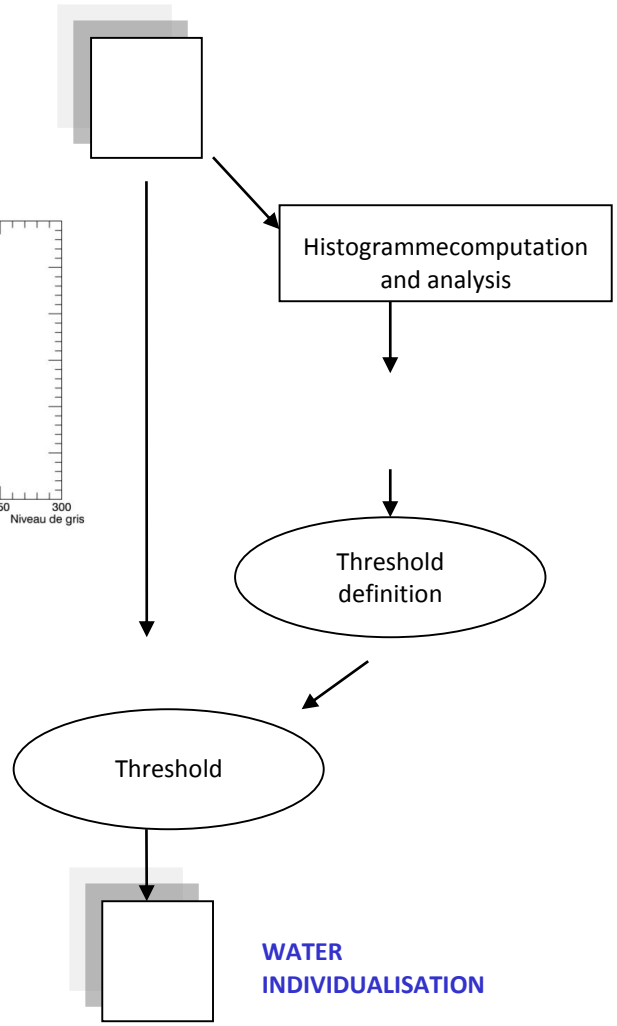


Flood mapping based on SAR data

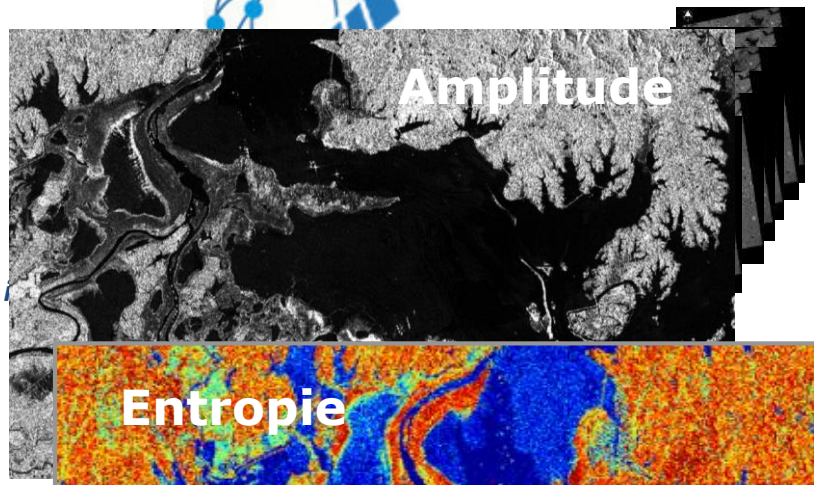
- **Water extraction by thresholding performed on:**
  - **Amplitude data (mediane fenetre glissante)**
  - **Coherence**
  - **Polarimetry approach (Shannon Entropy)**

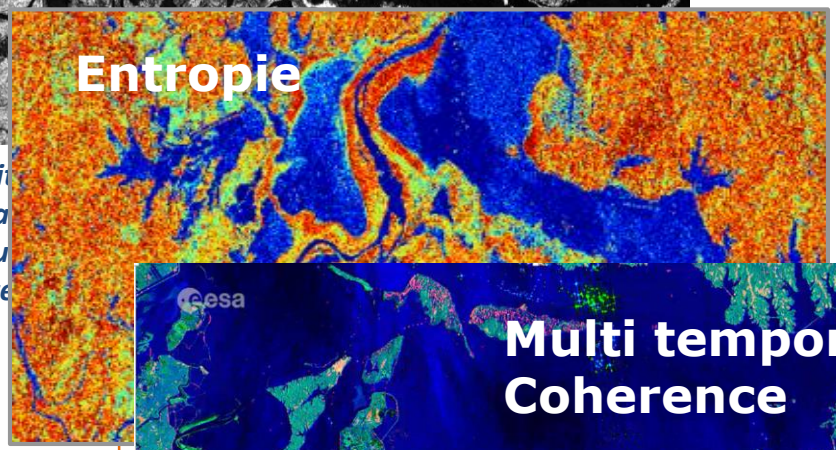
- **Methods of classification**
  - **Supervised**
  - **None supervised**
  - **Oriented object methods**
  - **SVM**
  - **Snake detection**
  - **…**

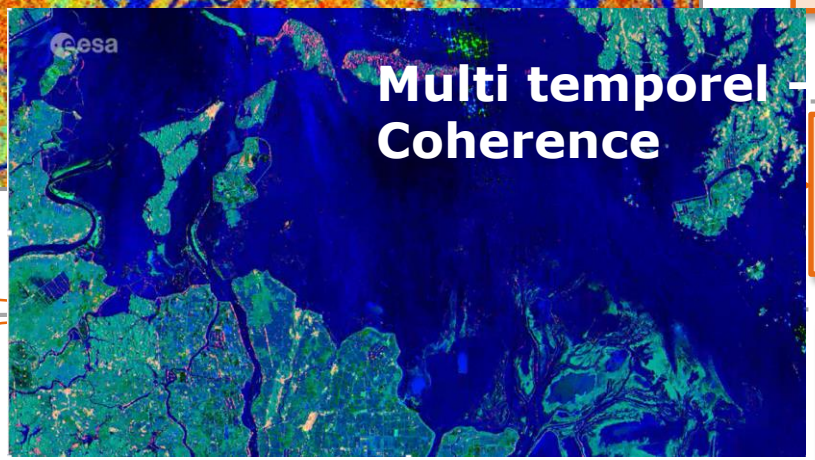




Schematic processing flow for Sentinel1 Sar data

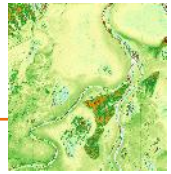






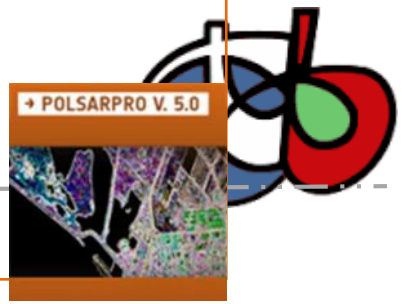
PreProcessing

DEM



Amplitude
texture
Polarmetric
primitives
Coherence

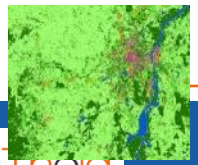
Extraction



Geometry

Validation

Database



Water product

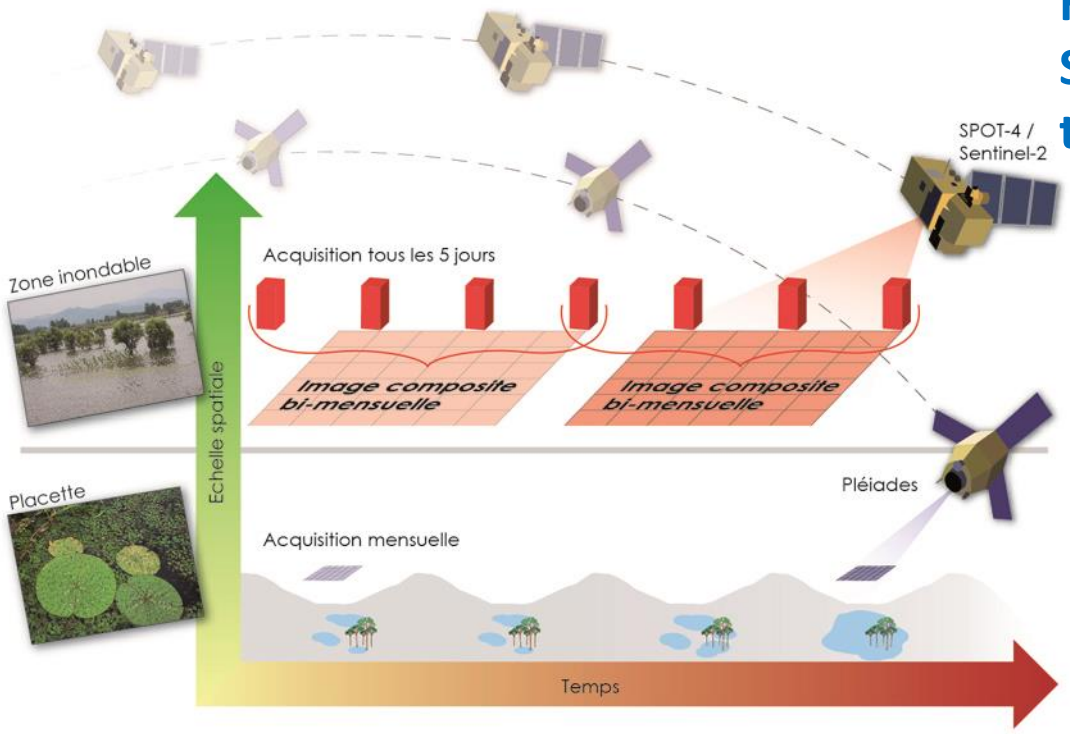
Primitives Image features pattern

Methods

Geometry

Validation

Validation based on multi source & multiscale optical and SAR



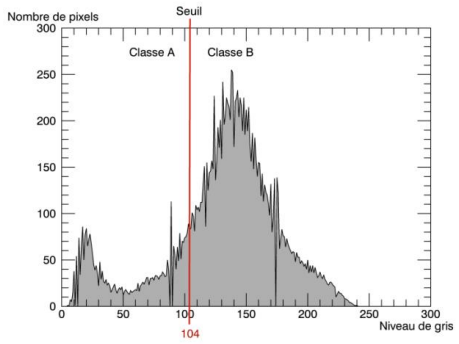
Sentinel2 / HJ/Deimos and Pleiades HR
Sentinel1/ TerraSAR, Wide ScanSAR to Staring Spot Light

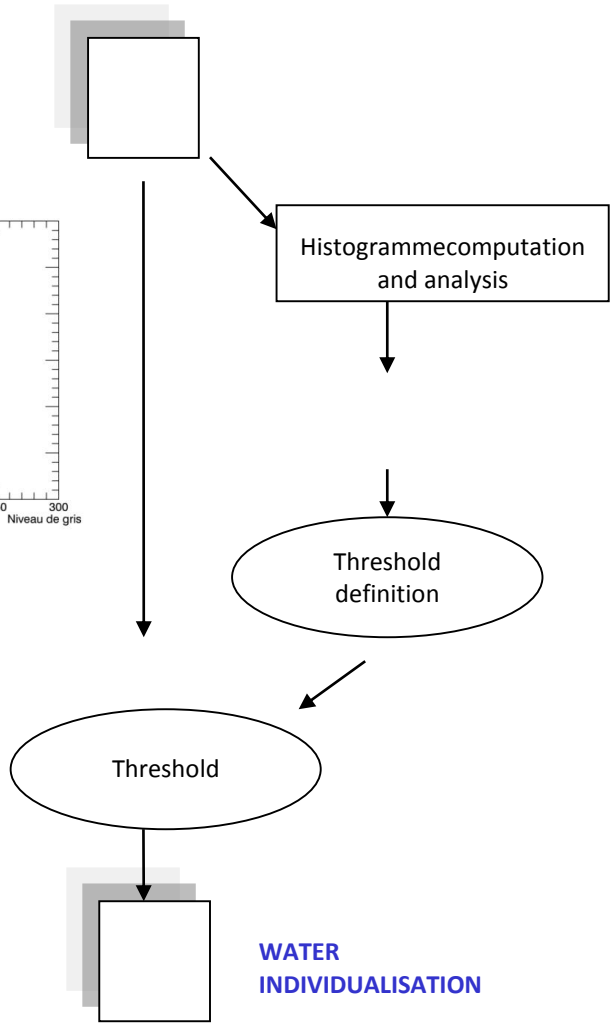
VHR SAR or Optical imagery allow to validate the HR derived flood extent

Flood mapping based on SAR data

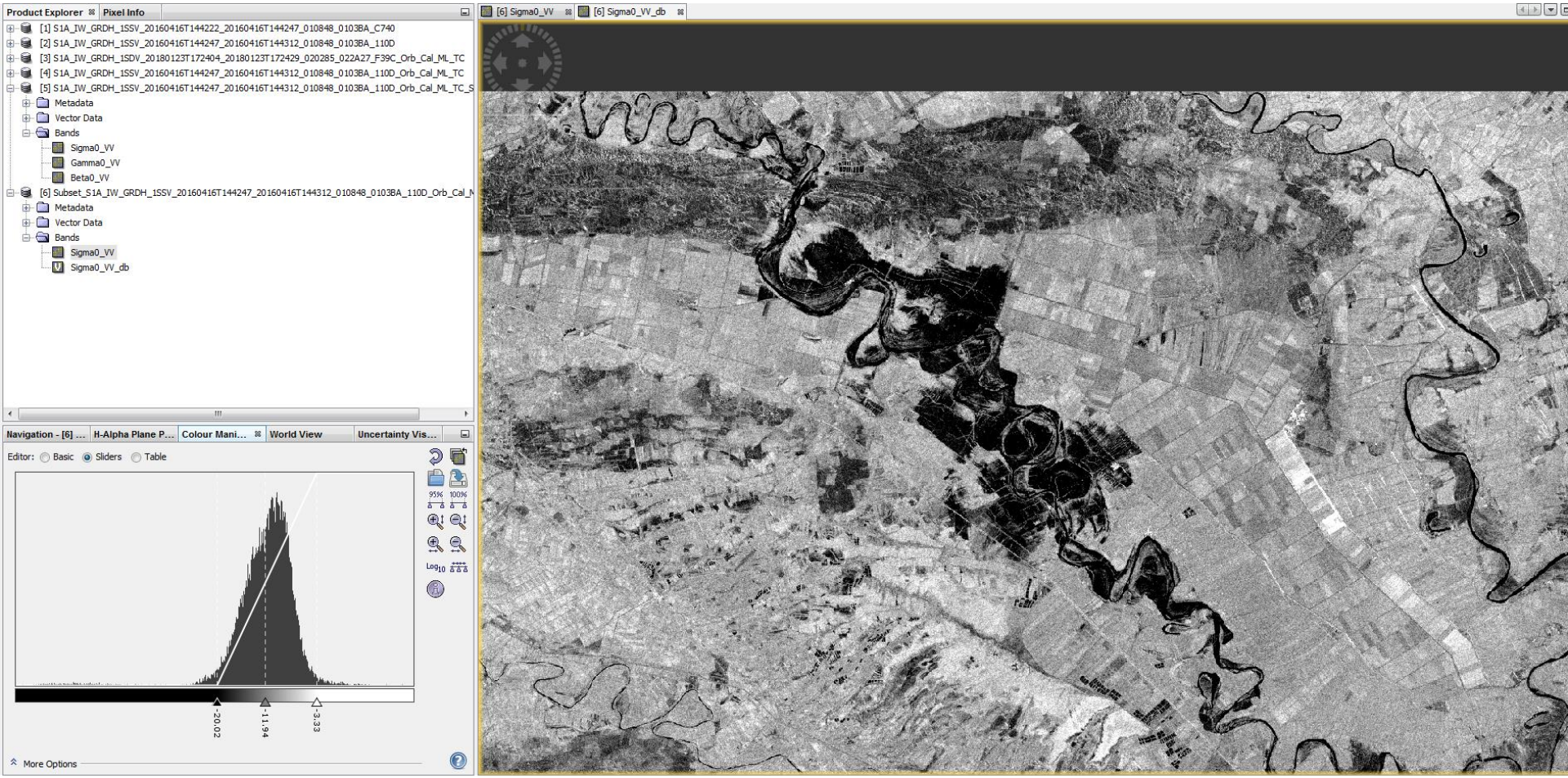
- **Water extraction by thresholding performed on:**
  - **Amplitude data (mediane window)**
  - **Coherence**
  - **Polarimetry approach (Shannon Entropy)**

- **Methods of classification**
  - **Supervised**
  - **None supervised**
  - **Oriented object methods**
  - **SVM**
  - **Snake detection**
  - **…**

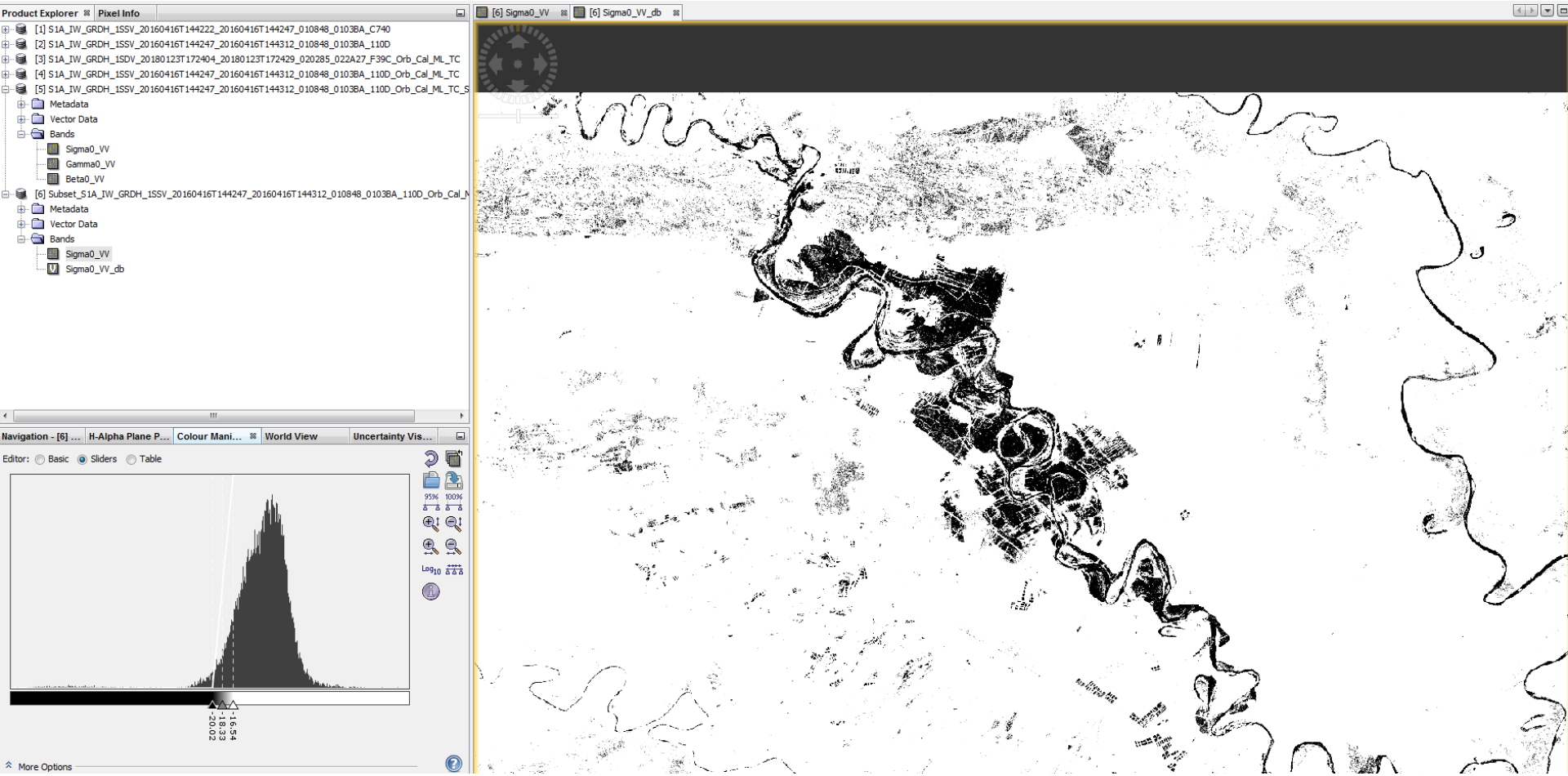




Water extraction based on thresholding appraoch

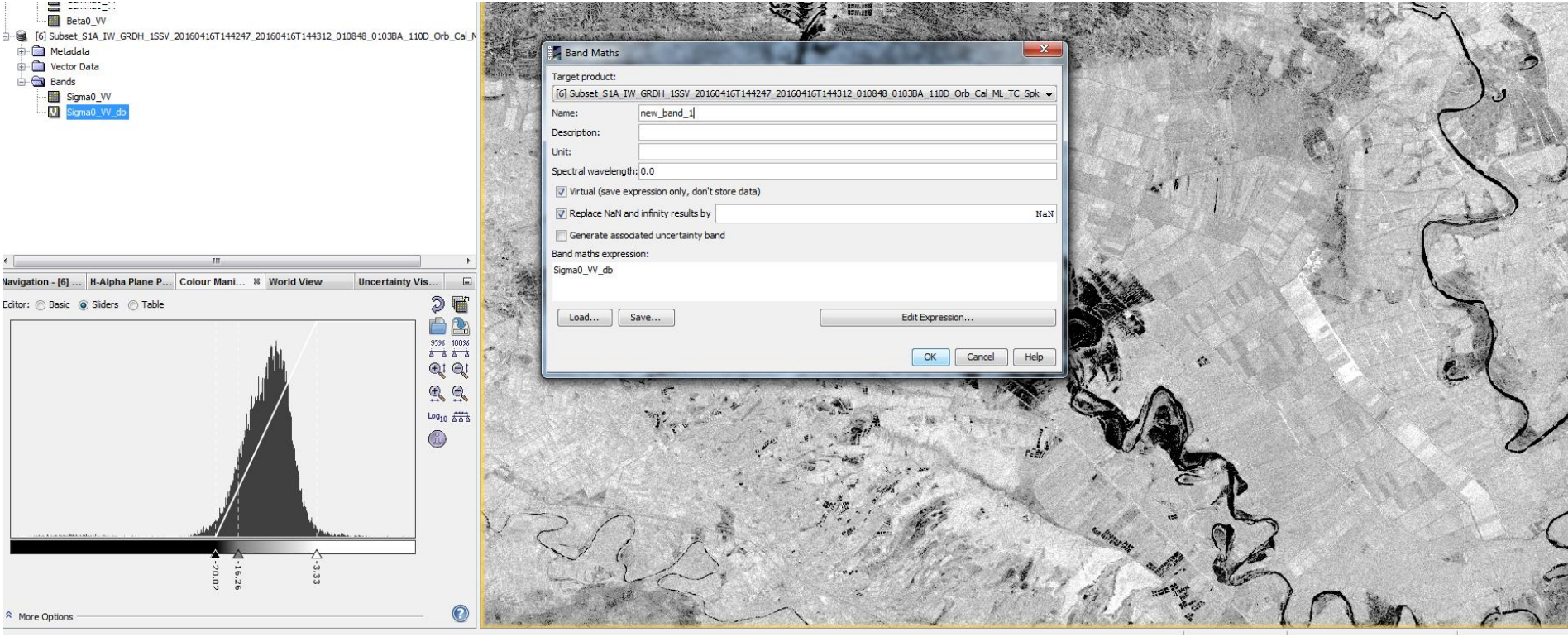


Water extraction based on thresholding appraoch



Water extraction based on thresholding appraoch

Change name into water

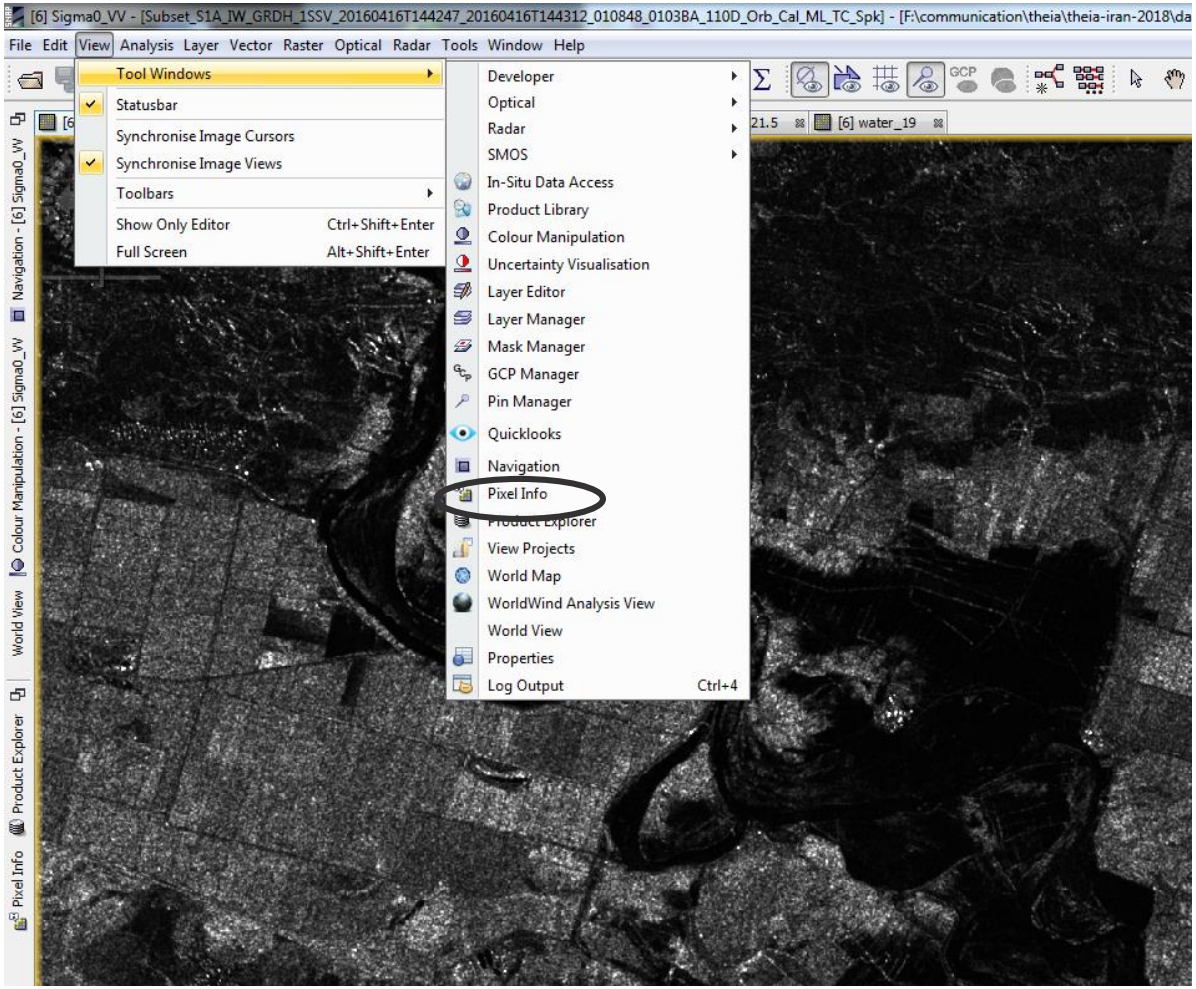


255*(Sigma0_VV_db<16.26)

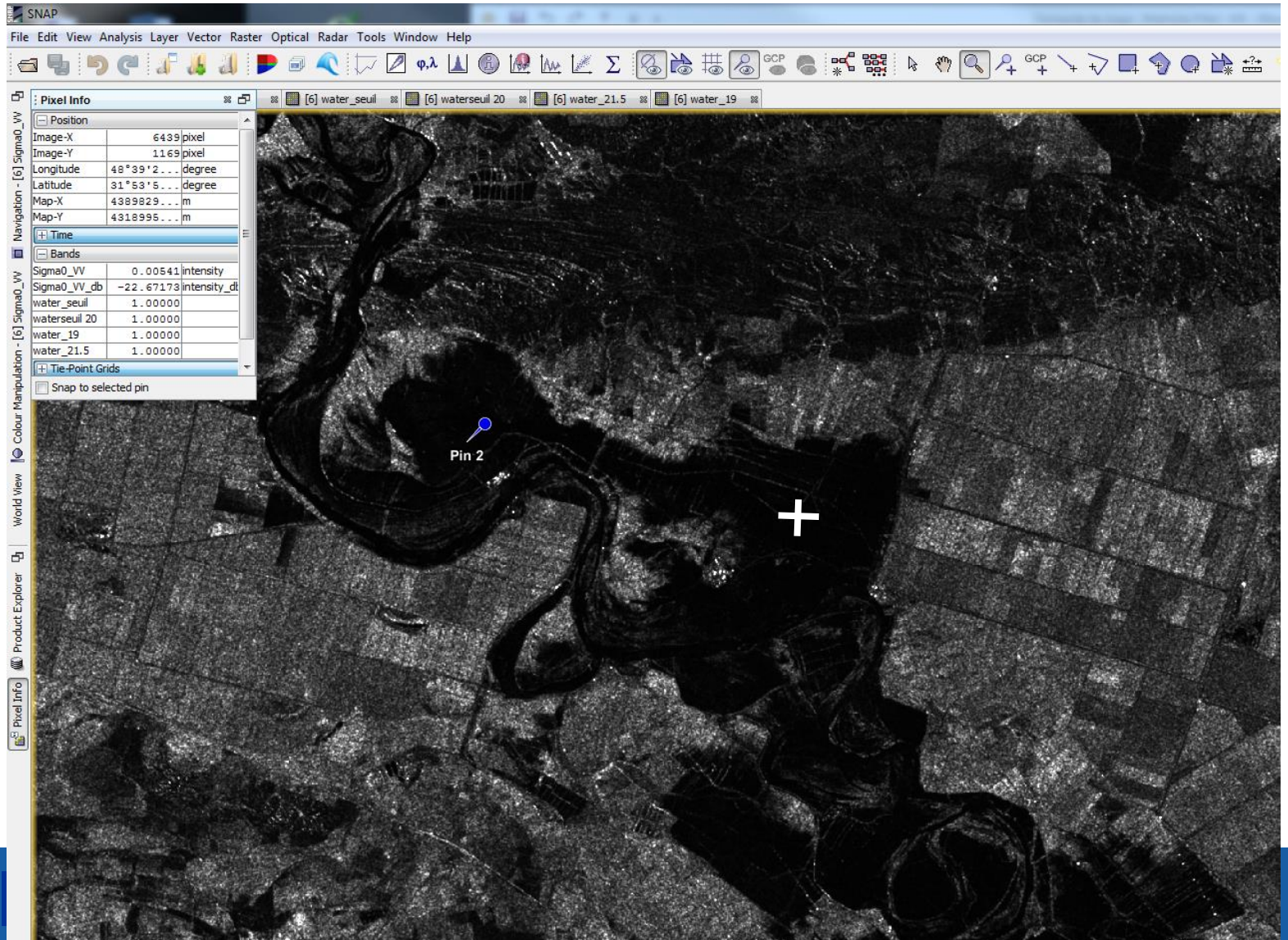
if Sigma0_VV_db <= -16.26 then 1 else 0

if Sigma0_VV_db <= -20 then 1 else 0

Water extraction based on thresholding appraoch

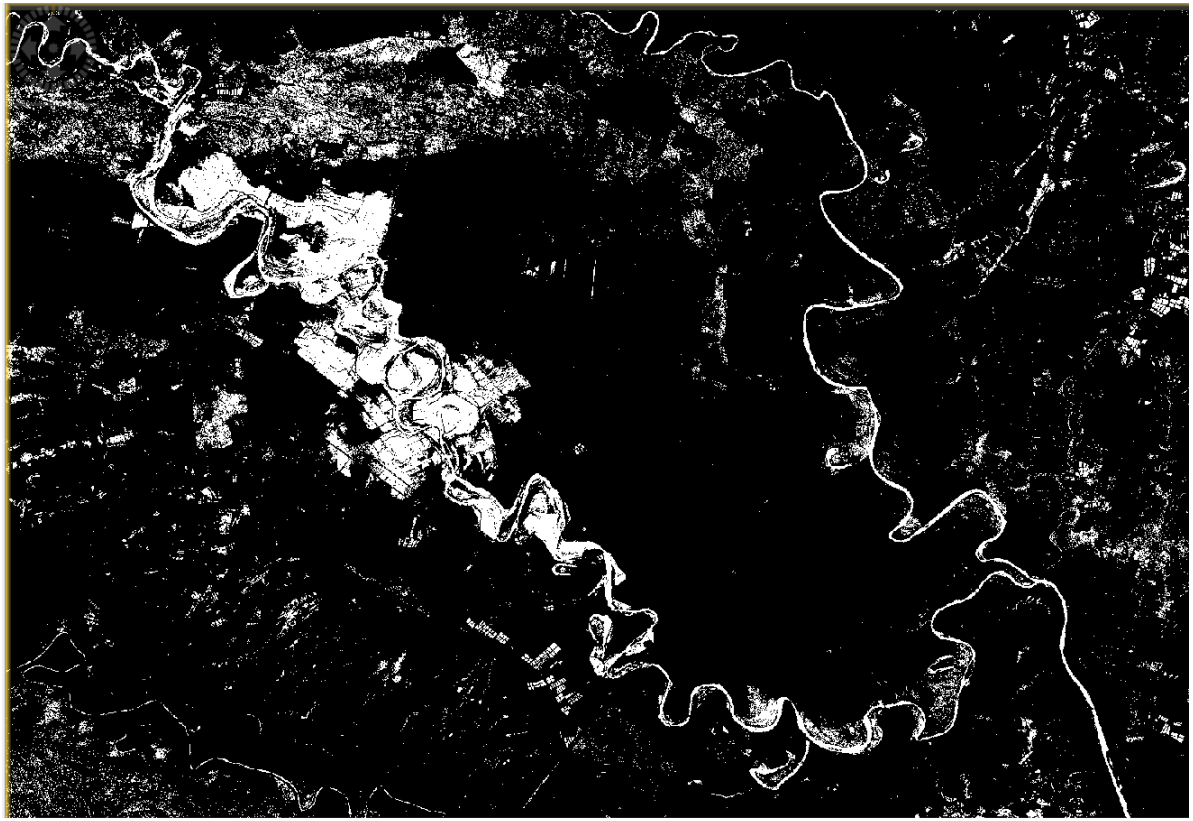


Water extraction based on thresholding appraoch



Water extraction based on thresholding appraoch

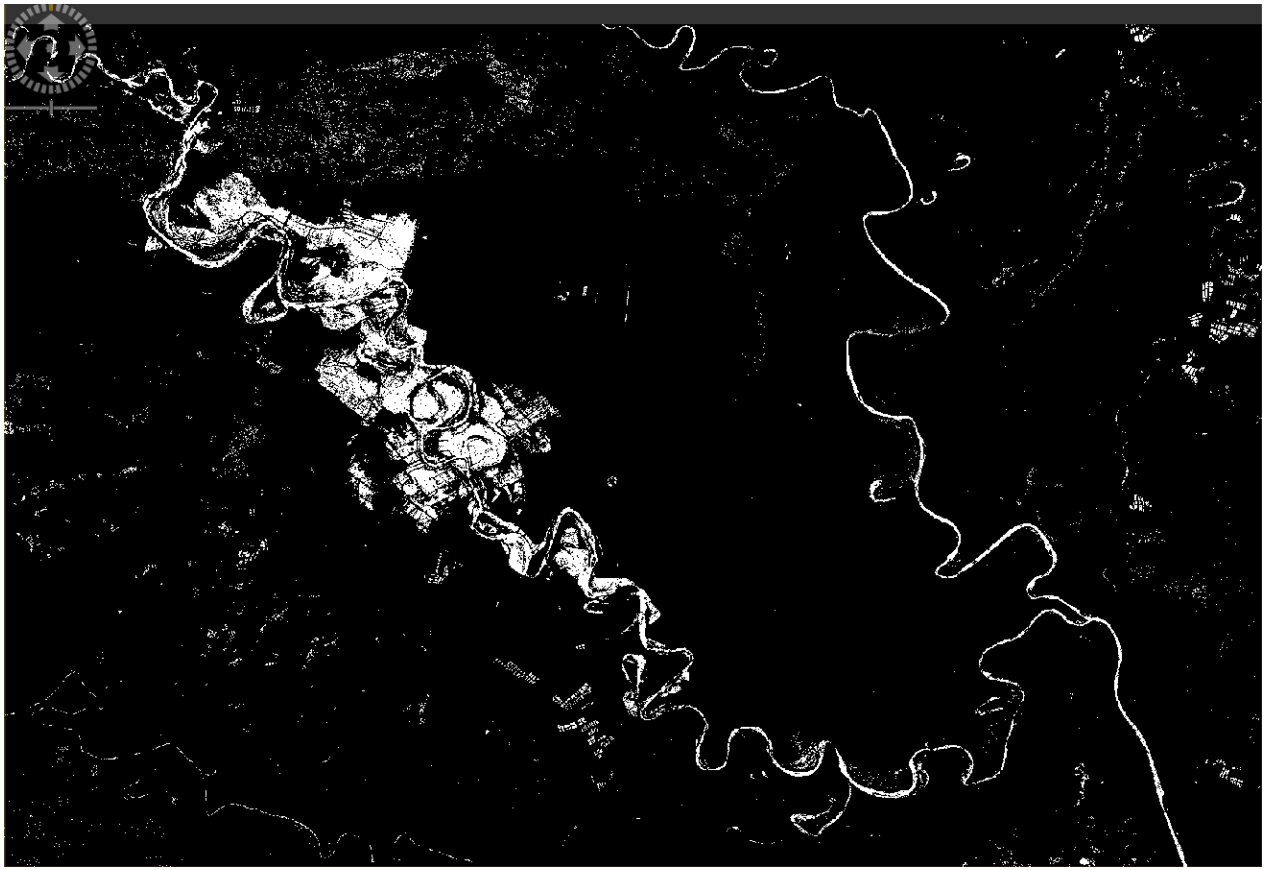
Test different threshold value



Seuil -16,5

Water extraction based on thresholding appraoch

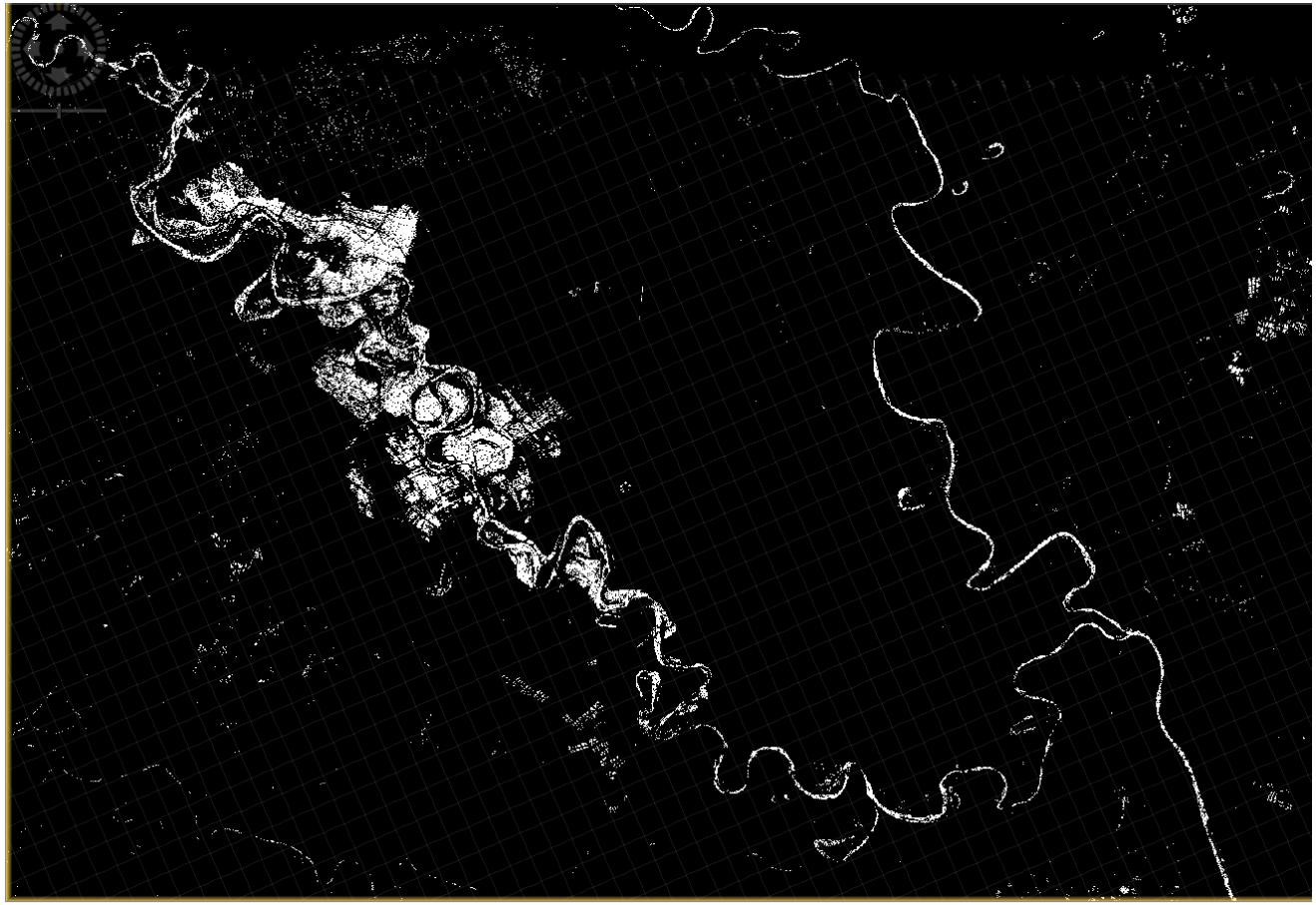
Test different threshold value



Seuil -19

Water extraction based on thresholding appraoch

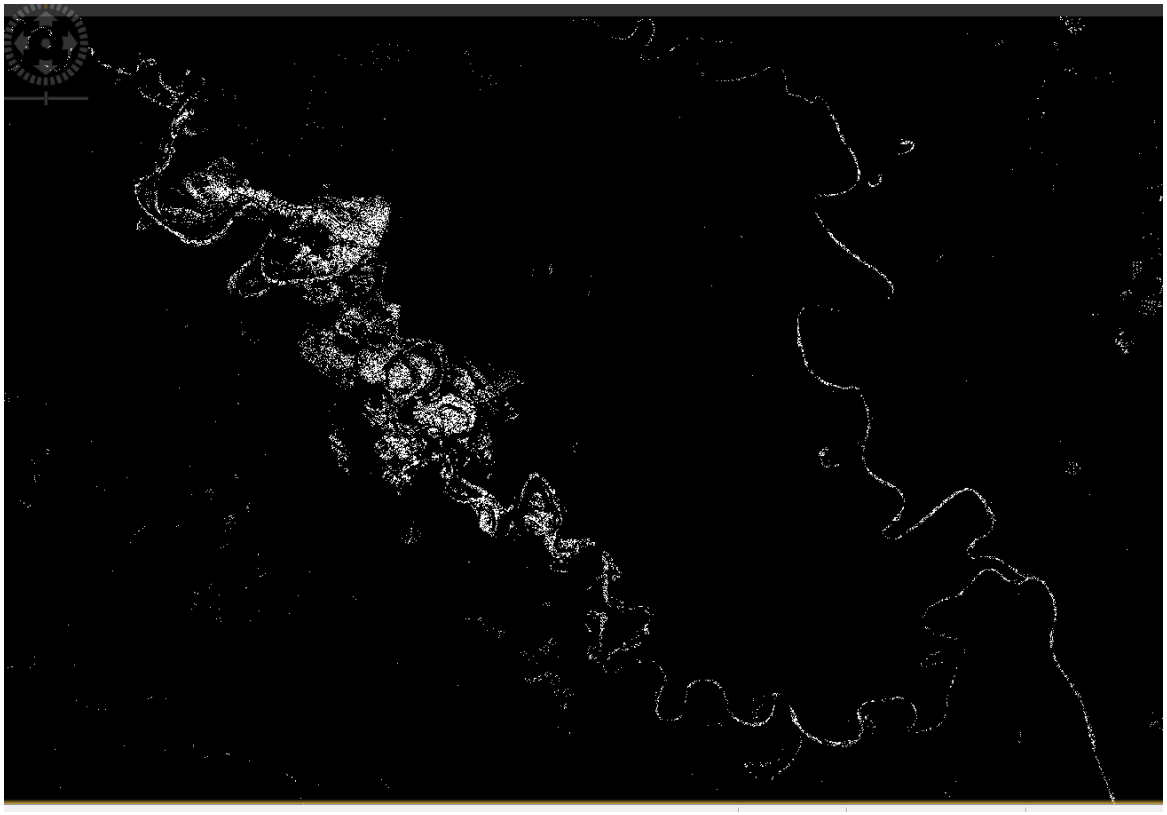
Test different threshold value



Seuil -20

Water extraction based on thresholding appraoch

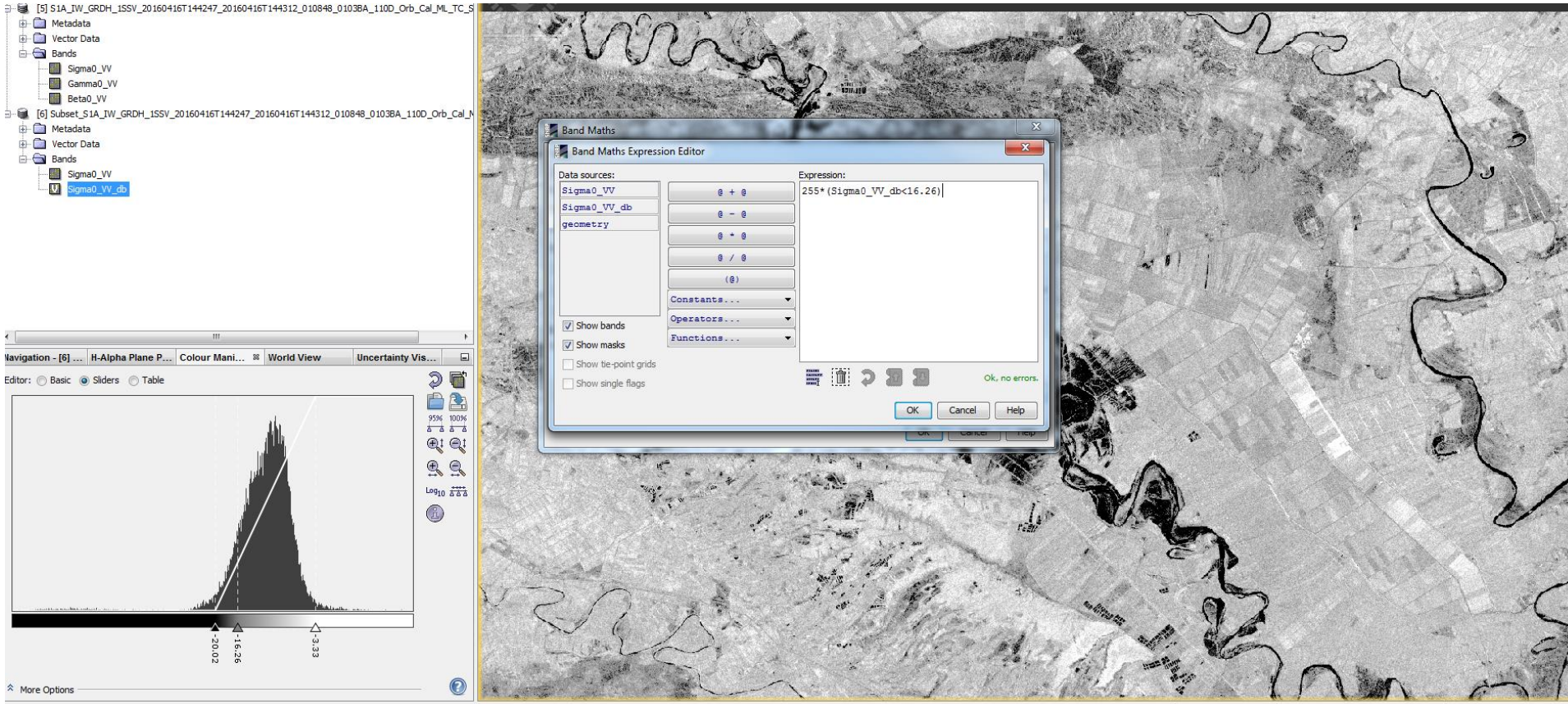
Test different threshold value



Seuil -21,5

Water extraction based on thresholding appraoch

Created a mask based on a threshold value: band math expression



Multitemporal approach

Preprocessing steps: Stack layers

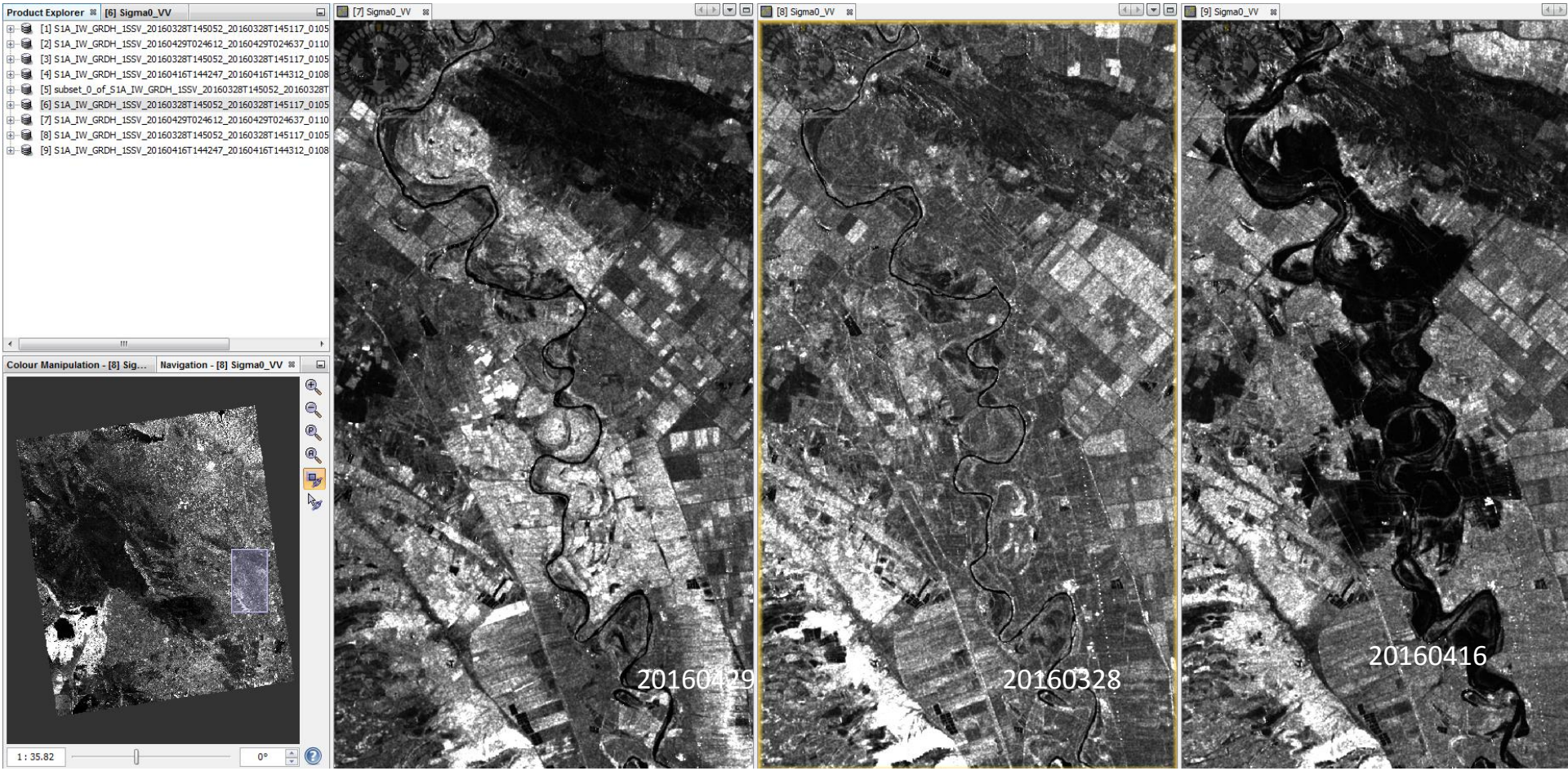
- **Create a multiemporal set:**

- **20160328 Pre event**
- **20160416 Crisis**
- **20160429 Post event**

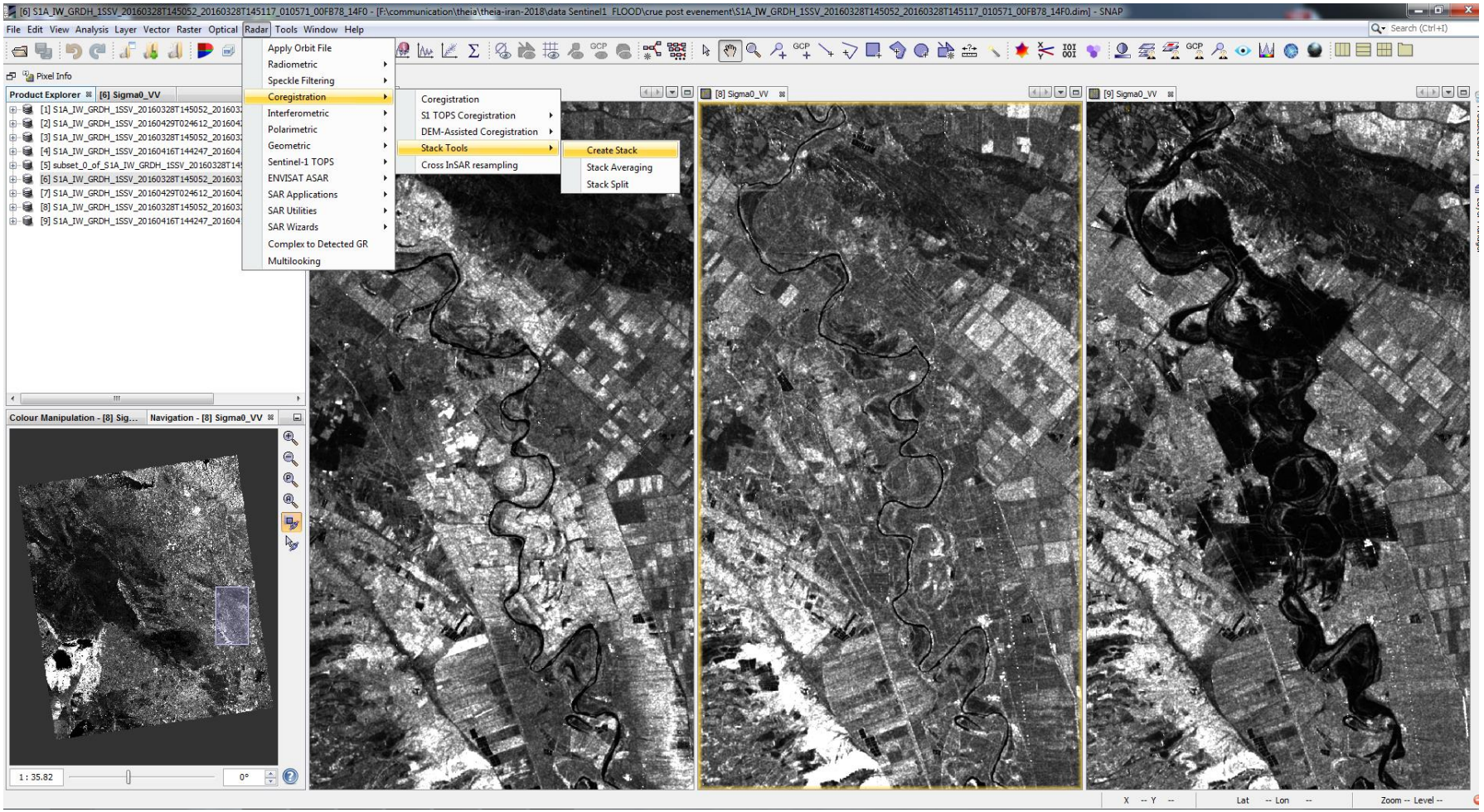
Radar => Coregistration => Stack Tools => Create Stack

-

Multitemporal approach
Preprocessing steps: Stack layers

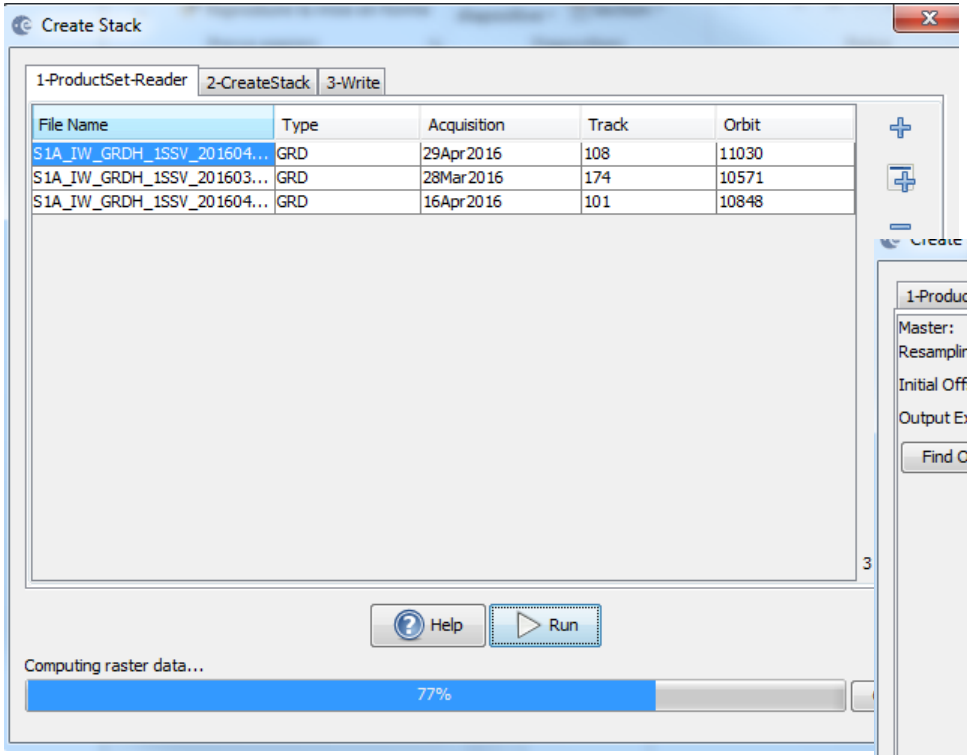


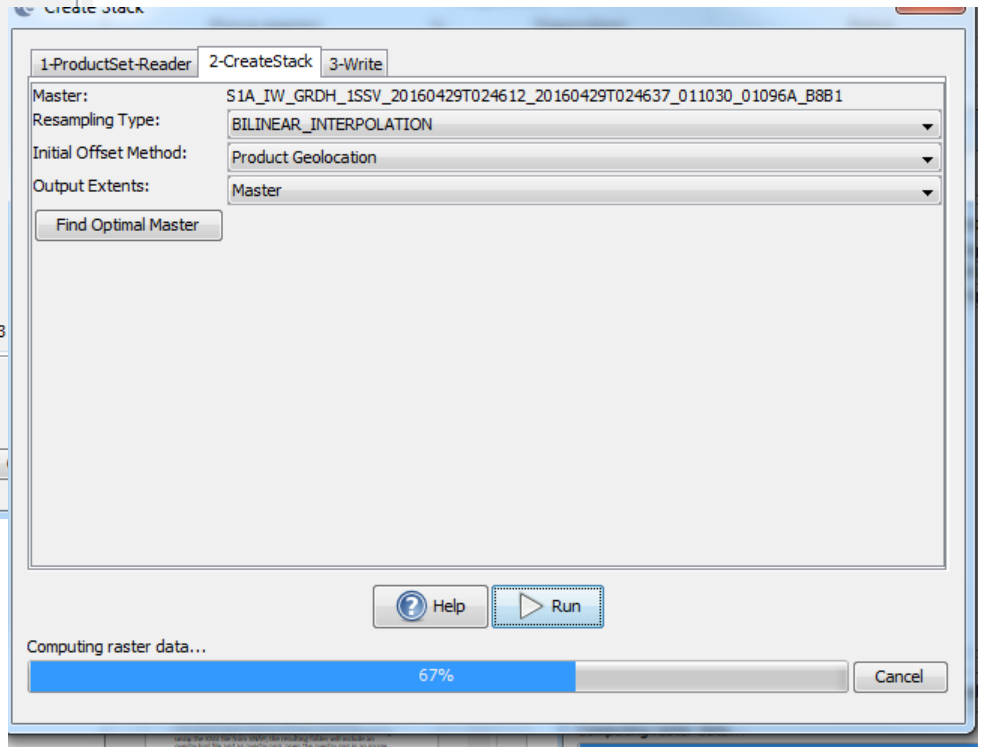
Multitemporal approach
Preprocessing steps: Stack layers



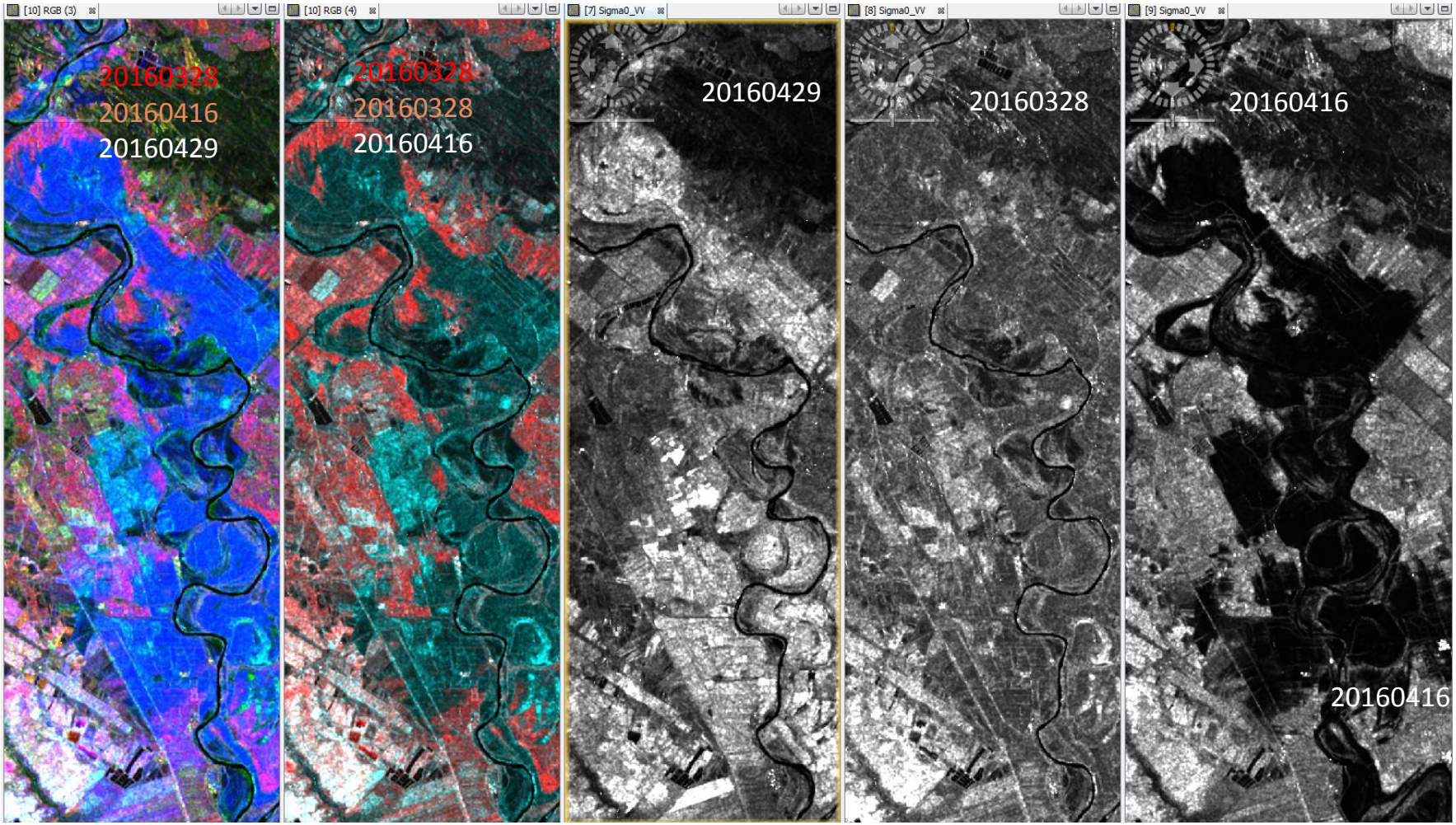
Multitemporal approach

Preprocessing steps: Stack layers



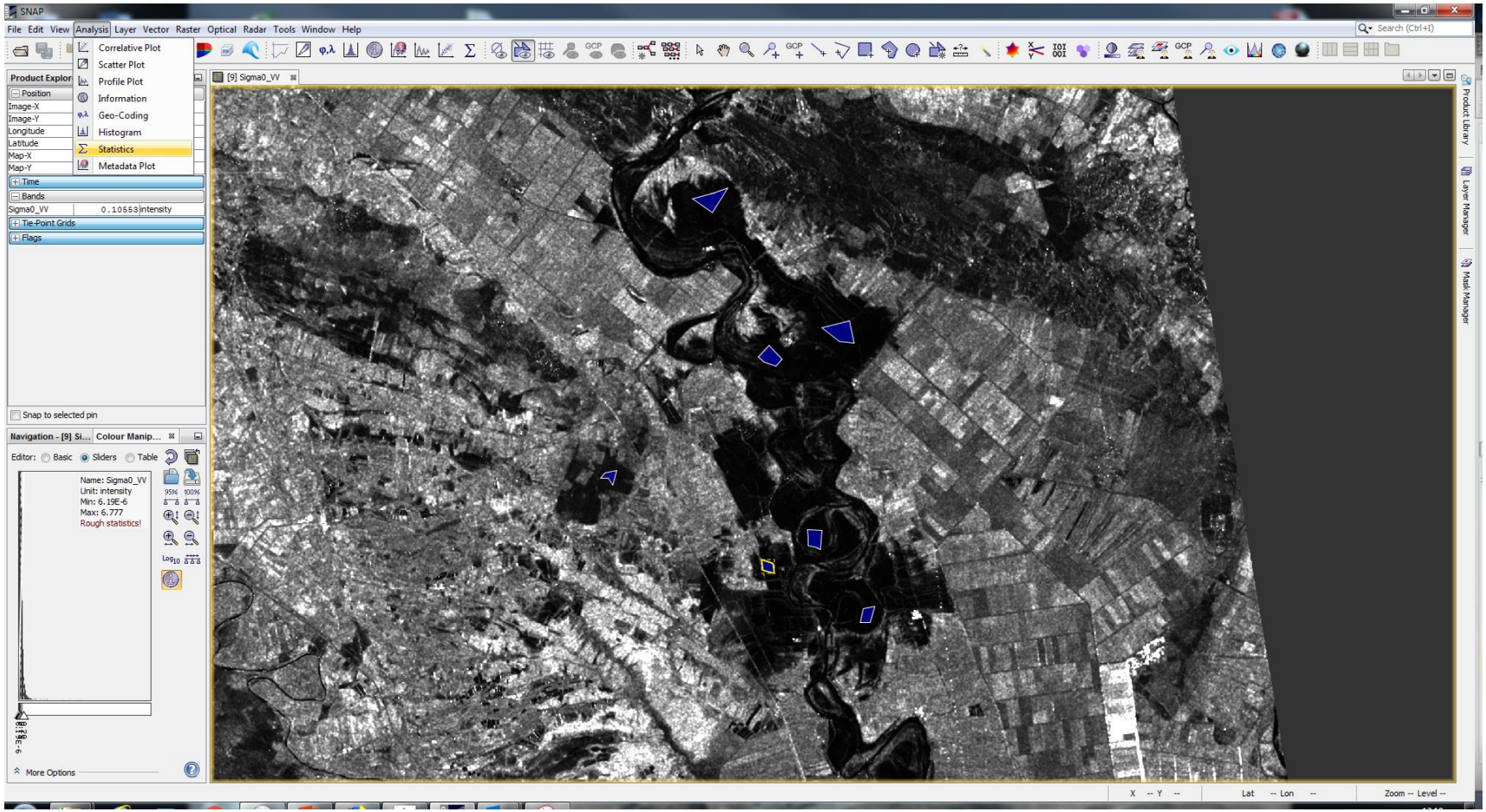


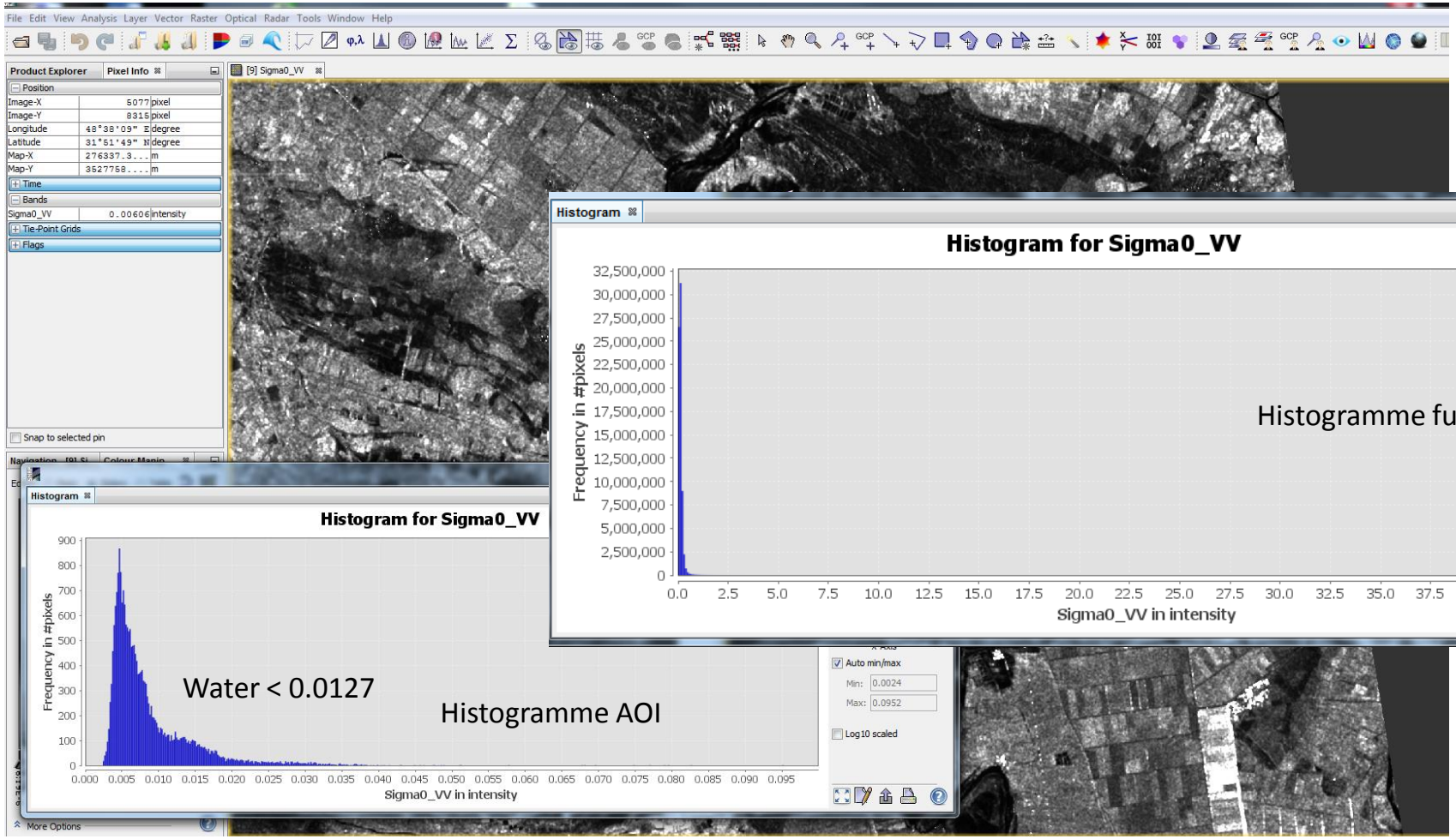
Multitemporal approach



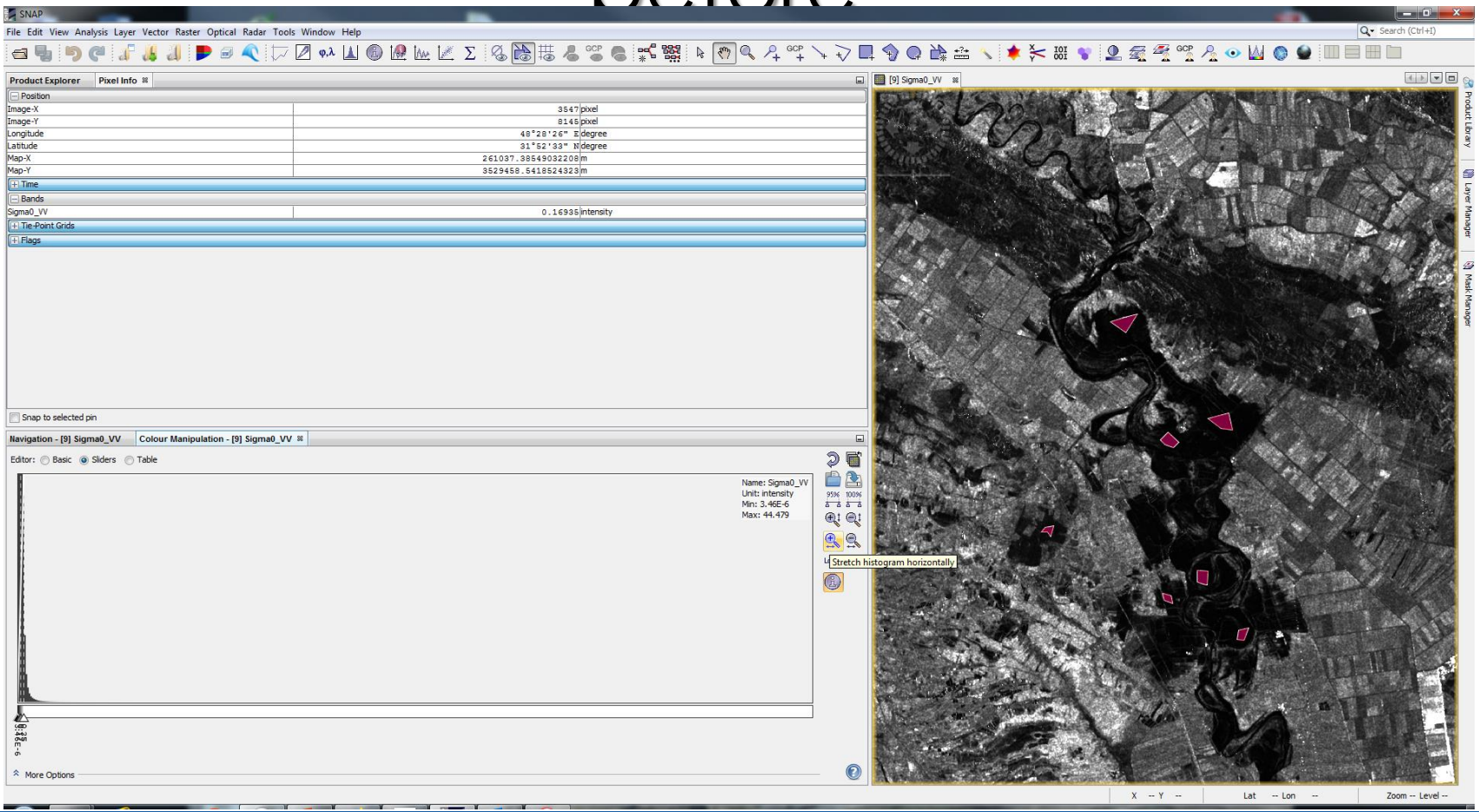
Images analysis


Product Explorer
Pixel Info
[9] Sigma0_VV
Position
Image-X 3259 pixel
Image-Y 7153 pixel
Longitude 48°26'27" E degree
Latitude 31°57'53" N degree
Map-X 258157.3... m
Map-Y 3539378.... m
Time
Bands
Sigma0_VV 0.14808 intensity
Tie-Point Grids
Flags
Snap to selected pin
Navigation - [9] Si...
Colour Manip...
Editor: Basic Sliders Table
Name: Sigma0_VV
Unit: intensity
Min: 6.19E-6
Max: 6.777
Rough statistics!
95%
100%
More Options

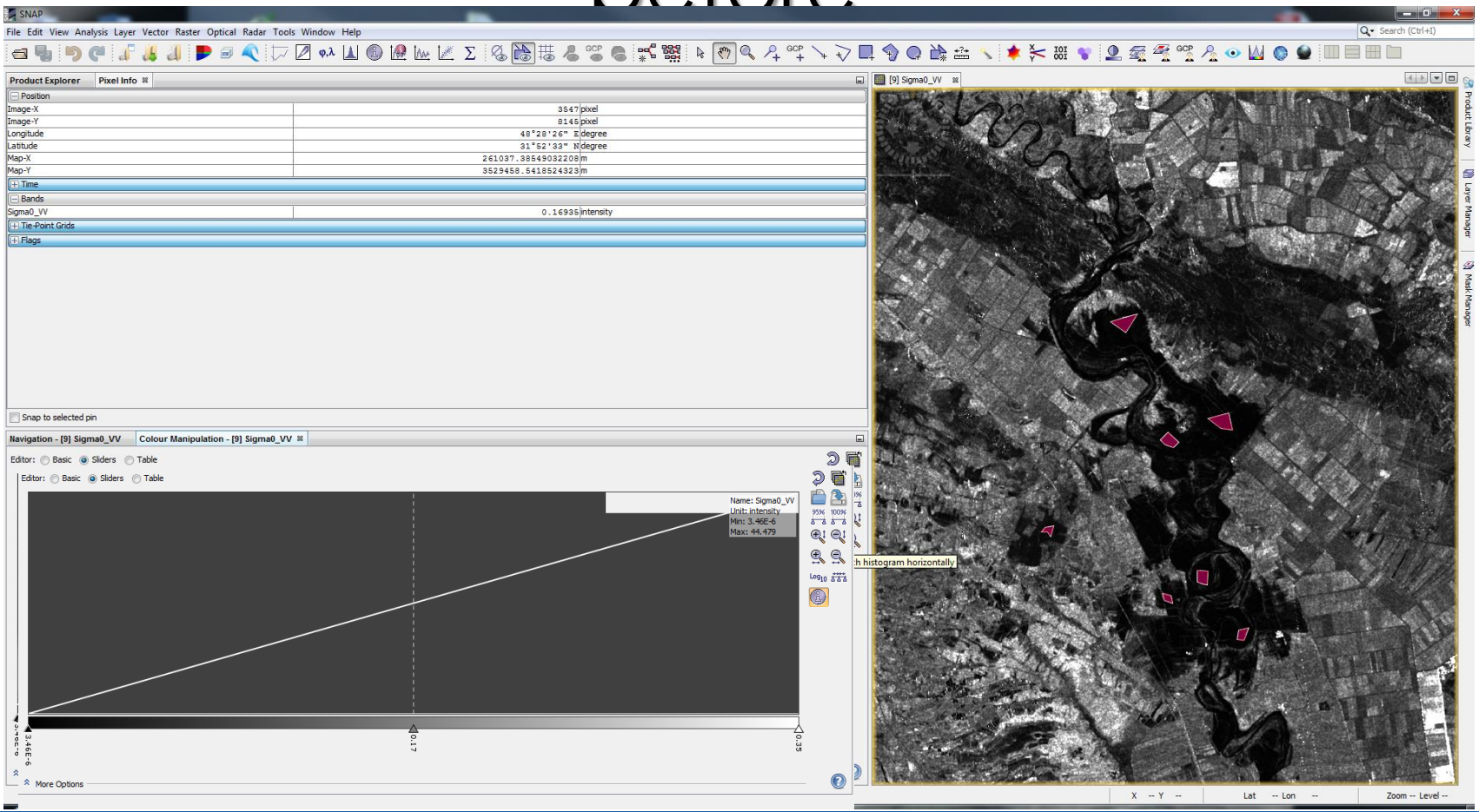

SNAP
File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Correlative Plot
Scatter Plot
Profile Plot
Information
Geo-Coding
Histogram
Statistics
Metadata Plot
Product Explor
Position
Image-X
Image-Y
Longitude
Latitude
Map-X
Map-Y
Time
Bands
Sigma0_VV
0.10553 intensity
Tie-Point Grids
Flags
Snap to selected pin
Navigation - [9] Si...
Colour Manip...
Editor: Basic Sliders Table
Name: Sigma0_VV
Unit: intensity
Min: 6.19E-6
Max: 6.777
Rough statistics!
More Options
[9] Sigma0_VV
Product Library
Layer Manager
Mask Manager
X -- Y --
Lat -- Lon --
Zoom -- Level --


Histogram for Sigma0_VV
Frequency in #pixels
Sigma0_VV in intensity
Histogramme full image
Water < 0.0127
Histogramme AOI

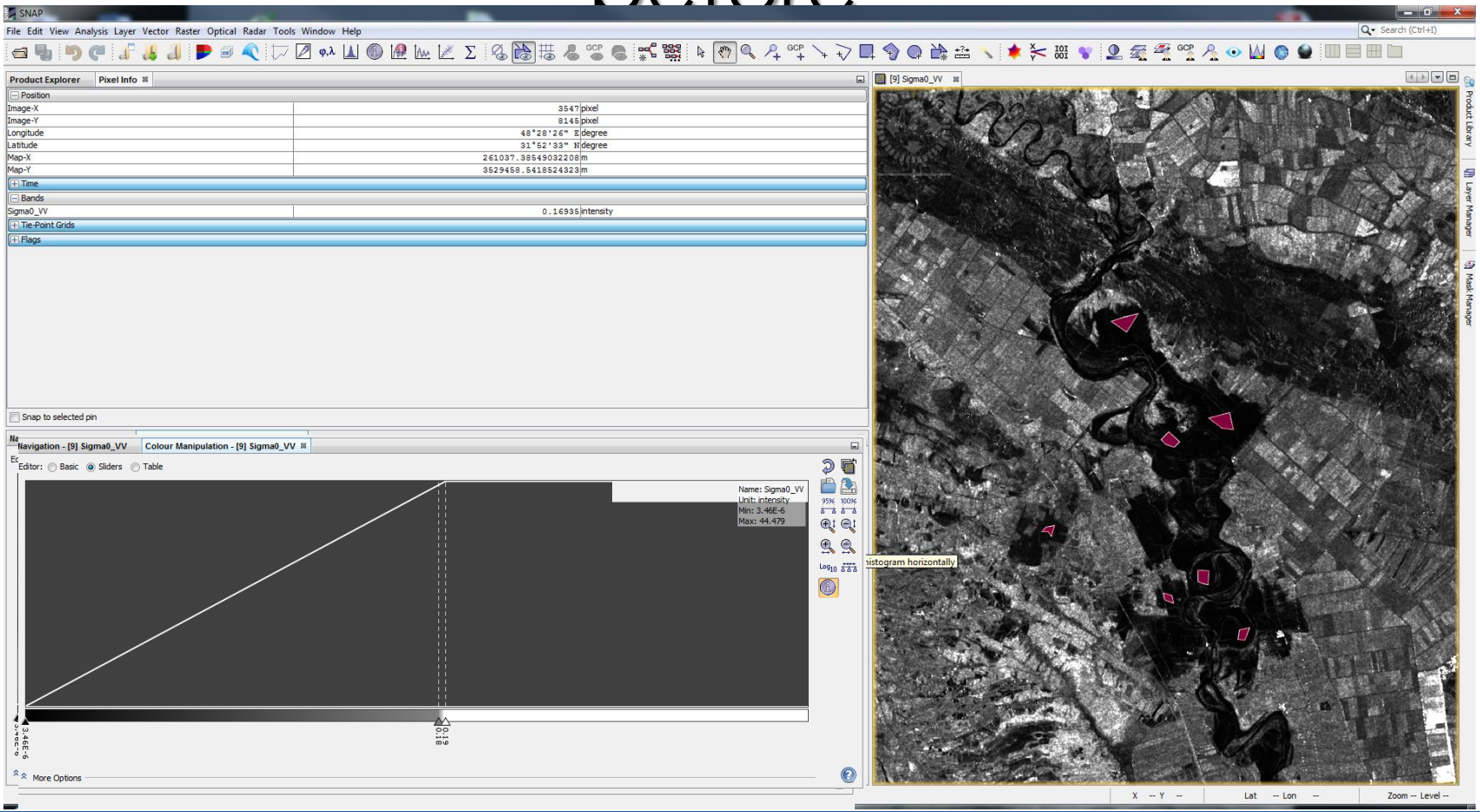
Lut manipulation: extent vertically before

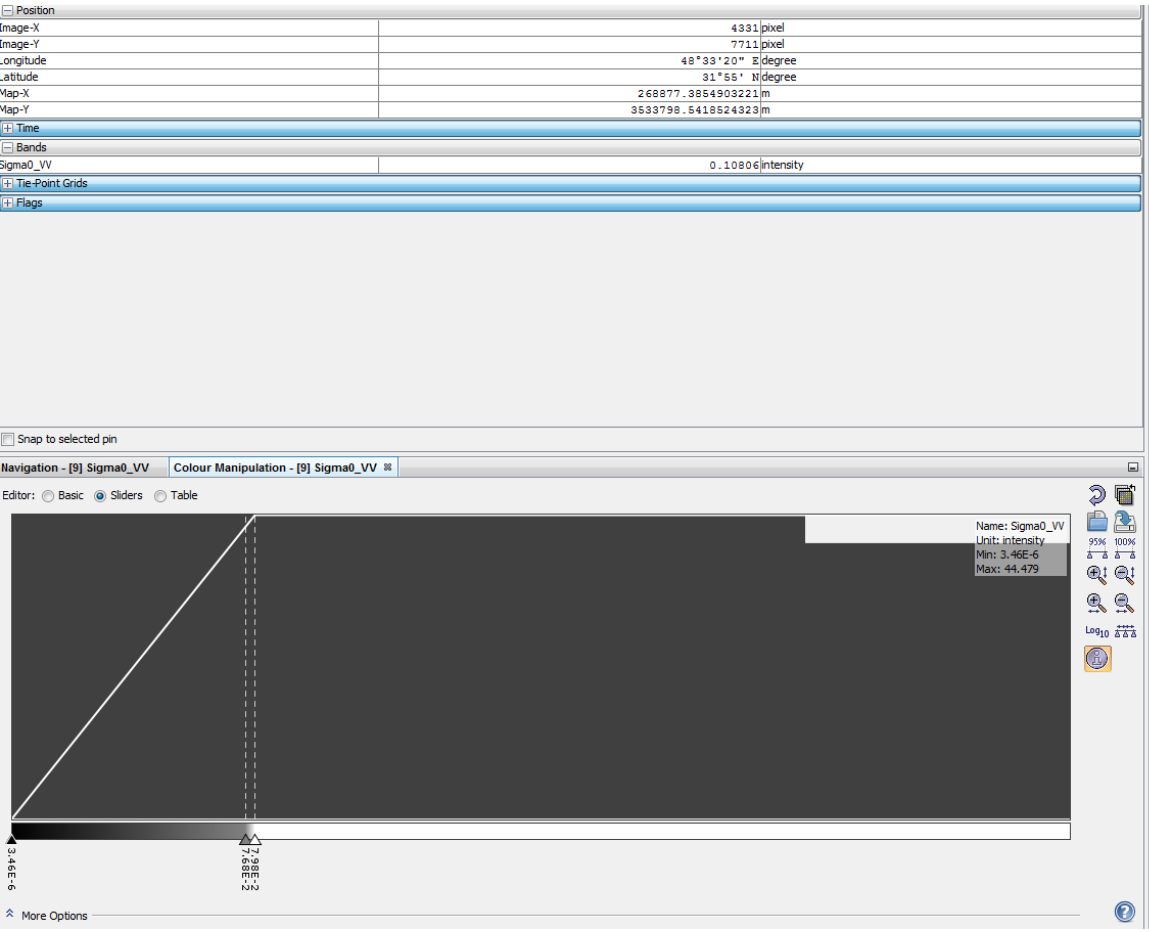


Lut manipulation: extent vertically before



Lut manipulation: extent vertically before



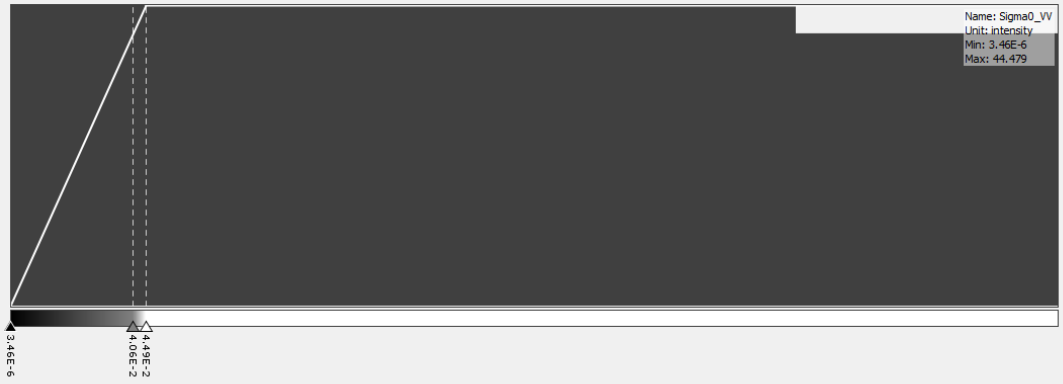

Position
Image-X 4331 pixel
Image-Y 7711 pixel
Longitude 48°33'20" E degree
Latitude 31°55' N degree
Map-X 268877.3854903221 m
Map-Y 3533798.5418524323 m
Time
Bands
Sigma0_VV 0.10806 intensity
Tie-Point Grids
Flags
Snap to selected pin
Navigation - [9] Sigma0_VV
Colour Manipulation - [9] Sigma0_VV
Editor: Basic Sliders Table
Name: Sigma0_VV
Unit: intensity
Min: 3.46E-6
Max: 44.479
95%
100%
Log10
3.46E-6
7.98E-2
7.68E-2
More Options

Position		
Image-X	3541	pixel
Image-Y	7299	pixel
Longitude	48°28'16" E	degree
Latitude	31°57'08" N	degree
Map-X	260977.38549032208	m
Map-Y	3537918.5418524323	m
Time		
Bands		
Sigma0_VV	0.06029	intensity
Tie-Point Grids		
Flags		

Snap to selected pin

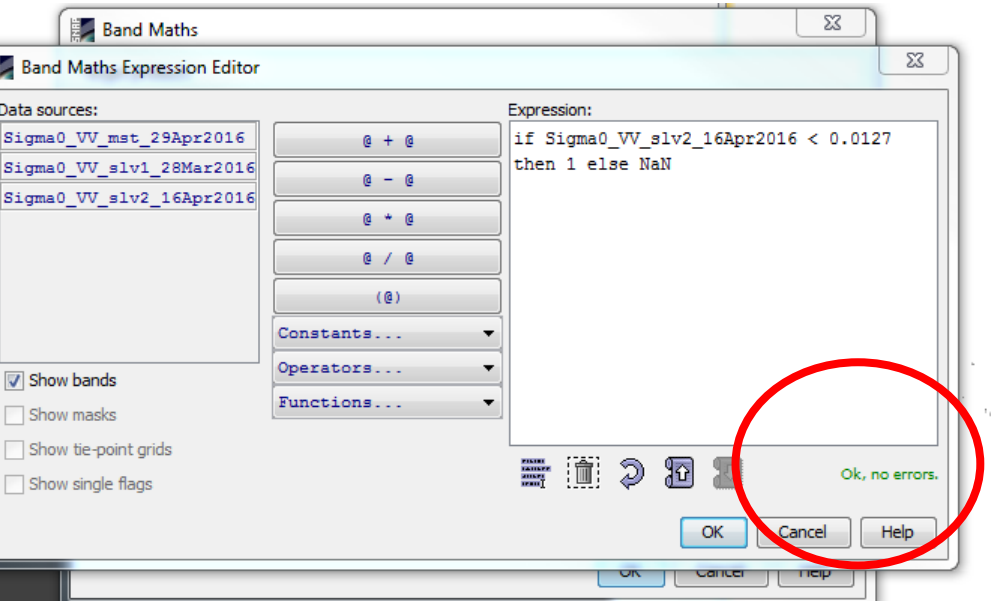
Navigation - [9] Sigma0_VV | Colour Manipulation - [9] Sigma0_VV

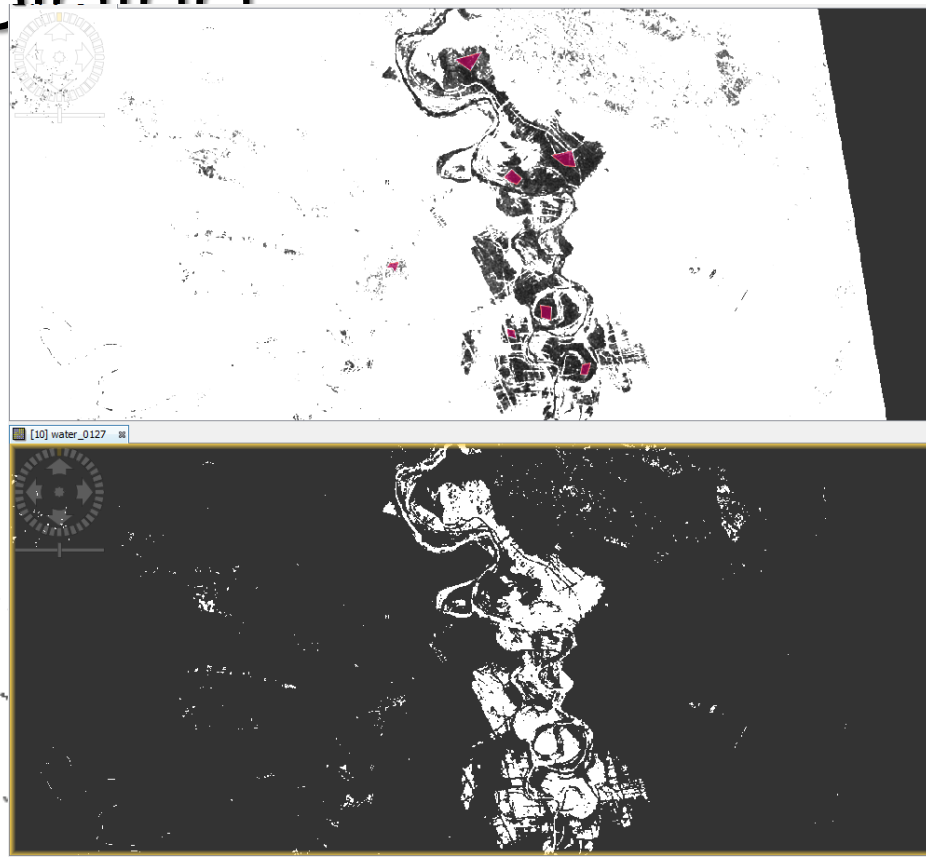
Editor: Basic Sliders Table

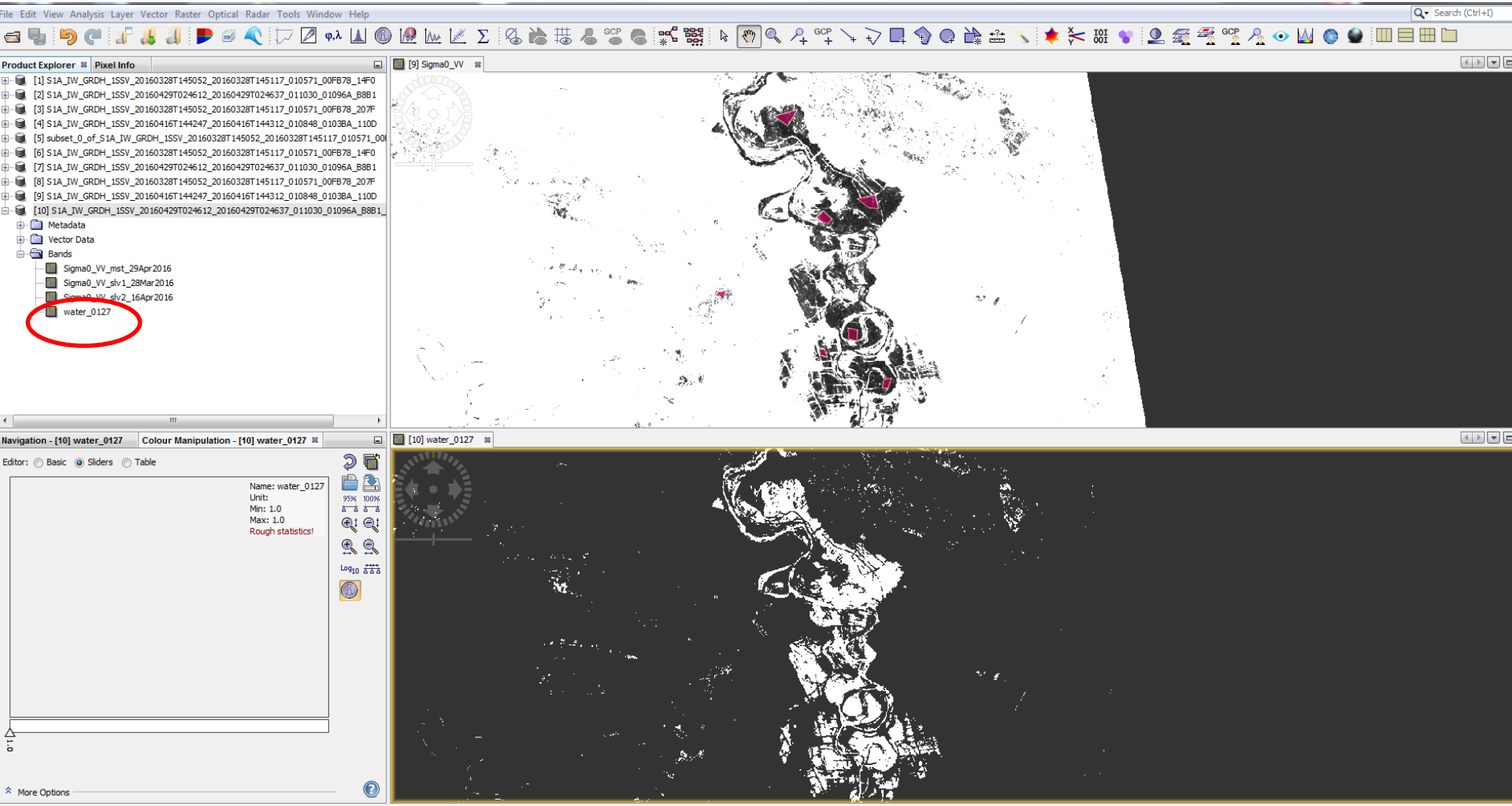


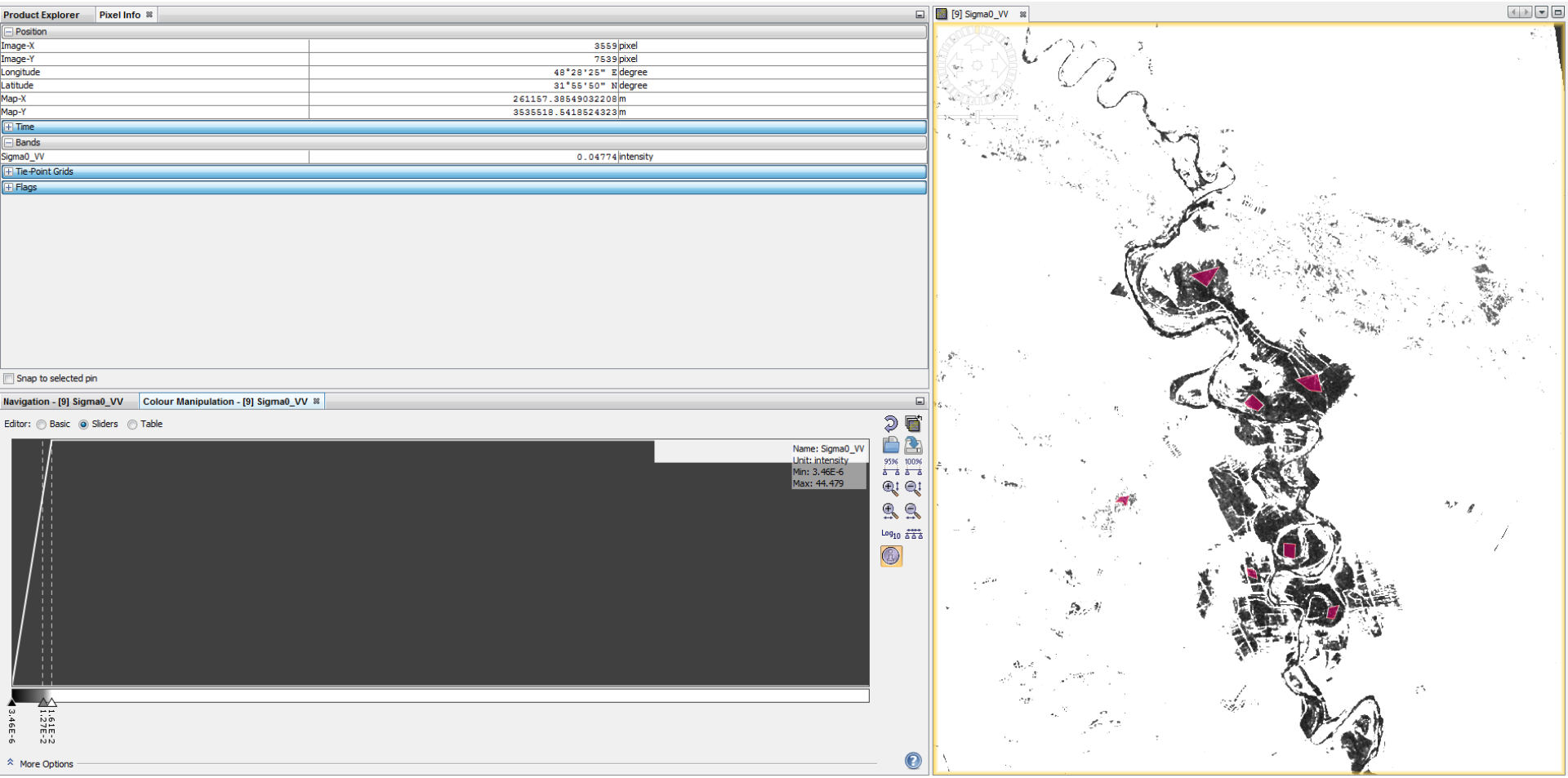
More Options

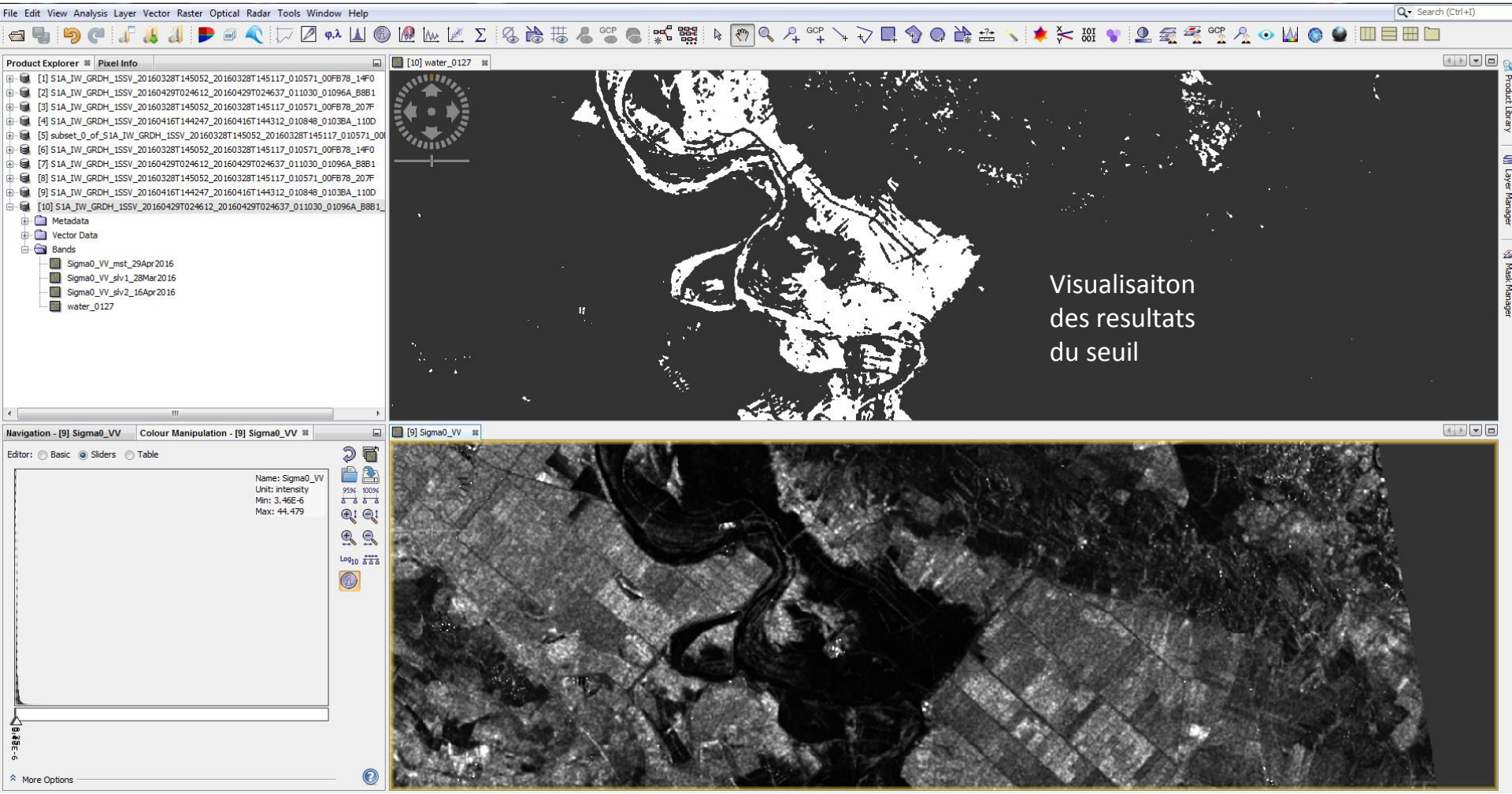
Thresholding



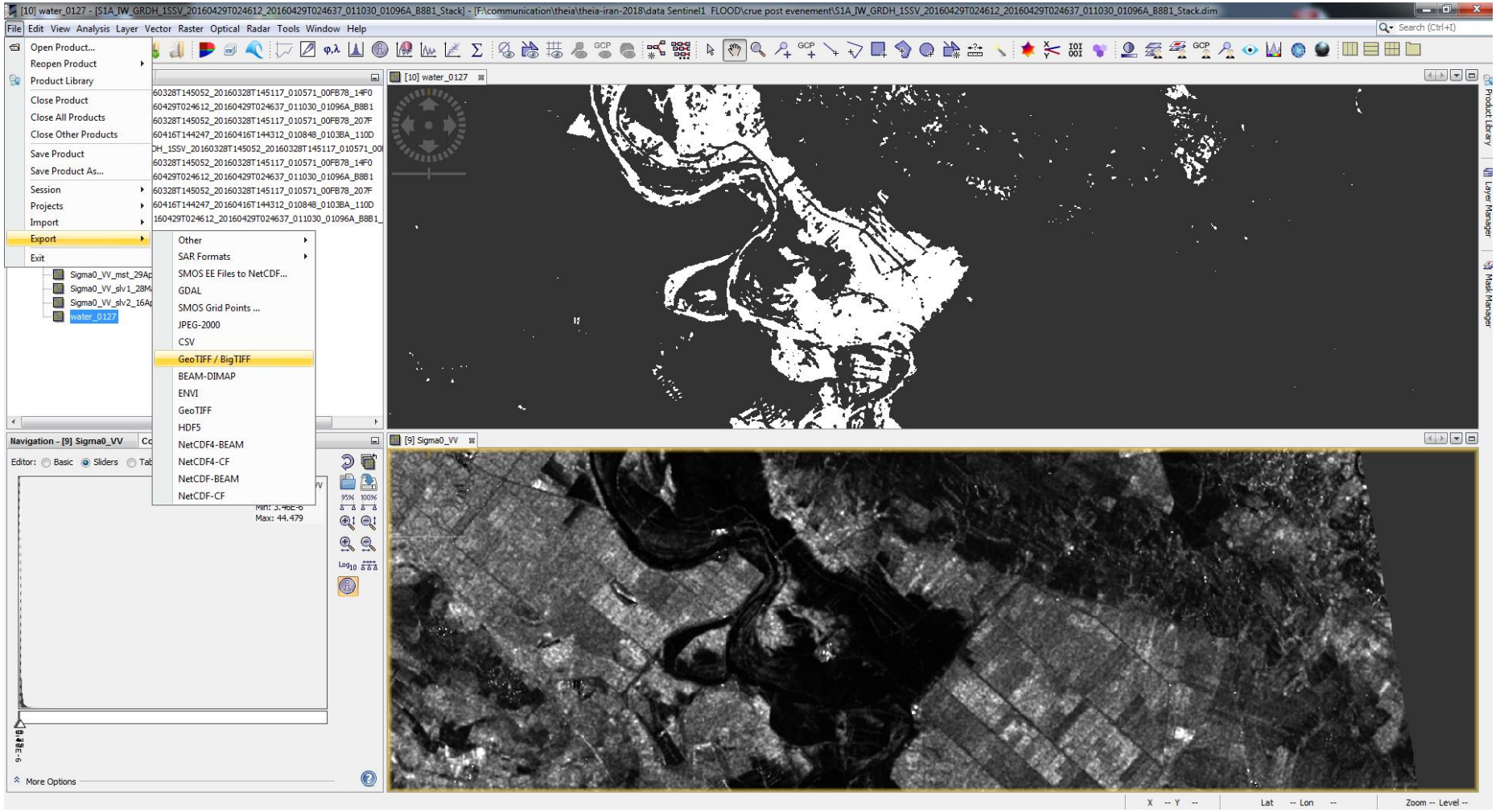



File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Product Explorer
Pixel Info
[1] S1A_IW_GRDH_1SSV_20160328T145052_20160328T145117_010571_00FB78_14F0
[2] S1A_IW_GRDH_1SSV_20160429T024612_20160429T024637_011030_01096A_B8B1
[3] S1A_IW_GRDH_1SSV_20160328T145052_20160328T145117_010571_00FB78_207F
[4] S1A_IW_GRDH_1SSV_20160416T144247_20160416T144312_010848_0103BA_110D
[5] subset_0_of_S1A_IW_GRDH_1SSV_20160328T145052_20160328T145117_010571_00
[6] S1A_IW_GRDH_1SSV_20160328T145052_20160328T145117_010571_00FB78_14F0
[7] S1A_IW_GRDH_1SSV_20160429T024612_20160429T024637_011030_01096A_B8B1
[8] S1A_IW_GRDH_1SSV_20160328T145052_20160328T145117_010571_00FB78_207F
[9] S1A_IW_GRDH_1SSV_20160416T144247_20160416T144312_010848_0103BA_110D
[10] S1A_IW_GRDH_1SSV_20160429T024612_20160429T024637_011030_01096A_B8B1_
Metadata
Vector Data
Bands
Sigma0_VV_mst_29Apr2016
Sigma0_VV_slv1_28Mar2016
Sigma0_VV_slv2_16Apr2016
water_0127
[9] Sigma0_VV
Navigation - [10] water_0127
Colour Manipulation - [10] water_0127
Editor: Basic Sliders Table
Name: water_0127
Unit:
Min: 1.0
Max: 1.0
Rough statistics!
More Options
[10] water_0127


Product Explorer
Pixel Info
Position
Image-X 3559 pixel
Image-Y 7539 pixel
Longitude 48°28'25" E degree
Latitude 31°55'50" N degree
Map-X 261157.38549032208 m
Map-Y 3535518.5418524323 m
Time
Bands
Sigma0_VV 0.04774 intensity
Tie-Point Grids
Flags
Snap to selected pin
Navigation - [9] Sigma0_VV
Colour Manipulation - [9] Sigma0_VV
Editor: Basic Sliders Table
Name: Sigma0_VV
Unit: intensity
Min: 3.46E-6
Max: 44.479
95%
100%
Log10
3.46E-6
1.27E-2
1.61E-2
More Options
[9] Sigma0_VV


File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Product Explorer
Pixel Info
[1] S1A_IW_GRDH_1SSV_20160328T145052_20160328T145117_010571_00FB78_14F0
[2] S1A_IW_GRDH_1SSV_20160429T024612_20160429T024637_011030_01096A_B8B1
[3] S1A_IW_GRDH_1SSV_20160328T145052_20160328T145117_010571_00FB78_207F
[4] S1A_IW_GRDH_1SSV_20160416T144247_20160416T144312_010848_0103BA_110D
[5] subset_0_of_S1A_IW_GRDH_1SSV_20160328T145052_20160328T145117_010571_00(
[6] S1A_IW_GRDH_1SSV_20160328T145052_20160328T145117_010571_00FB78_14F0
[7] S1A_IW_GRDH_1SSV_20160429T024612_20160429T024637_011030_01096A_B8B1
[8] S1A_IW_GRDH_1SSV_20160328T145052_20160328T145117_010571_00FB78_207F
[9] S1A_IW_GRDH_1SSV_20160416T144247_20160416T144312_010848_0103BA_110D
[10] S1A_IW_GRDH_1SSV_20160429T024612_20160429T024637_011030_01096A_B8B1
Metadata
Vector Data
Bands
Sigma0_VV_mst_29Apr2016
Sigma0_VV_slv1_28Mar2016
Sigma0_VV_slv2_16Apr2016
water_0127
[10] water_0127
Visualisaiton
des resultats
du seuil
Navigation - [9] Sigma0_VV
Colour Manipulation - [9] Sigma0_VV
Editor: Basic Sliders Table
Name: Sigma0_VV
Unit: intensity
Min: 3.46E-6
Max: 44.479
More Options
[9] Sigma0_VV
Product Library
Layer Manager
Mask Manager

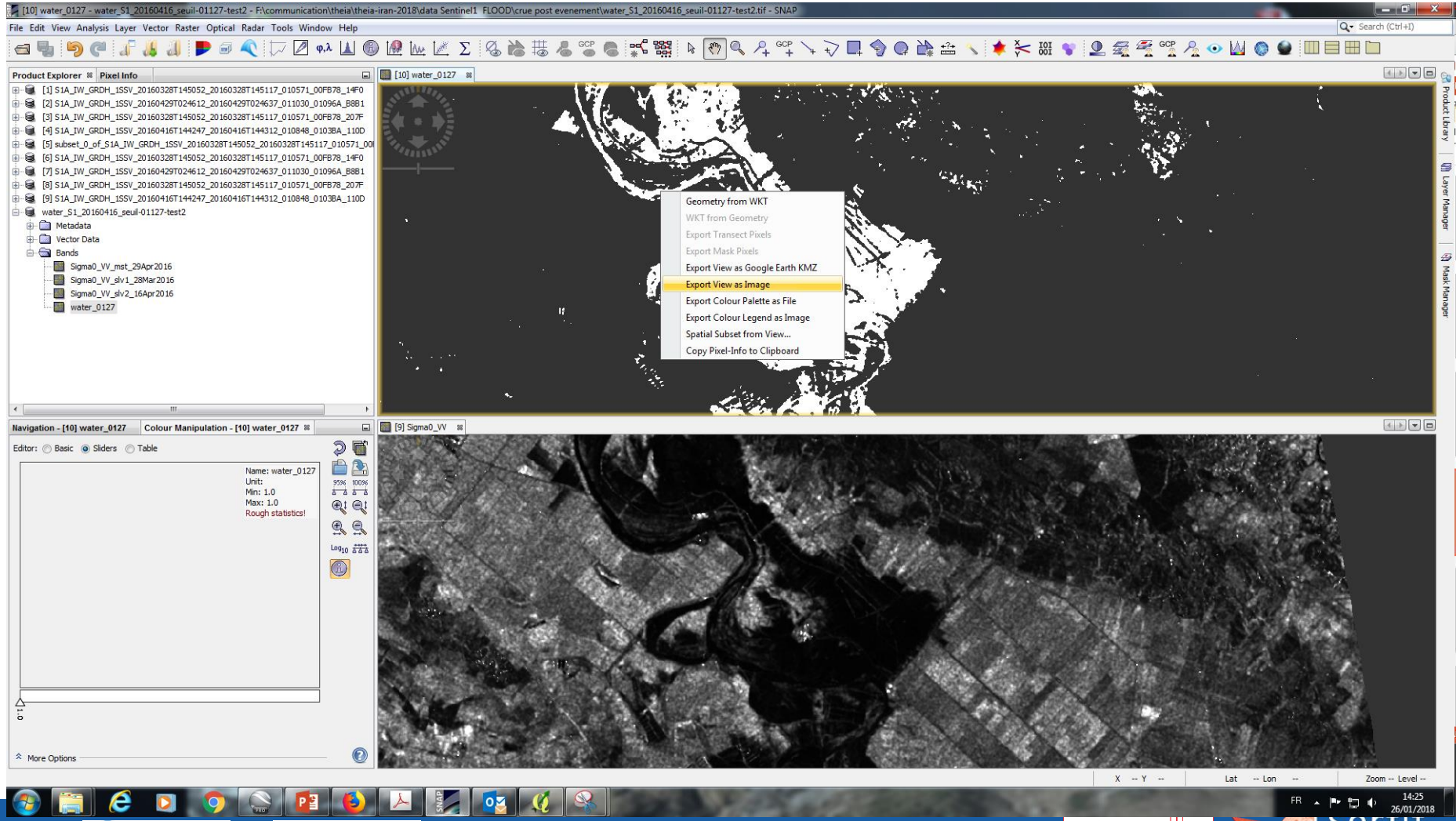
Export the mask to GIS..

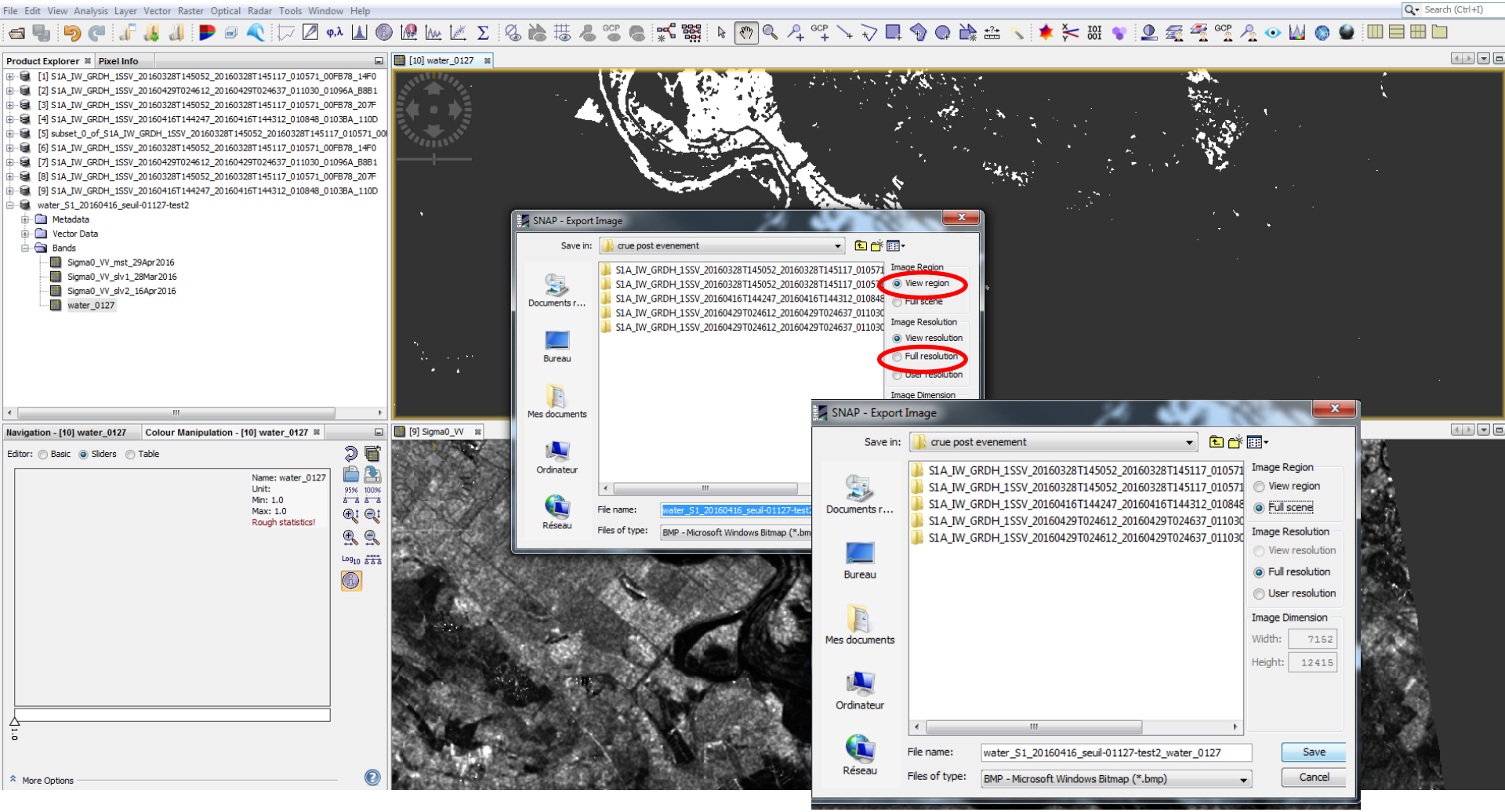


Direct export

Export the mask to GIS..

Export by view




File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Product Explorer
Pixel Info
[10] water_0127
water_S1_20160416_seuil-01127-test2
Metadata
Vector Data
Bands
Sigma0_VV_mst_29Apr2016
Sigma0_VV_slv1_28Mar2016
Sigma0_VV_slv2_16Apr2016
water_0127
SNAP - Export Image
Save in:
crue post evenement
Image Region
View region
Full scene
Image Resolution
View resolution
Full resolution
User resolution
Image Dimension
Width: 7152
Height: 12415
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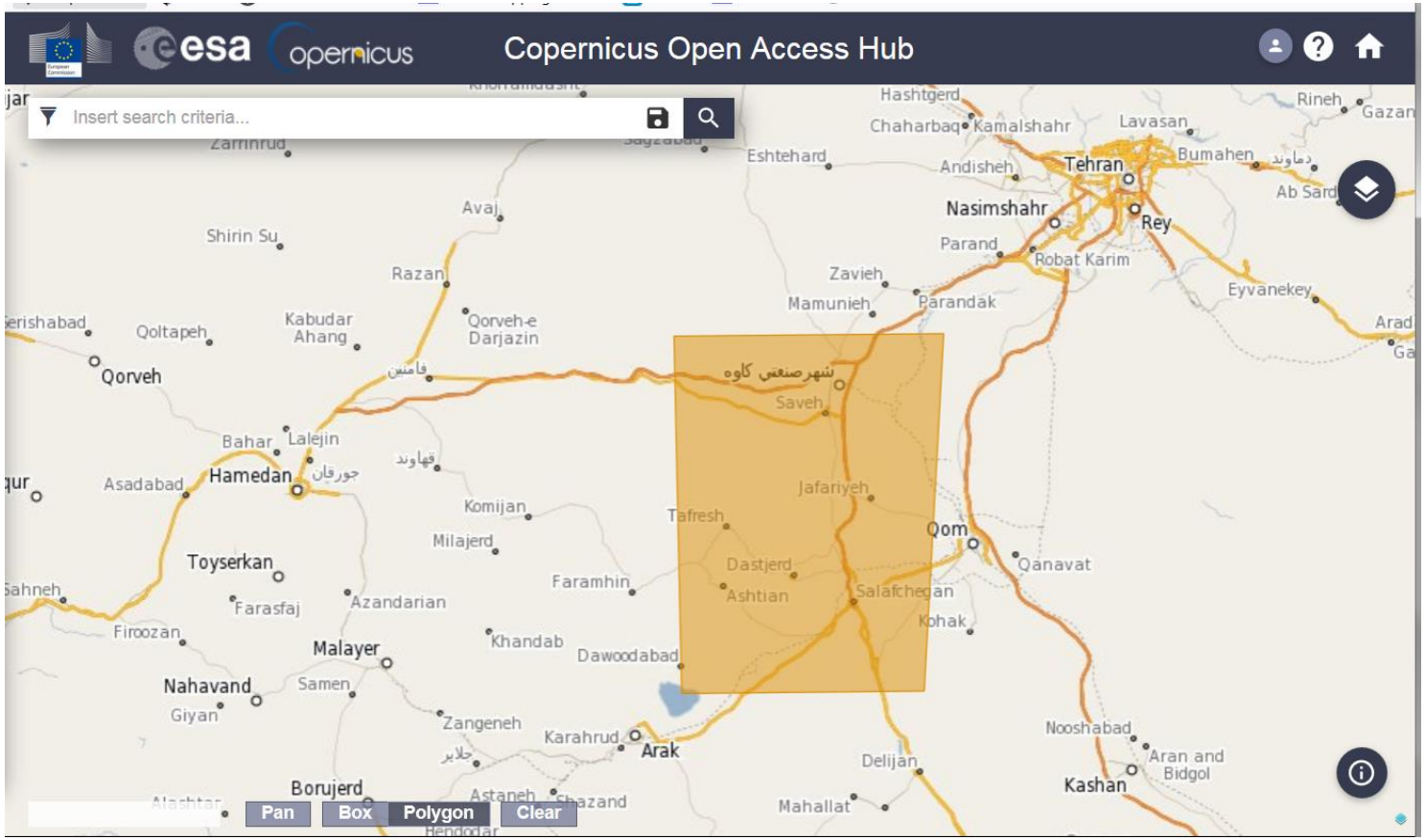
Copernicus Open Access Hub
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Ab Sard
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Razan
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Kabudar Ahang
Qoltapeh
Qorveh
Bahar
Lalejin
Hamedan
Asadabad
Komijan
Milajerd
Toyserkan
Farasfaj
Azandarian
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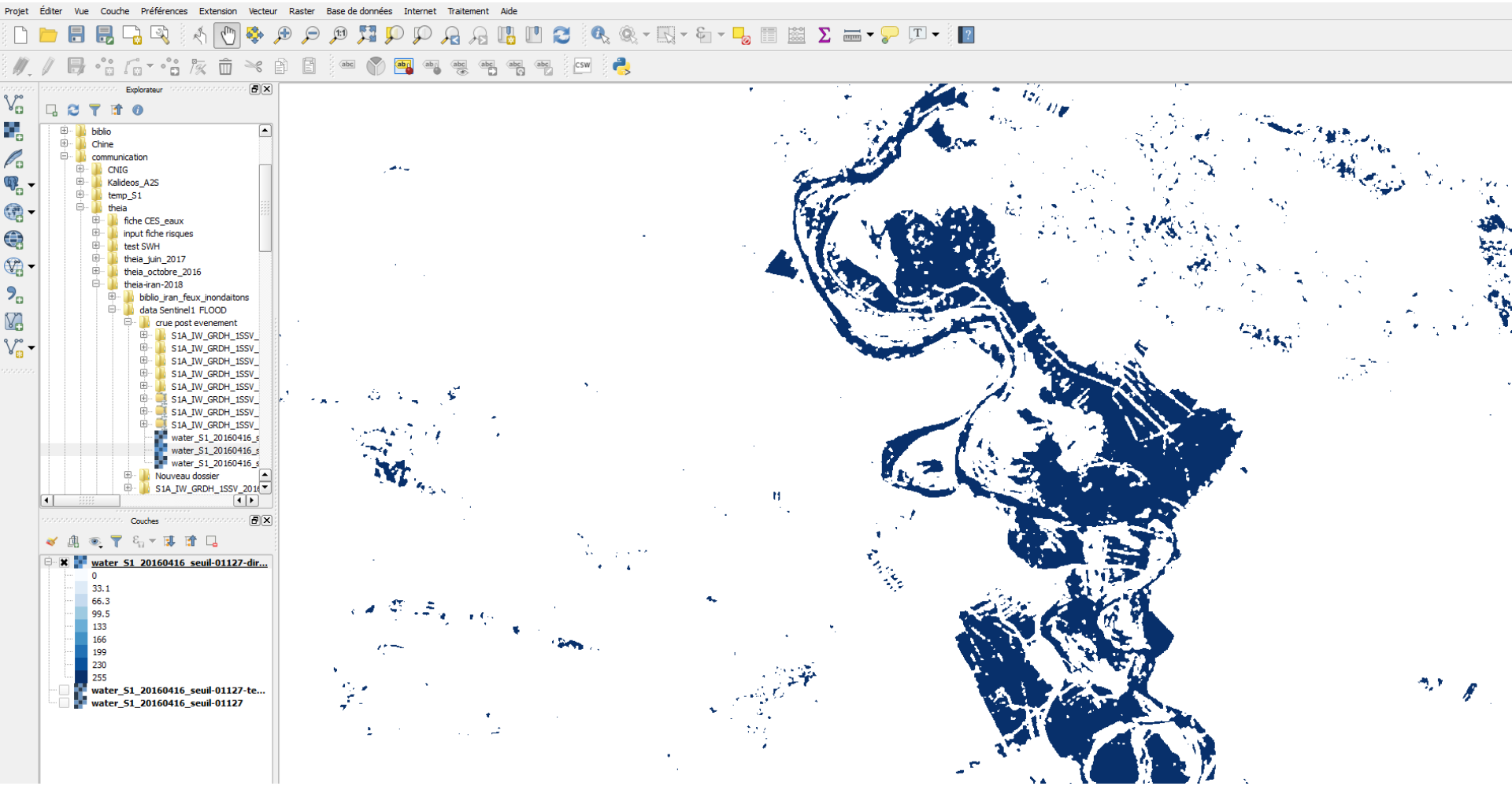
Projet Éditer Vue Couche Préférences Extension Vecteur Raster Base de données Internet Traitement Aide
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Couches
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33.1
66.3
99.5
133
166
199
230
255
water_S1_20160416_seuil-01127-te...
water_S1_20160416_seuil-01127

Visualization in Google Earth

- To visualize the water band in Google Earth, export it as a KMZ file; select on the Menu panel File --> Export --> Other --> View as Google Earth KMZ. The KMZ file can directly be imported to Google Earth.

- In order to display solely the water pixels, you can do the following: unzip the KMZ file from SNAP; the resulting folder will include an overlay.kml file and an overlay.png; open the overlay.png in an image editor (e.g., IrfanView) and set the background color to transparent;

- optionally, you can change the white color to another color; override the overlay.png and import the overlay.kml to Google Earth.

- (Note: When using IrfanView, change the mask color via the Menu panel Image --> Replace Color. When saving the image as overlay.png, check Save Transparent Color, Save Transparency as Alpha channel, and Use main window color for transparency.)

Flood event mapping exploiting

SENTINEL 1 SAR data

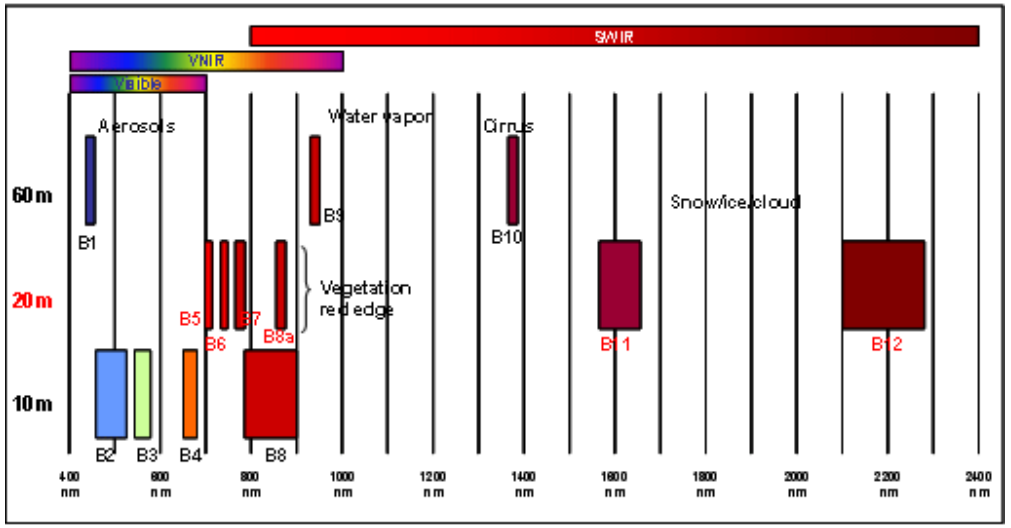
&

SENTINEL 2 optical image

Case of the April 2016 flood in Western, Iran

Dr Herve YESOU ICube – SERTIT

Sentinel 2



Sentinel 2

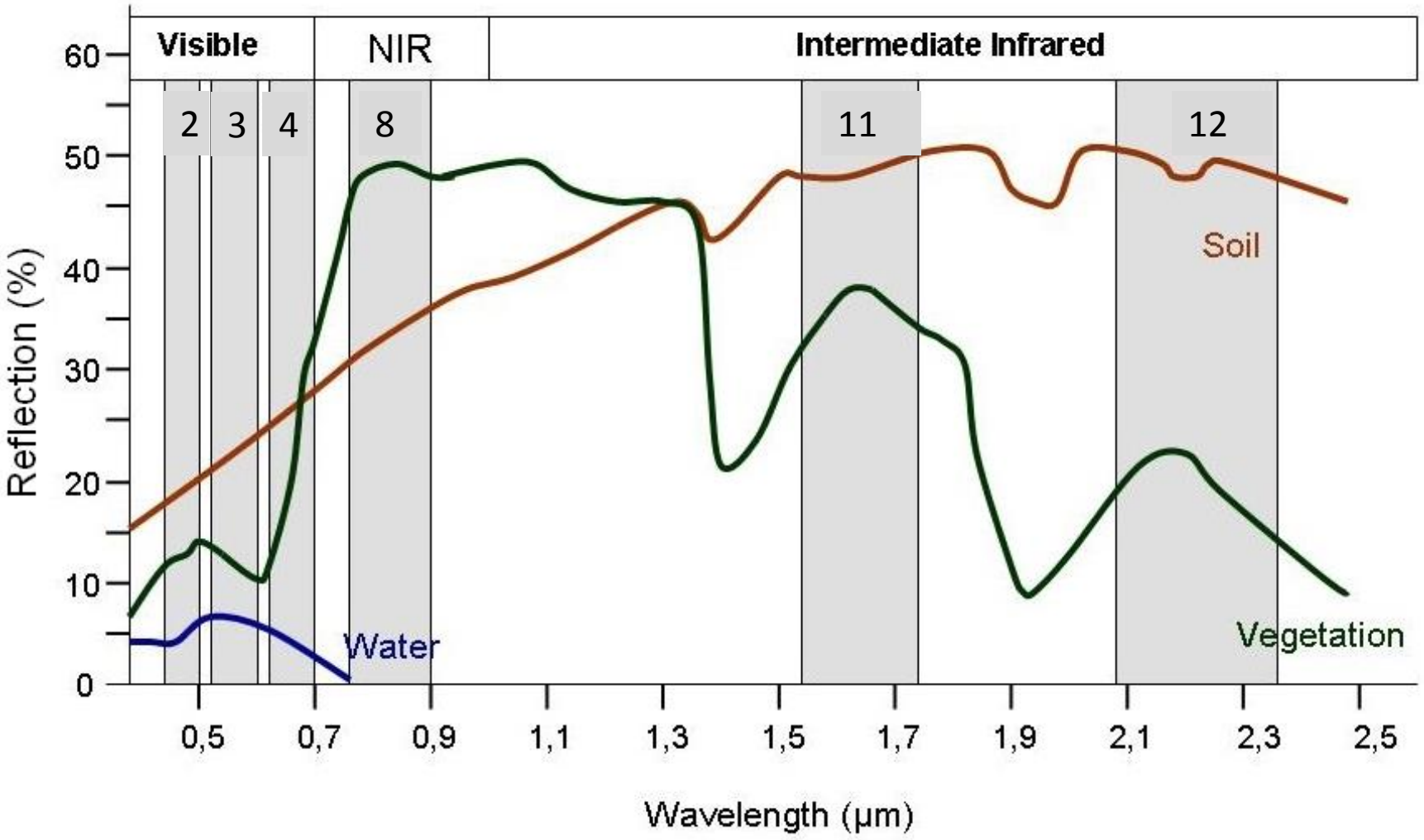
- **Highest Resolution same as SPOT5 (10m)**
- **Presence of two SWIR bands (heritage of landsat)**
- **Large swath (MERIS heritage)**
- **Revisiting time 10 – 5 days**

- **Free access**

***Sentinel*-2A : on 23 June 2015**
***Sentinel*-2B : on 7 march 2017**

opernicus
Europe's eyes on Earth

Sentinel 2


Visible
NIR
Intermediate Infrared
2
3
4
8
11
12
Soil
Water
Vegetation
Reflection (%)
0
10
20
30
40
50
60
0,5
0,7
0,9
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1,3
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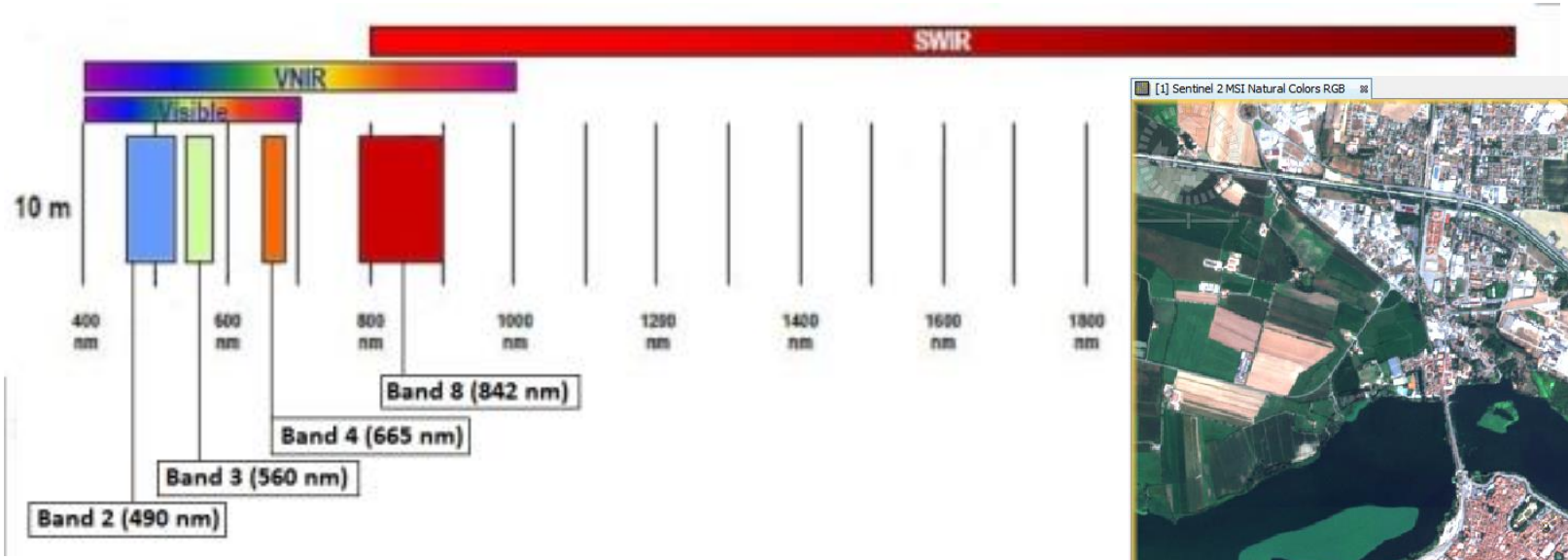
1,7
1,9
2,1
2,3
2,5
Wavelength (µm)

Sentinel 2 A/B:

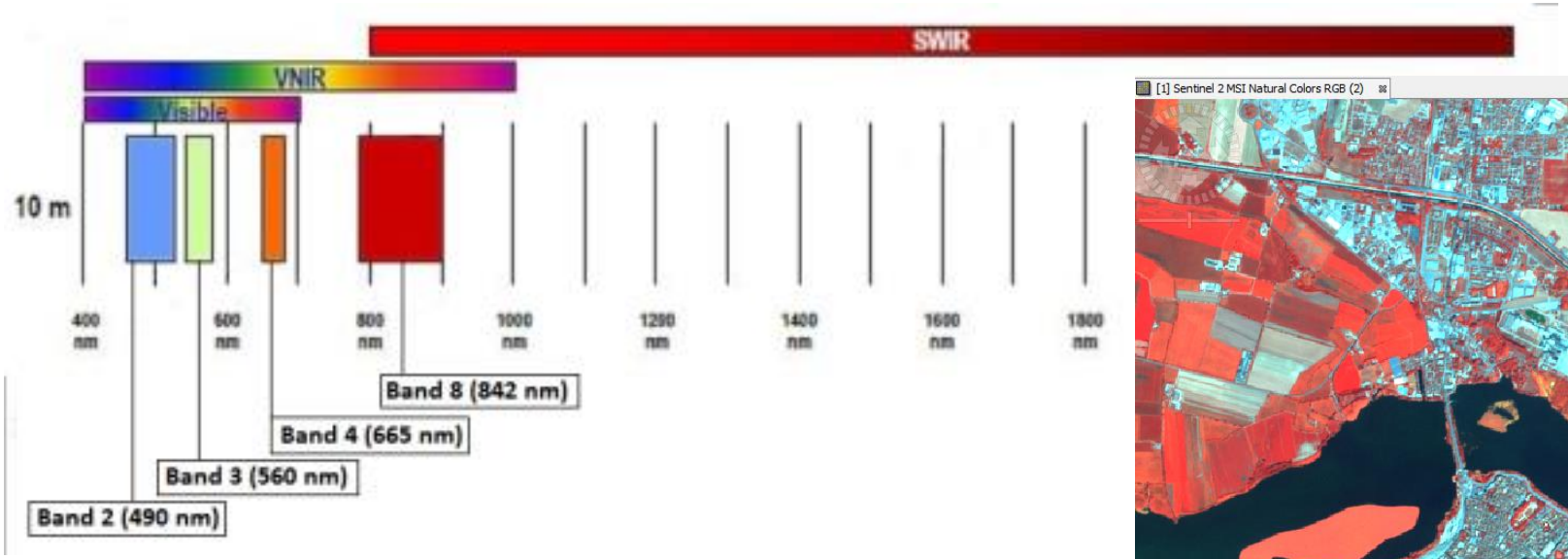


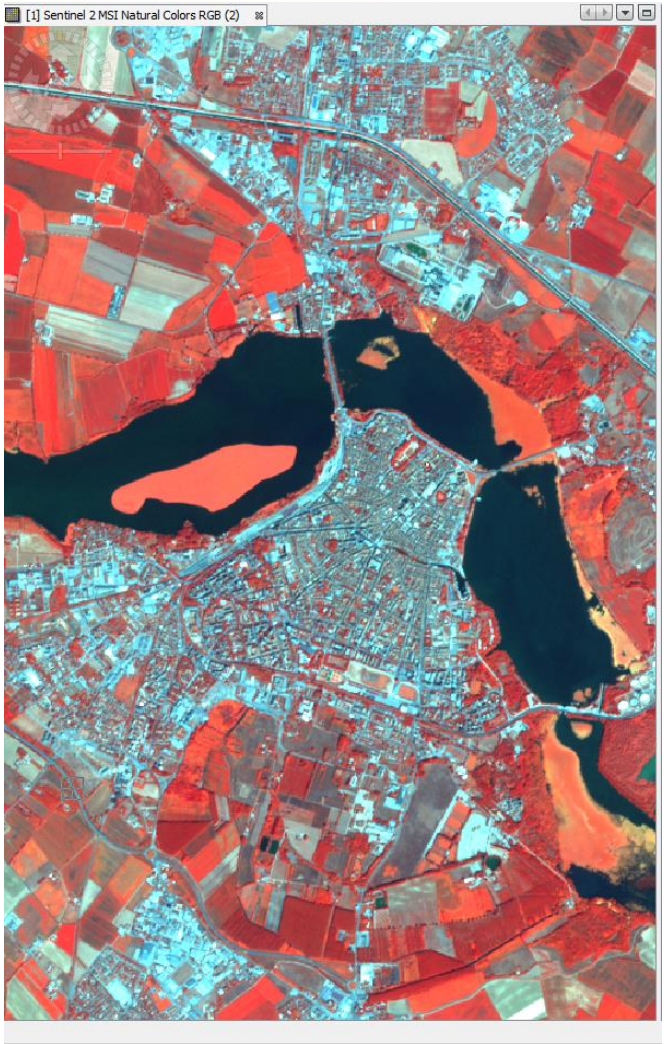
Natural color composite 10m

B4, B3, B2 in RGB

opernicus
The European Earth Observation Programme

Sentinel 2 A/B:



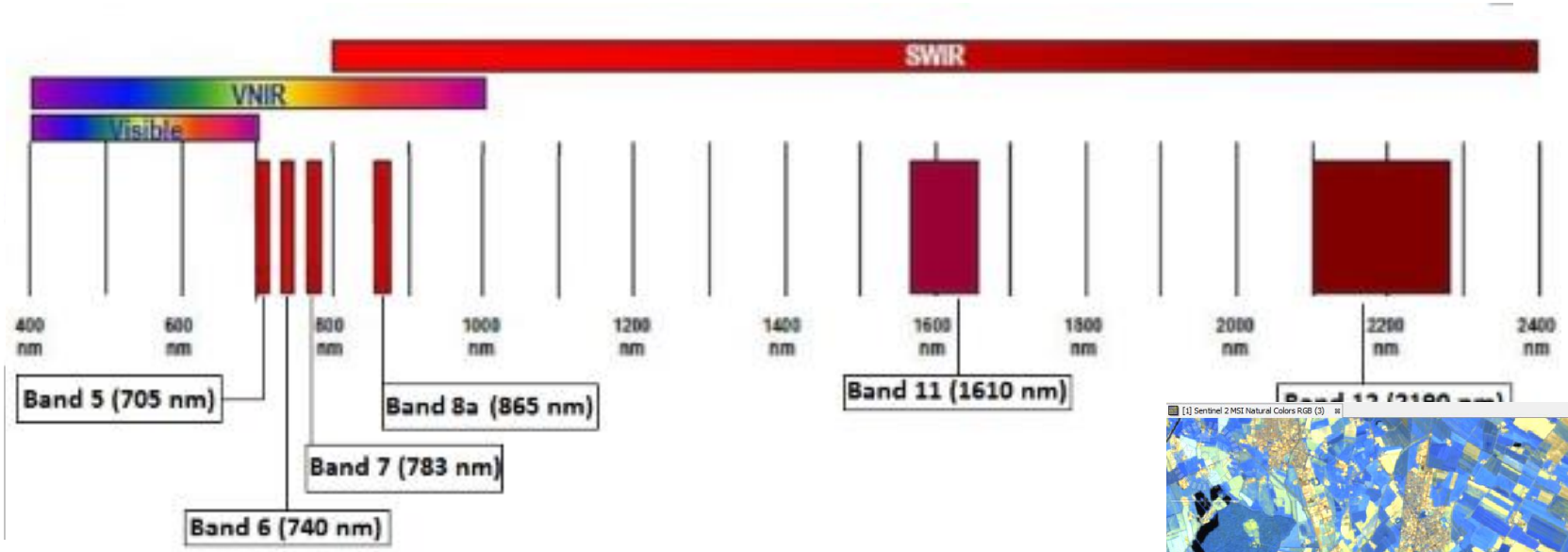


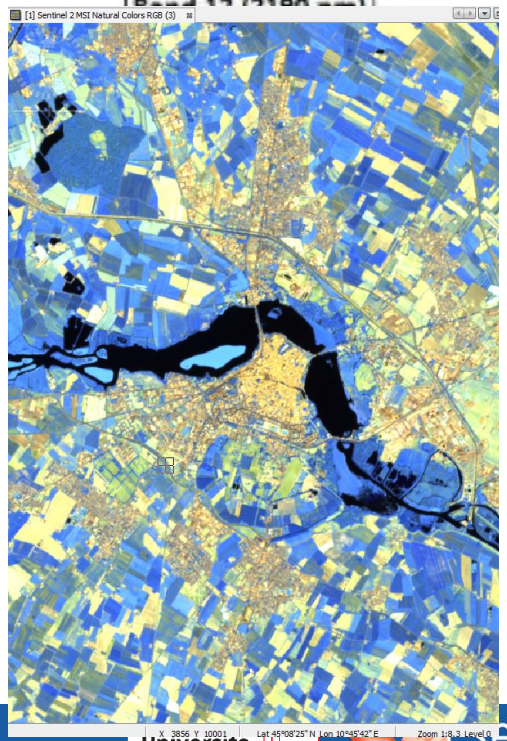
False color composite 10m

B8, B4, B3 in RGB

opernicus
The European Earth Observation Programme

Sentinel 2 A/B:

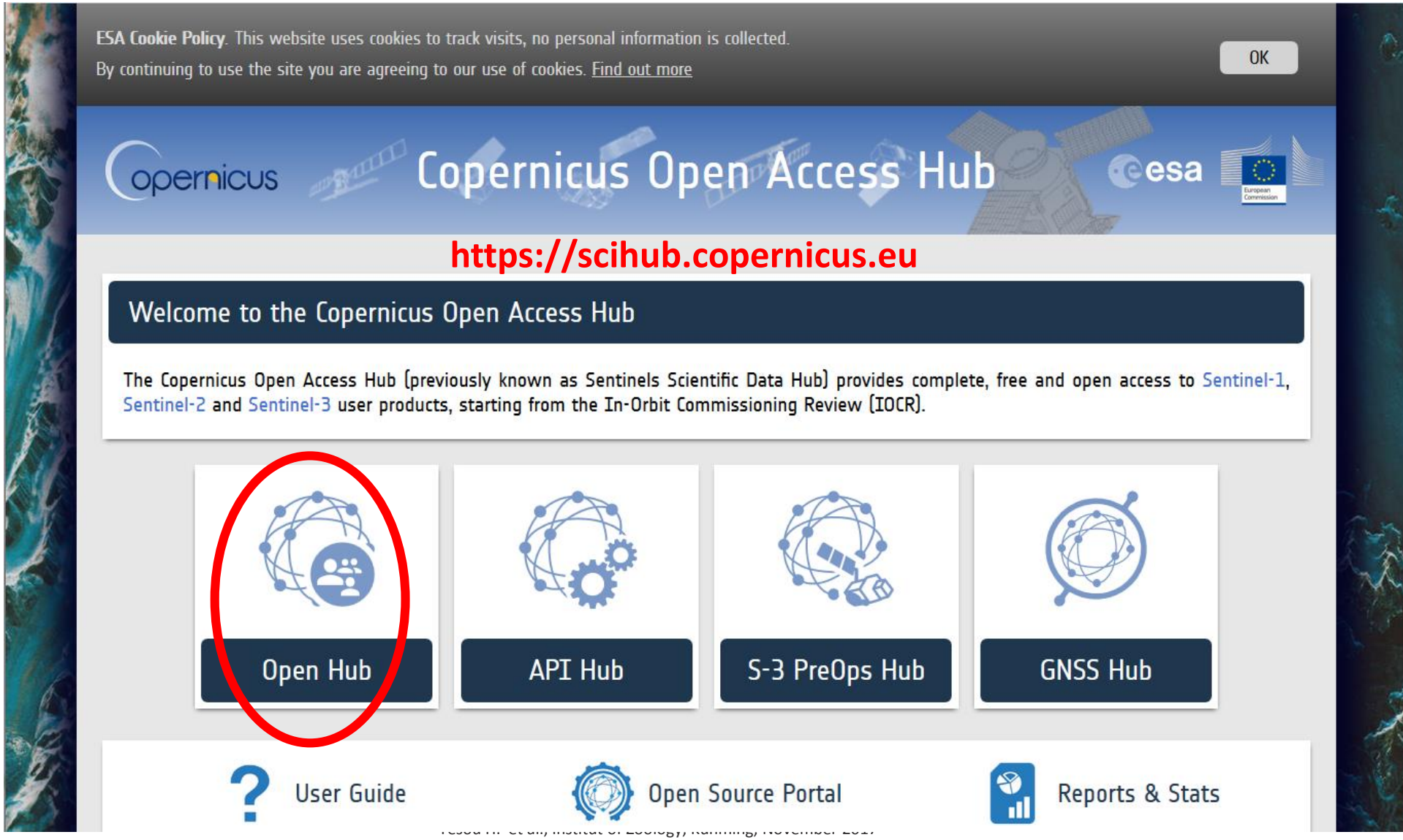




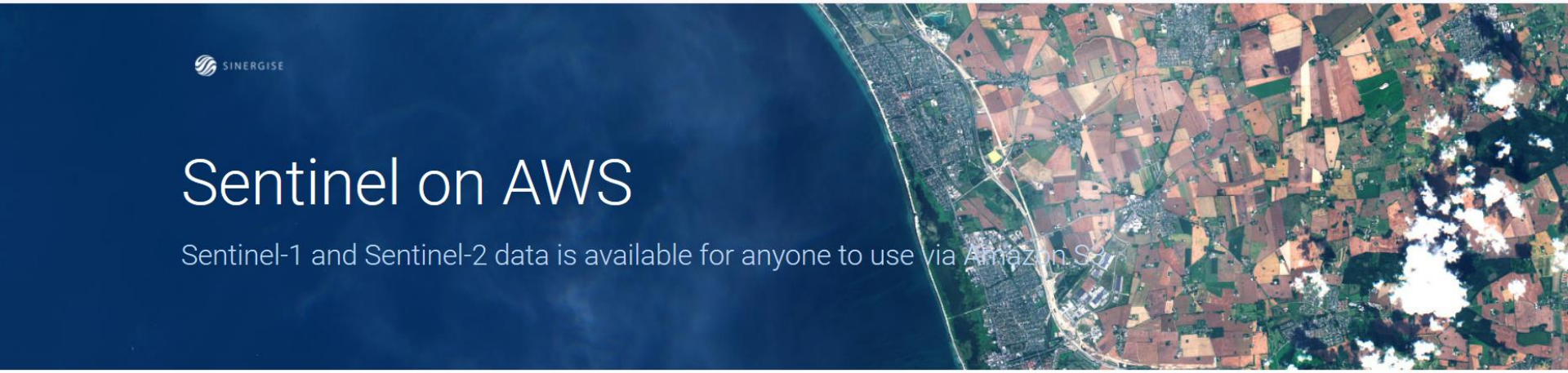
False color compsoite SWIR-NIR 20m

B12, B11, B8a in RGB

Data access: Sentinel 2



Others access: Sentinel2



Find general info about the dataset on Register of Open Data on AWS - Sentinel-1 and Sentinel-2

Sentinel-2 L1C dataset will be set to "Requester pays" by end of June 2018 in a manner similar to Sentinel-2 L2A and Sentinel-1 GRD were from the beginning. This may affect your workflow. Visit this page to find out details and how to embrace the changes.

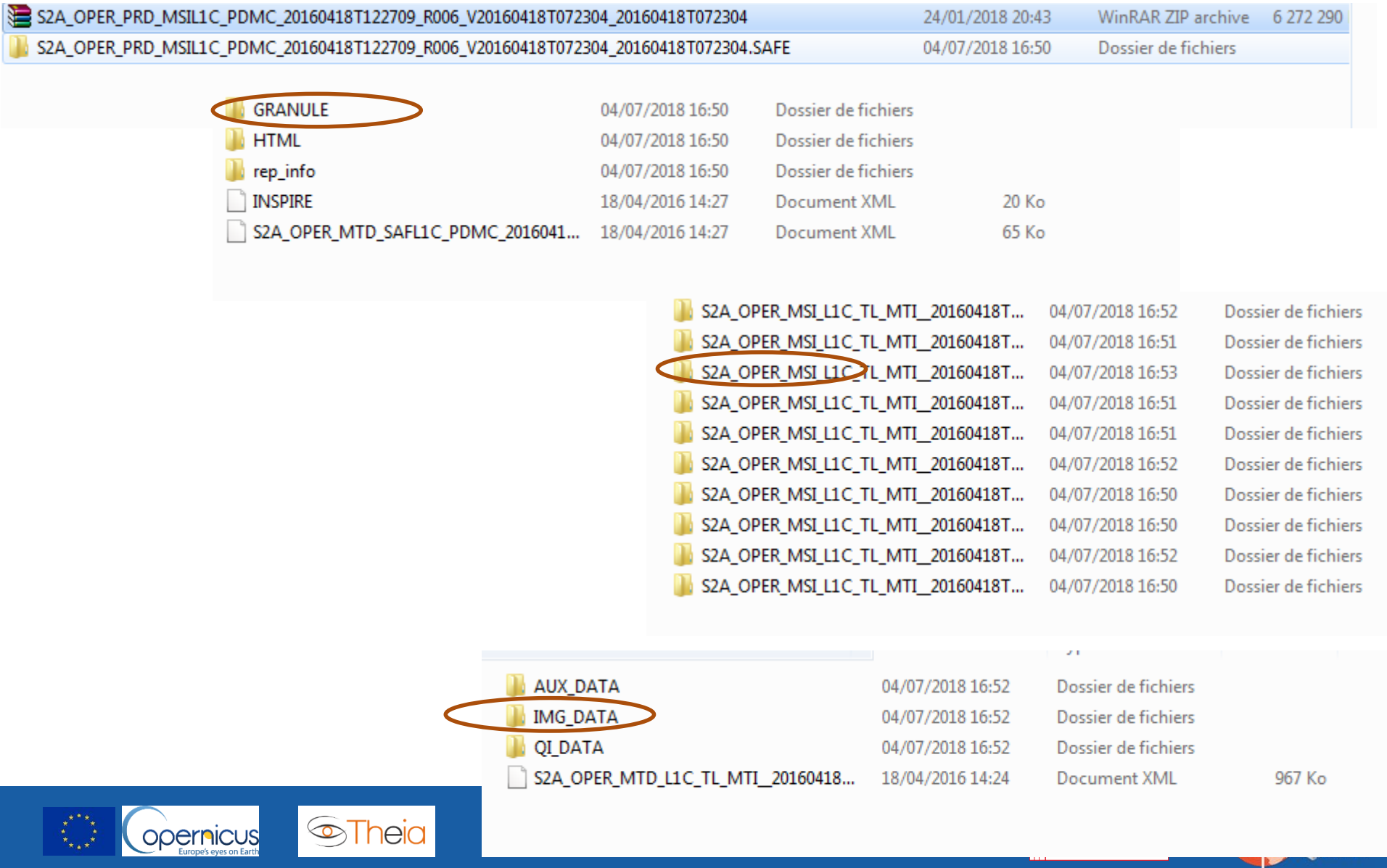
Data structure for Sentinel-1

Each file is its own object in Amazon S3.. The basic data format is the following:

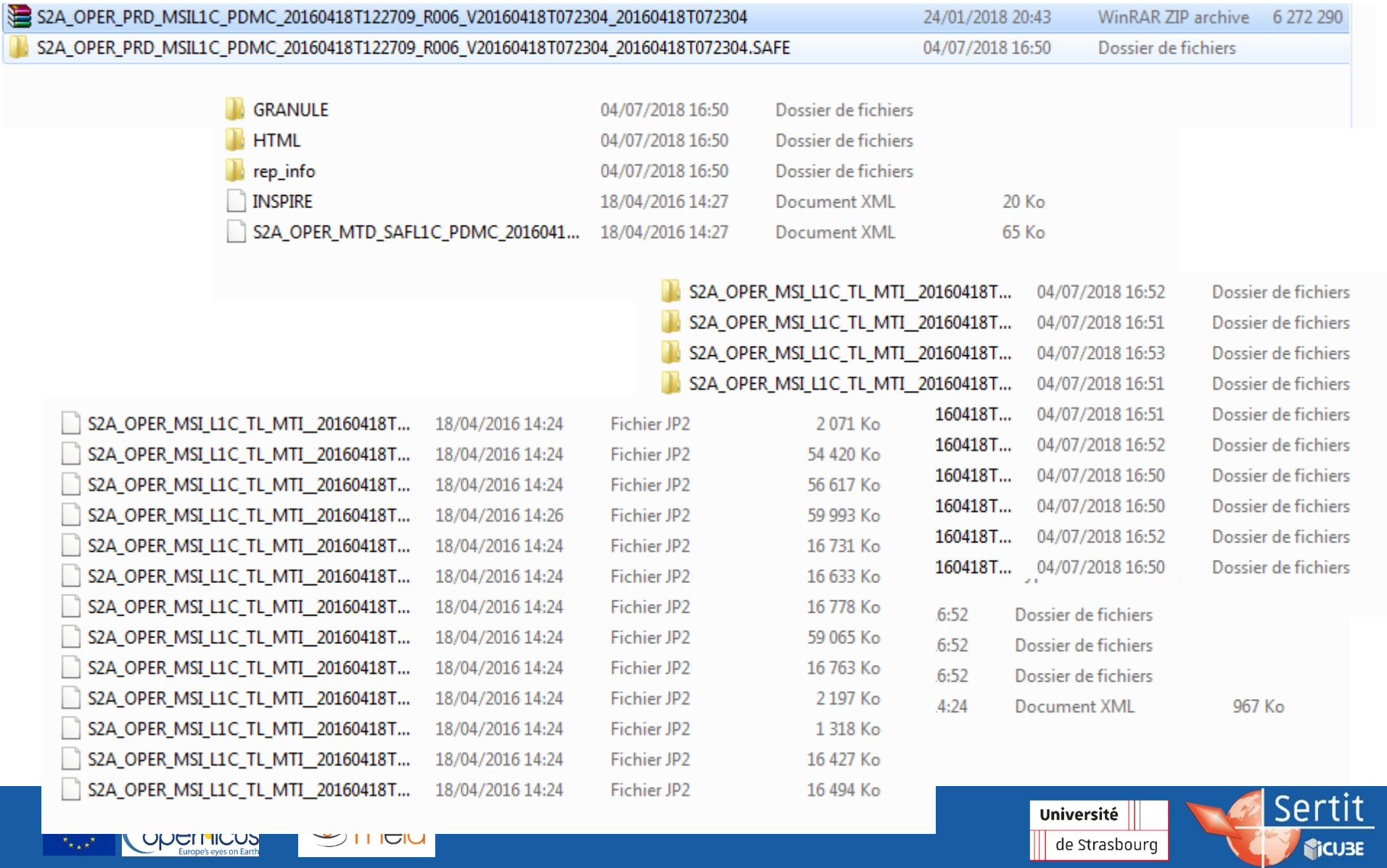
https://sentinel-pds.s3-website.eu-central-1.amazonaws.com/

https://sentinel-pds.s3-website.eu-central-1.amazonaws.com

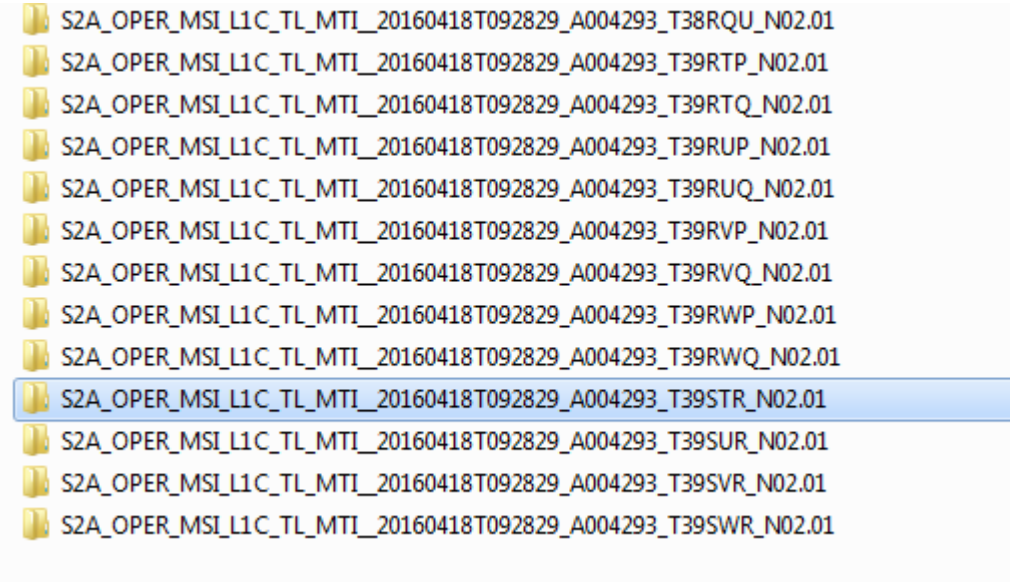
Sentinel 2 structures



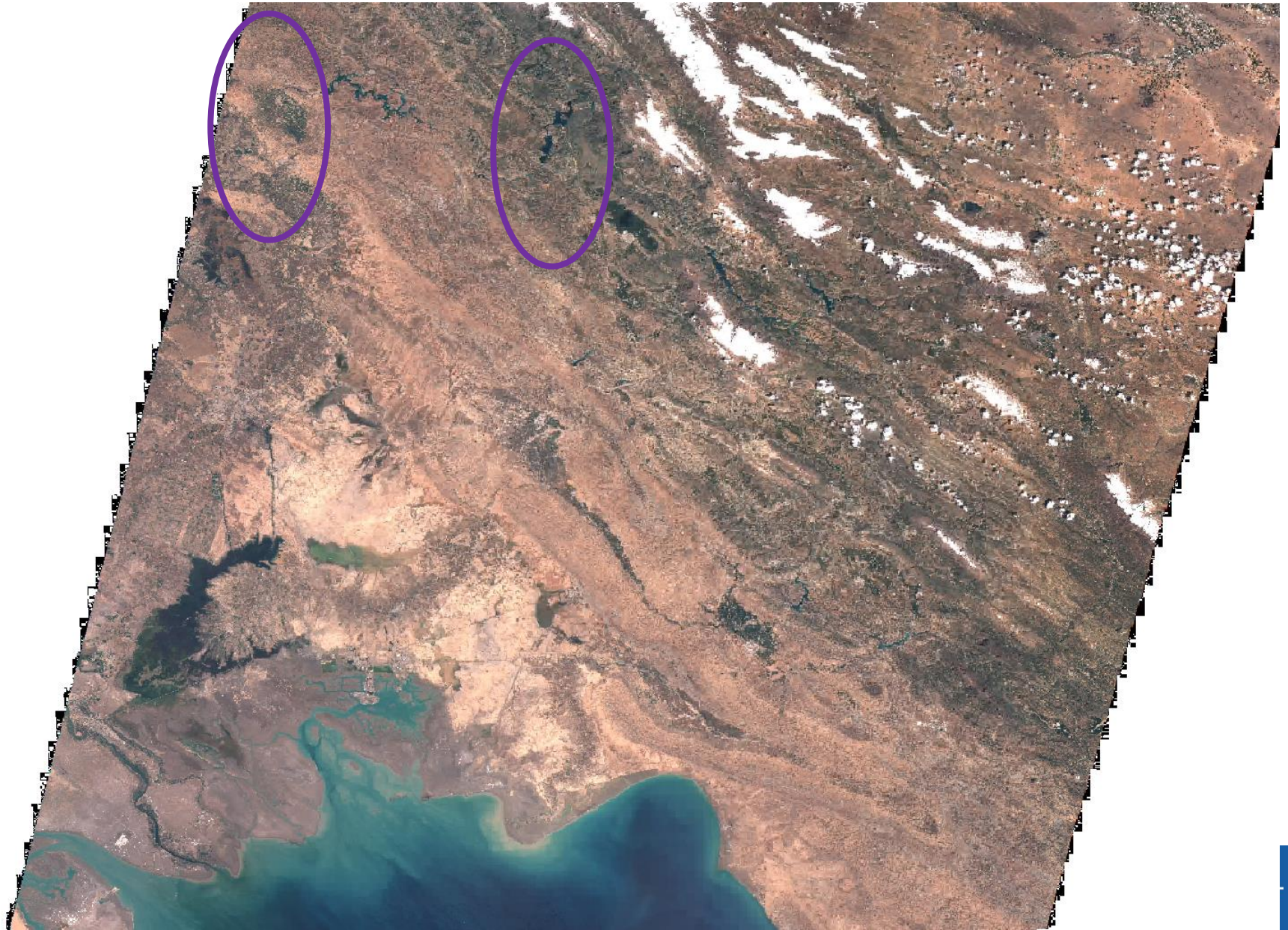
Sentinel 2 structures

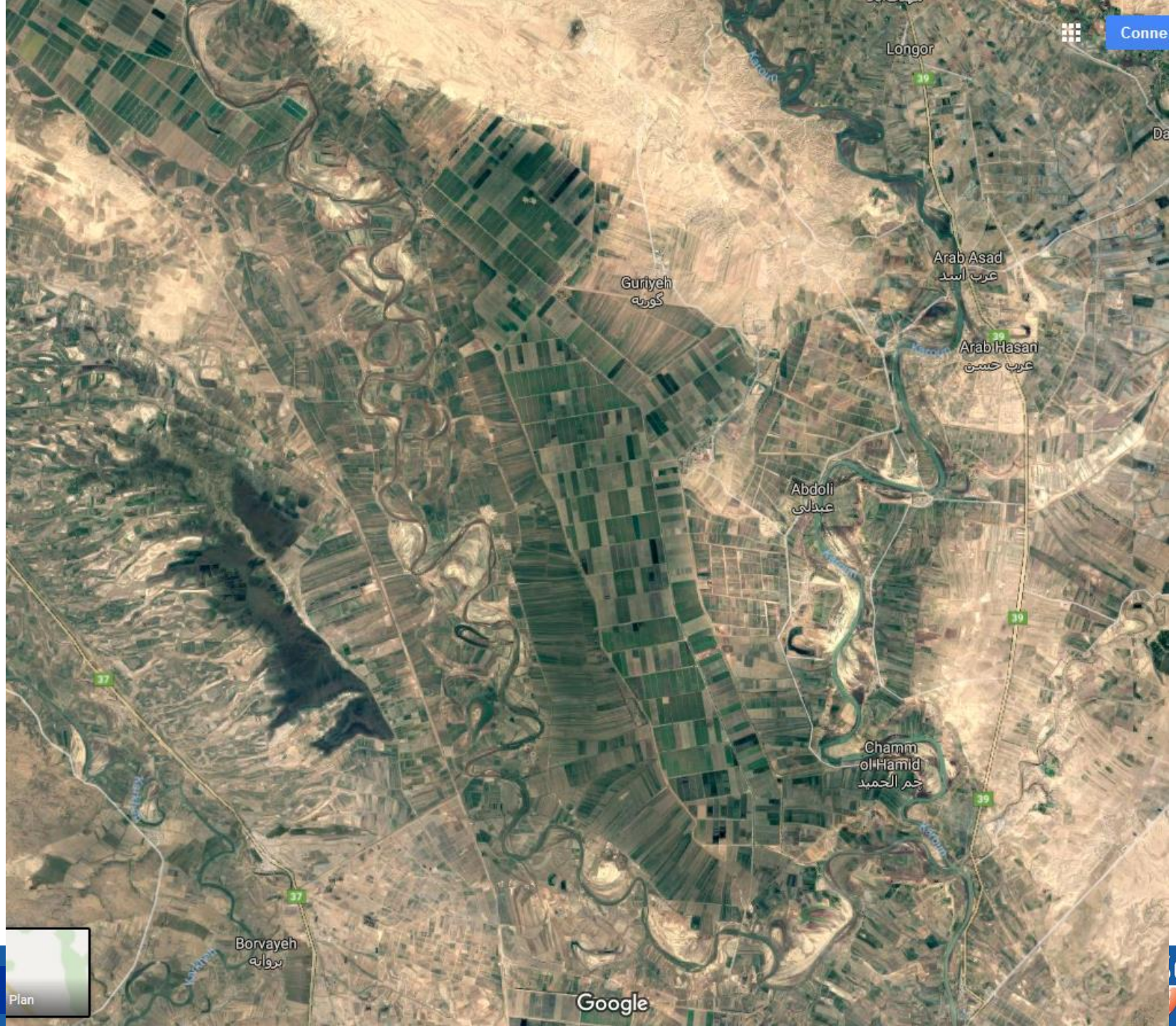


Sentinel 2 structures



- Tile of interest
- S2A_OPER_MSI_L1C_TL_MTI__20160418T092829_A004293_T39STR_N02.01

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Borvayeh
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Plan
Google

10 metre spatial resolution:

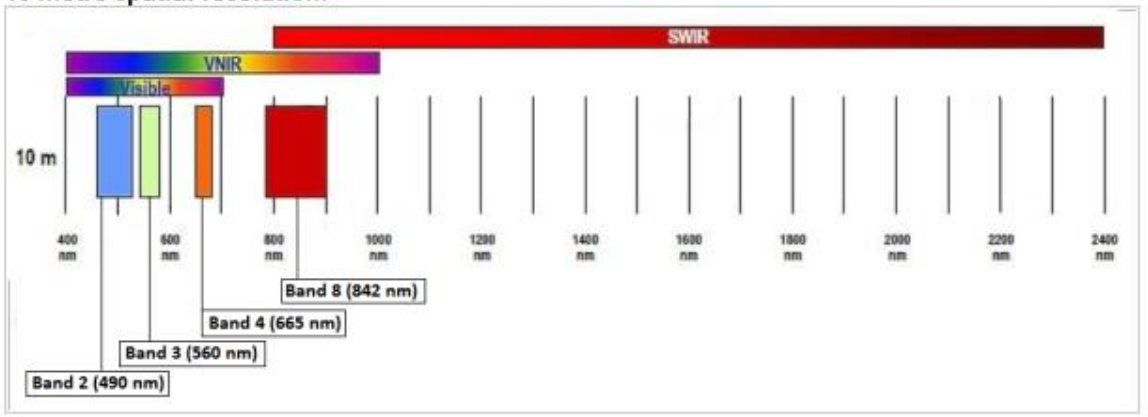


Figure 1: SENTINEL-2 10 m spatial resolution bands: B2 (490 nm), B3 (560 nm), B4 (665 nm) and B8 (842 nm)

20 metre spatial resolution:

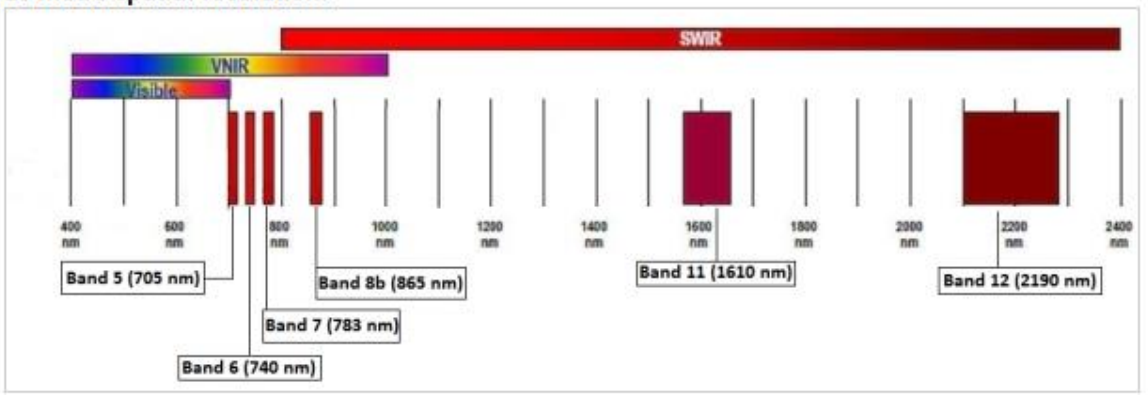


Figure 2: SENTINEL-2 20 m spatial resolution bands: B5 (705 nm), B6 (740 nm), B7 (783 nm), B8b (865 nm), B11 (1610 nm) and B12 (2190 nm)

60 metre spatial resolution:

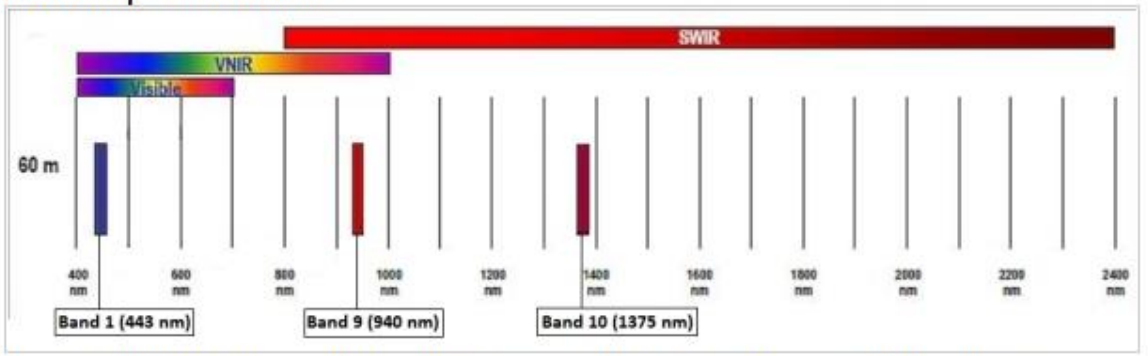
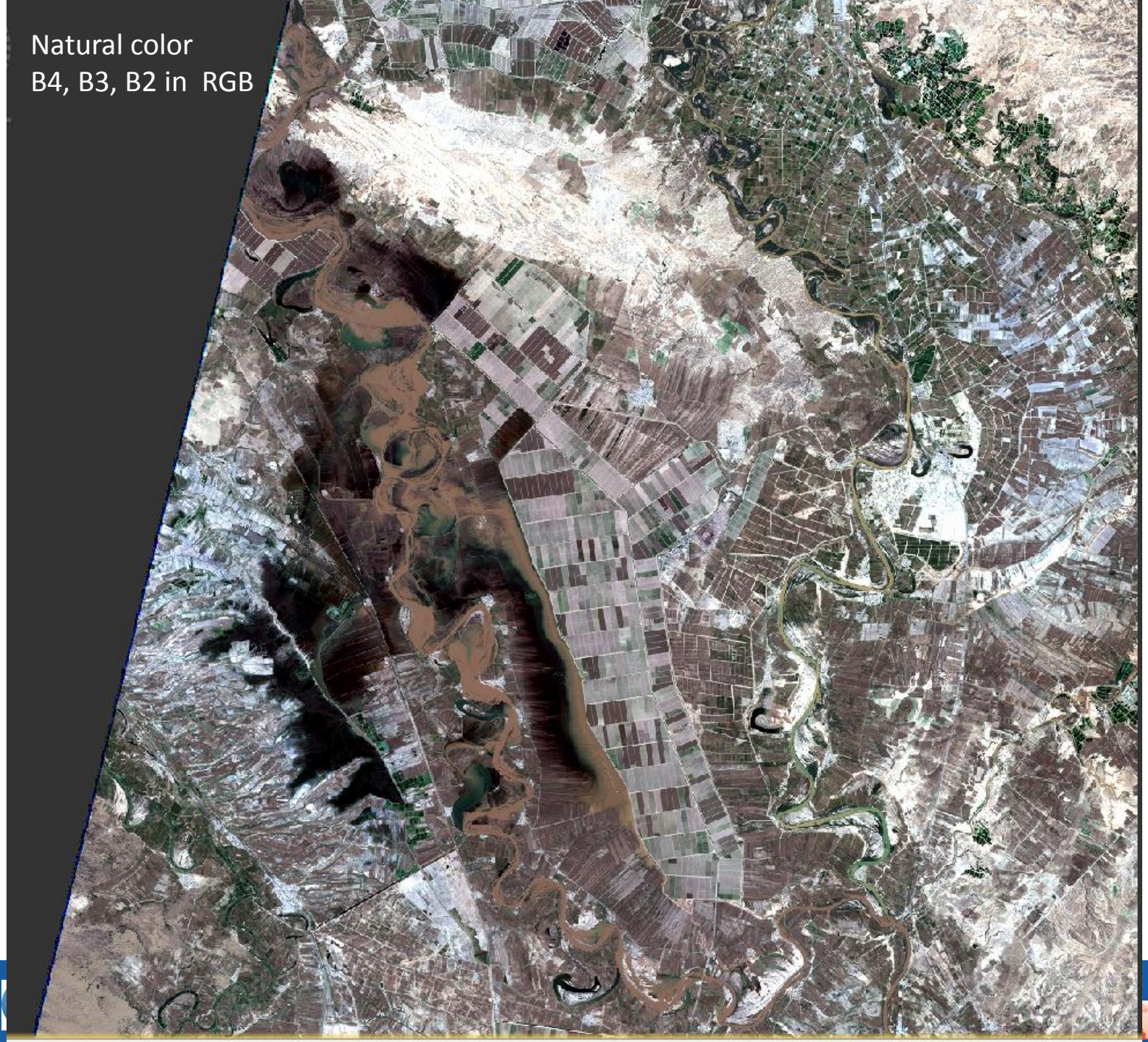
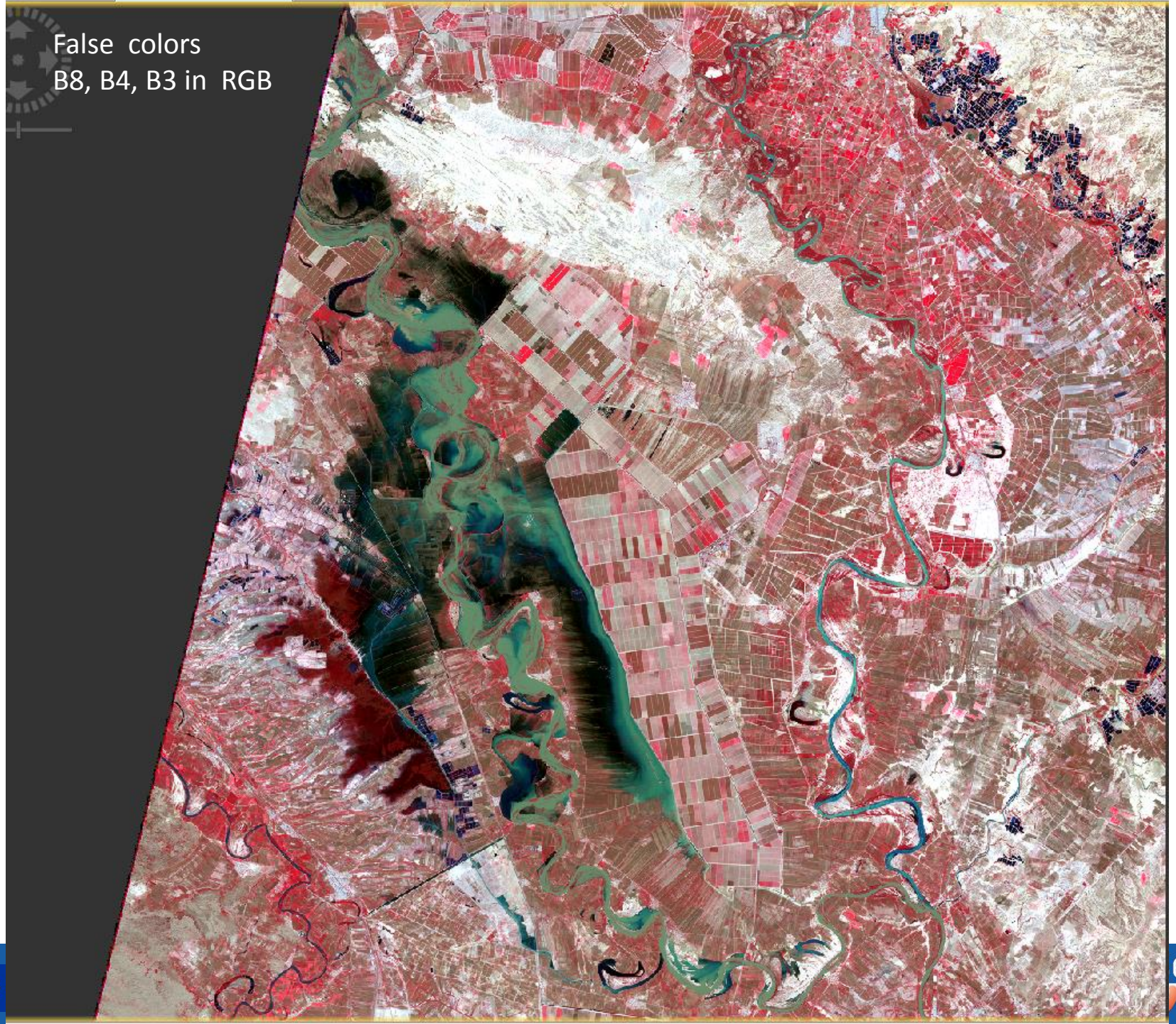
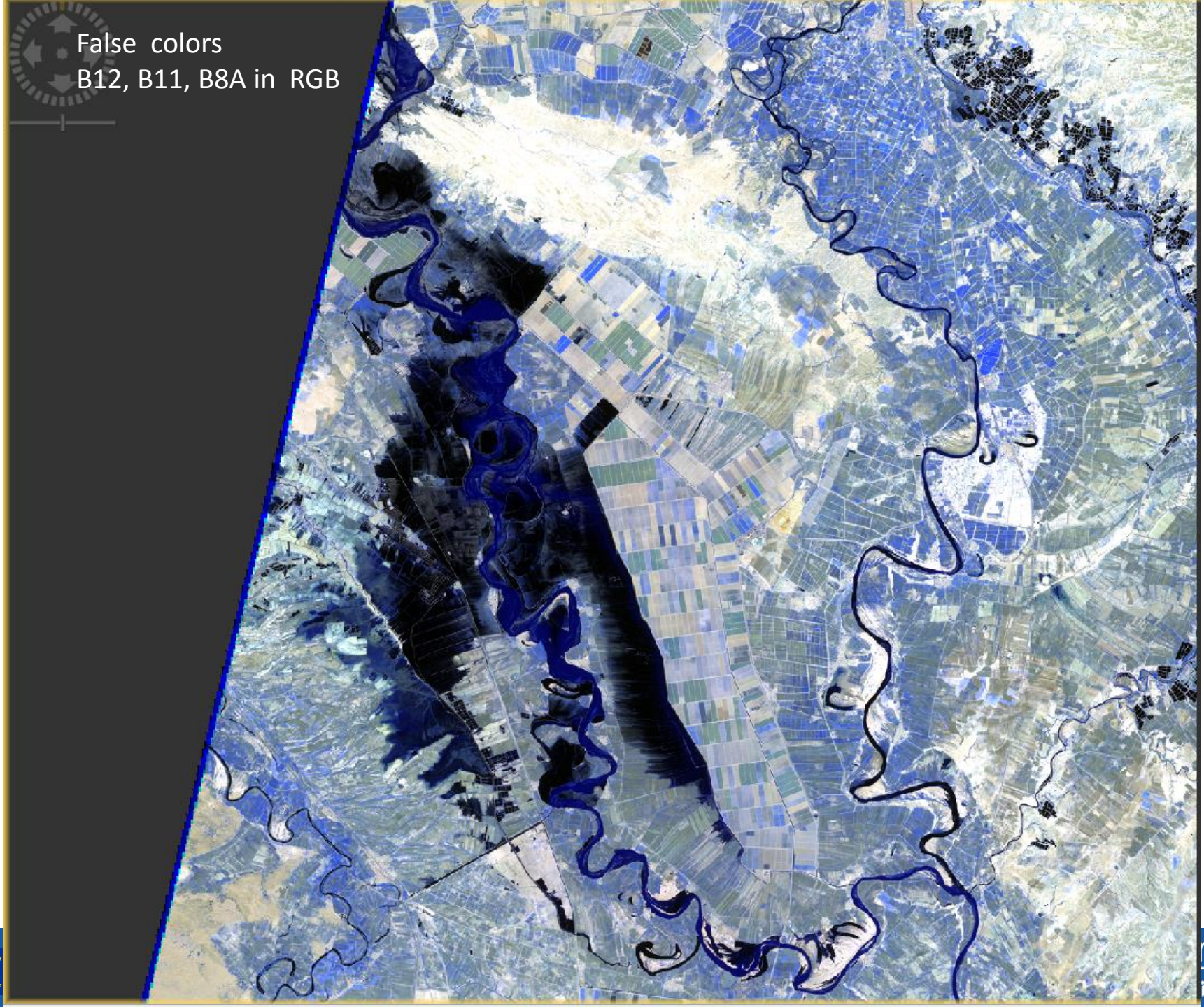


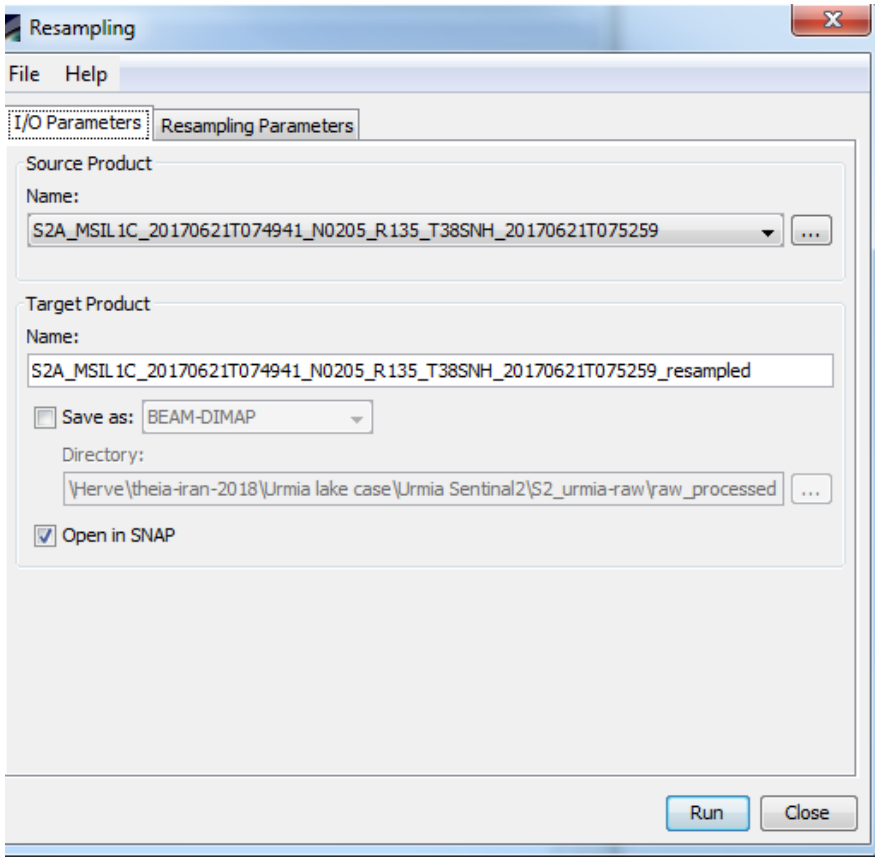
Figure 3: SENTINEL-2 60 m spatial resolution bands: B1 (443 nm), B9 (940 nm) and B10 (1375 nm)

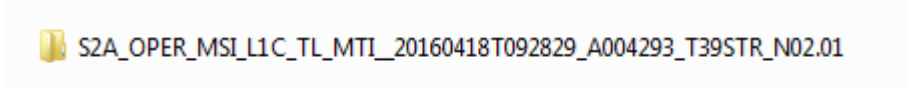

Natural color
B4, B3, B2 in RGB

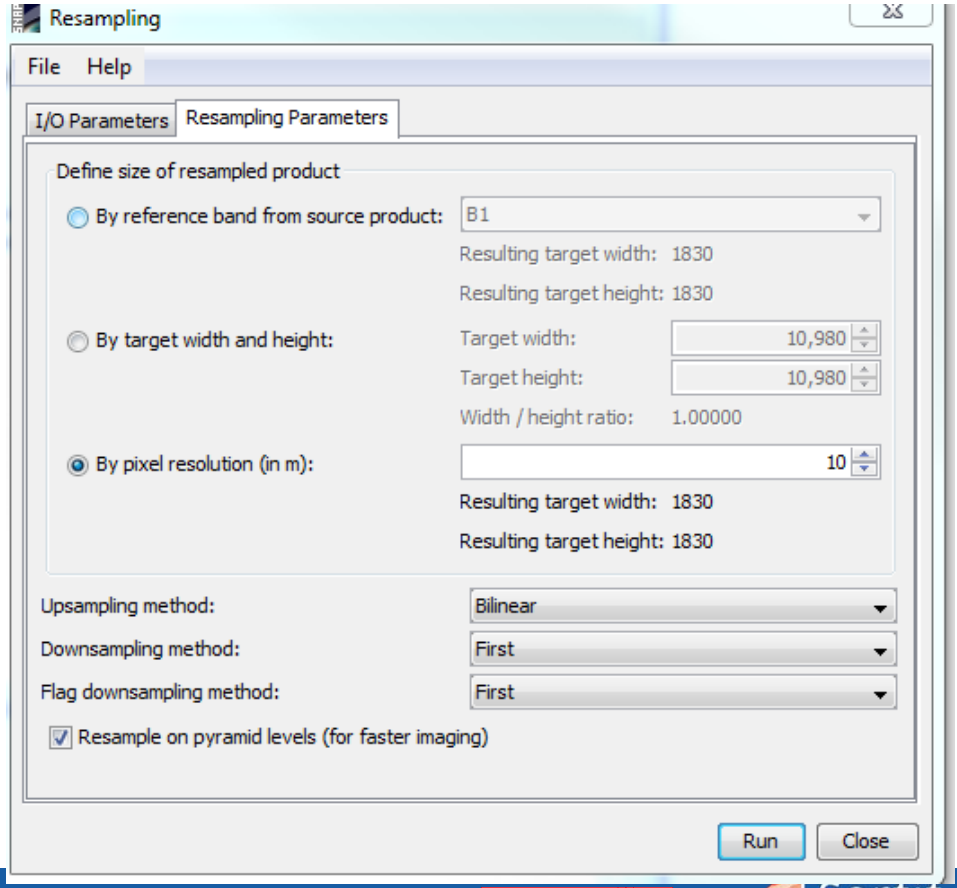

False colors
B8, B4, B3 in RGB

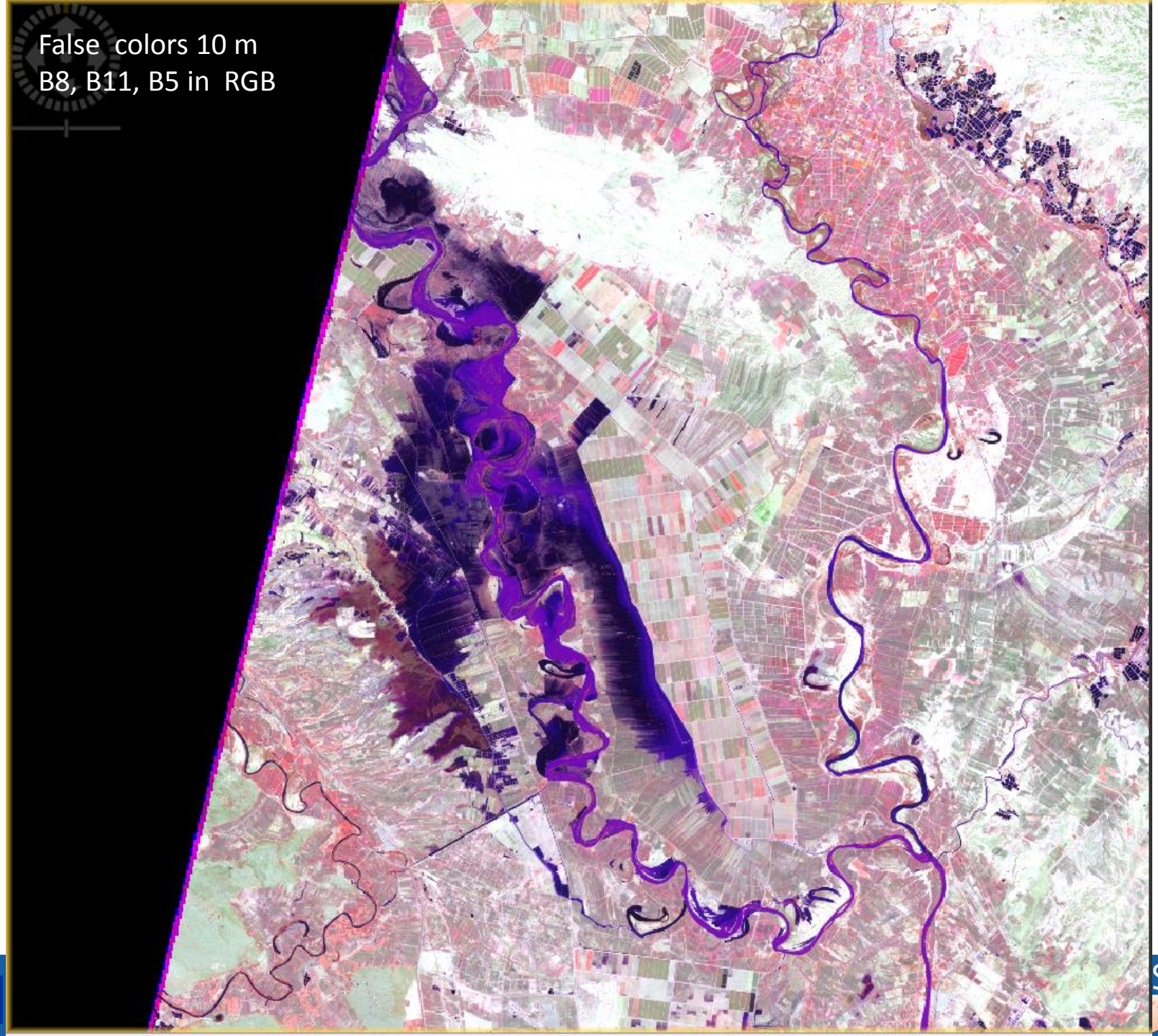

False colors
B12, B11, B8A in RGB

Preprocessing: Resampling: 10 mn

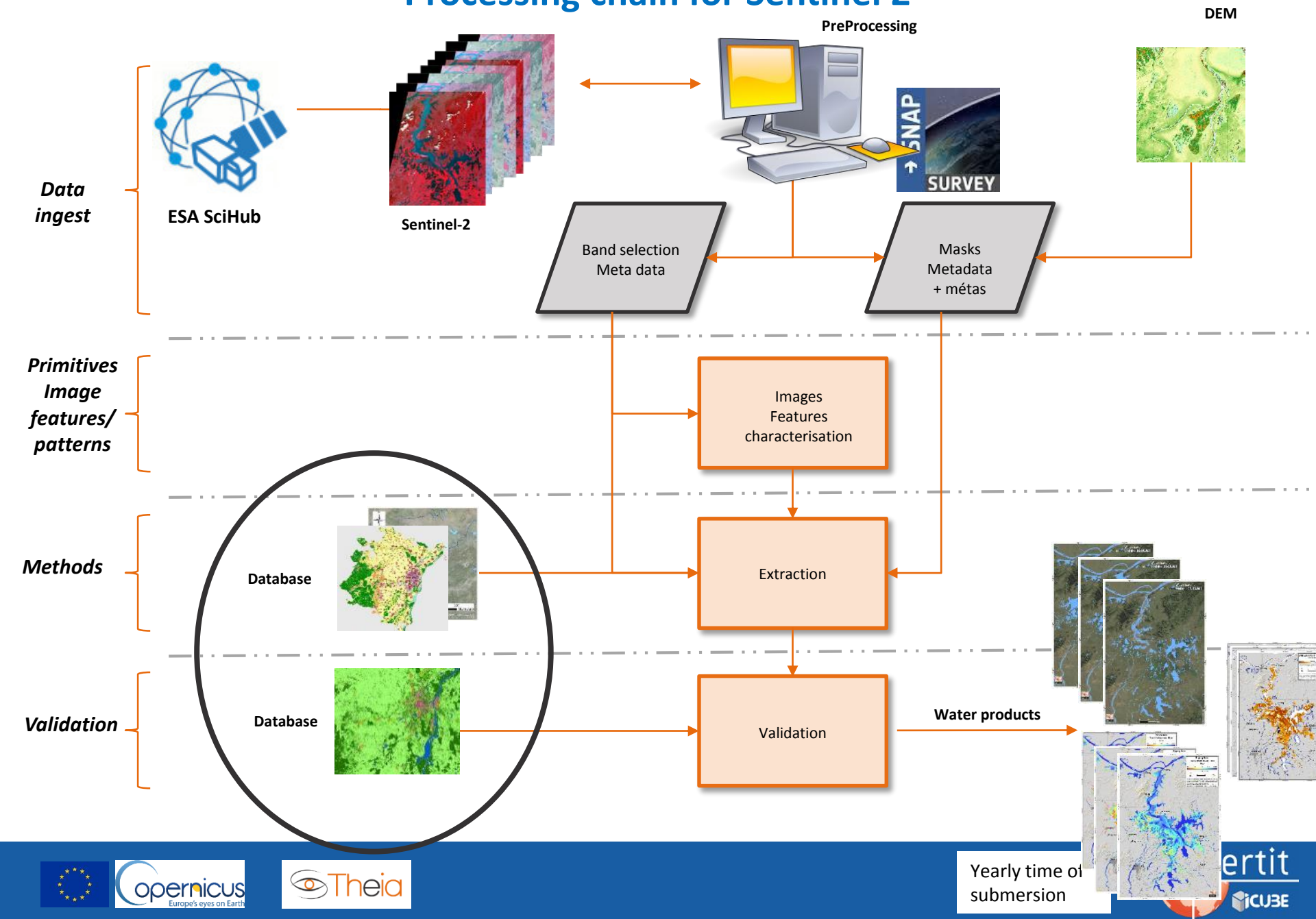




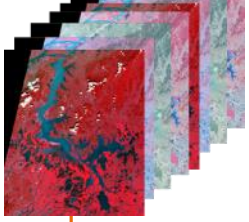



False colors 10 m
B8, B11, B5 in RGB

Processing chain for Sentinel 2



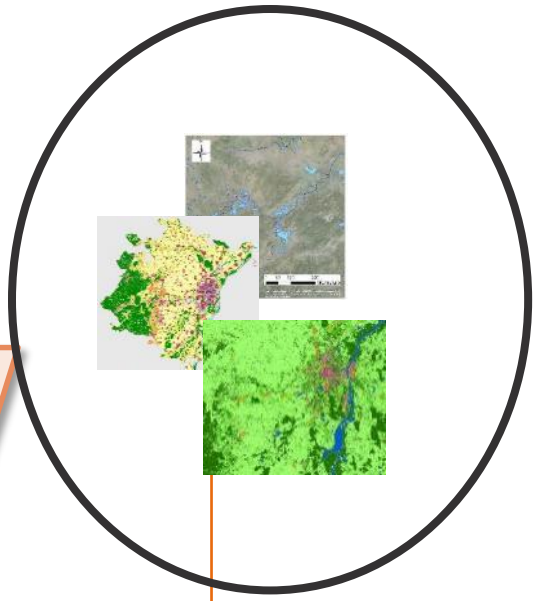
S2 primitives' image extraction



False friend of SWIR signatures

Indices:
NDVI, NDWI, , AWEI, INH, SBI

Spectral space
IHS, ….



Binary mask + métas (GeoTiff)

Primitives, features

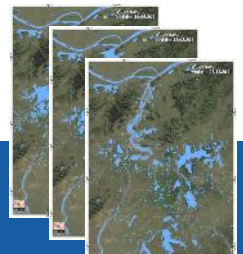
Binary mask + métas (GeoTiff)

Thematic extraction

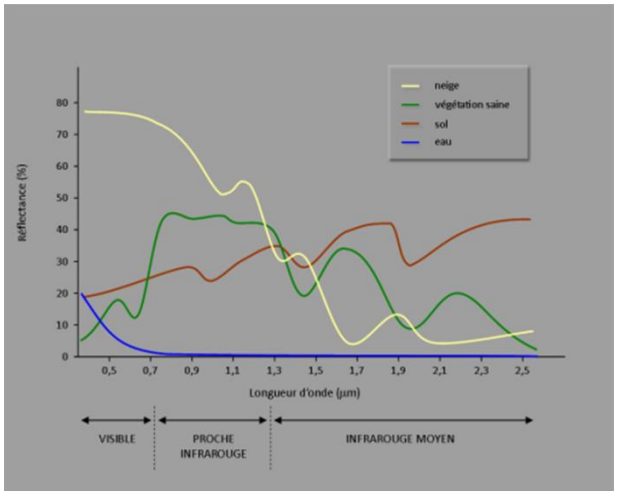
Simple or multiple thresholds

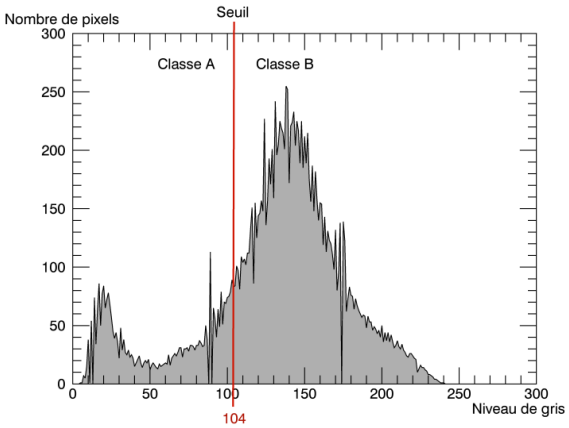
SVM, classification

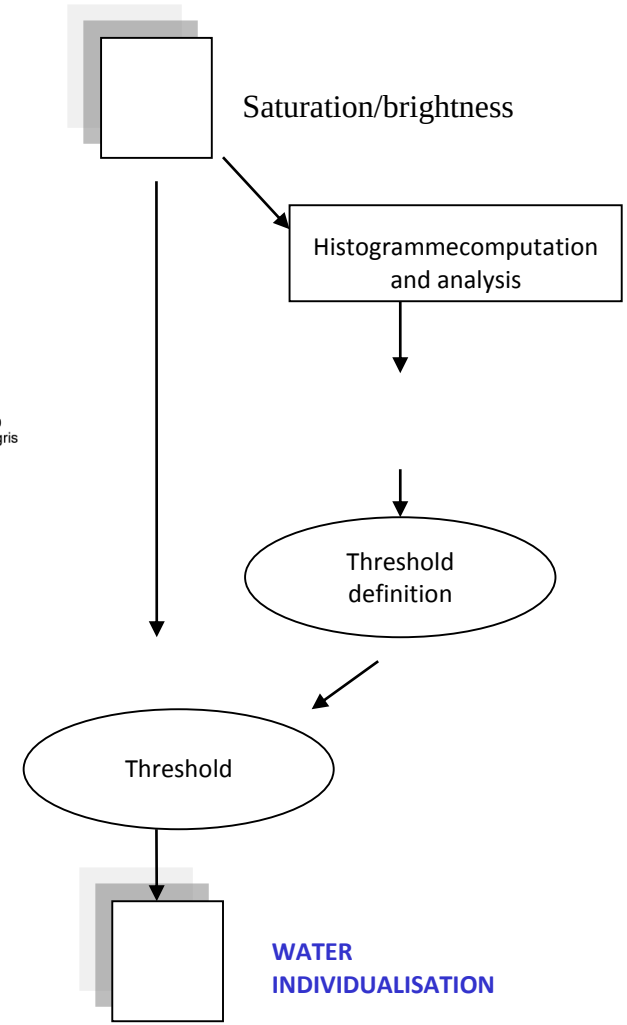
Water mask + metadata



Flood mapping based on thresholding of raw channel and /or indice







Fundamentals: : water areas can be very bright if containing suspended materials

Extraction of water bodies from:

- **Brightness Standard or Tasseled Cap**
- **First component of a PCA,**
- **Saturation indices of a HIS transformation**

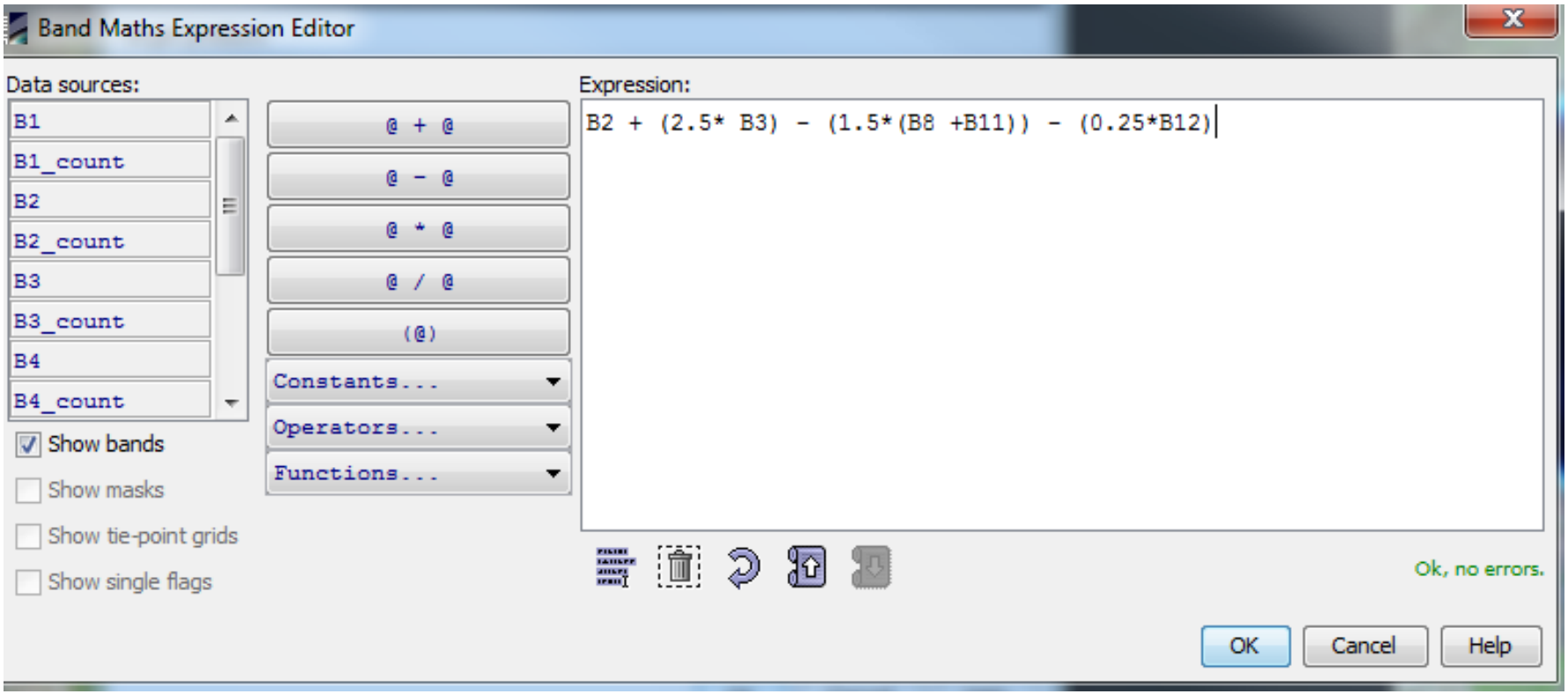
Classical water bodies related indices

Index	Equation	Remark
Normalized Difference Water Index	NDWI = (Green − NIR)/(Green + NIR)	Water has positive va
Normalized Difference Moisture Index	NDMI = (NIR − MIR)/(NIR + MIR)	Water has positive va
Modified Normalized Difference Water Index	MNDWI = (Green − MIR)/(Green + MIR)	Water has positive va
Water Ratio Index	WRI = (Green + Red)/(NIR + MIR)	Value of water body greater than 1
Normalized Difference Vegetation Index	NDVI = (NIR − Red)/(NIR + Red)	Water has negative va
Automated Water Extraction Index	AWEI = 4 × (Green-MIR) − (0.25 × NIR + 2.75 × SWIR)	Water has positive va

Selected indices: AWEI indice

$$AWEI_{sh} = Blue_{band} + (2.5 * Green_{band}) - 1.5 * (NIR_{band} + SWIR1_{band}) - (0.25 * SWIR2_{band})$$

B2 + (2.5 * B3) - (1.5 * (B8 + B11)) - (0.25 * B12)

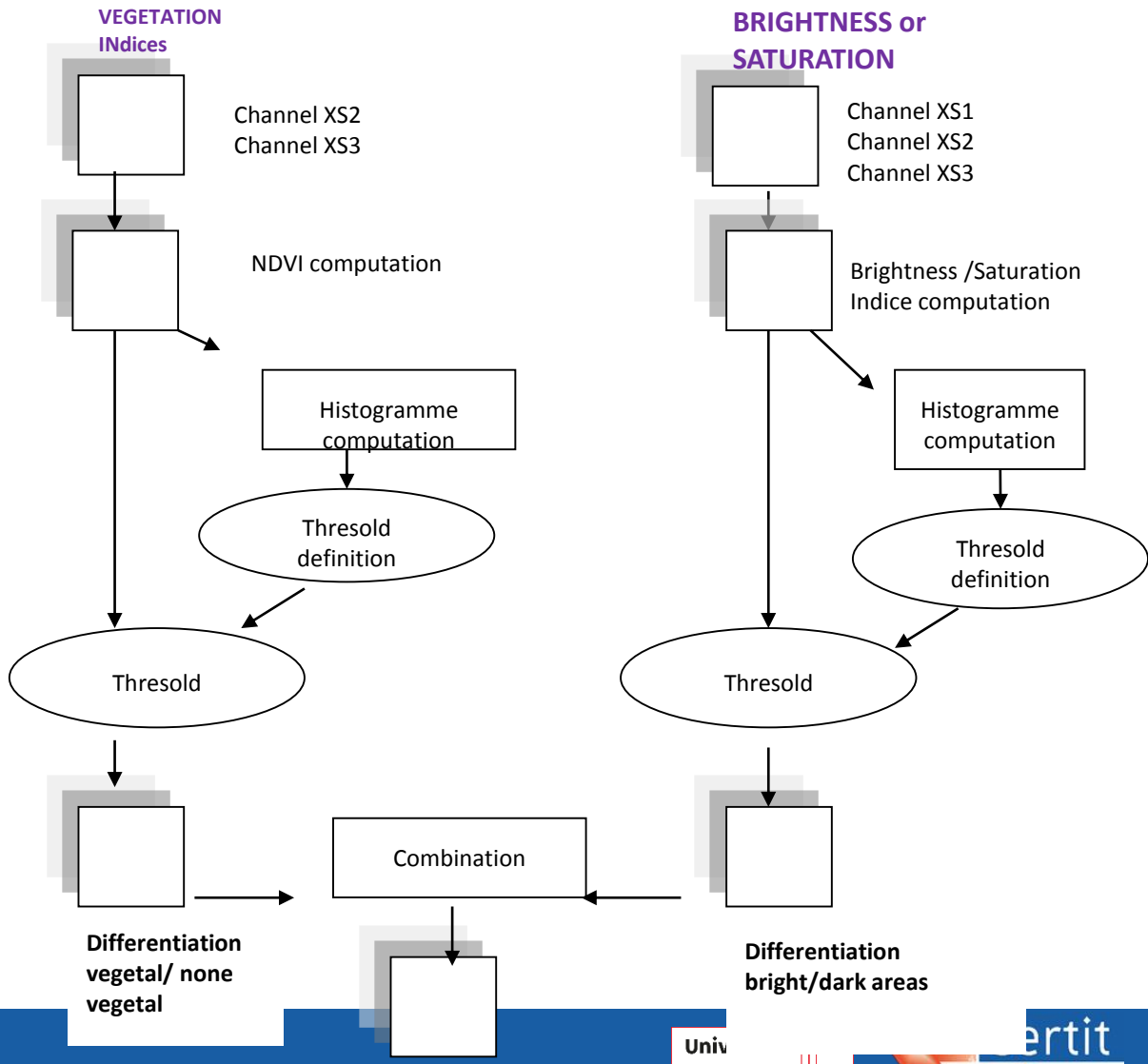


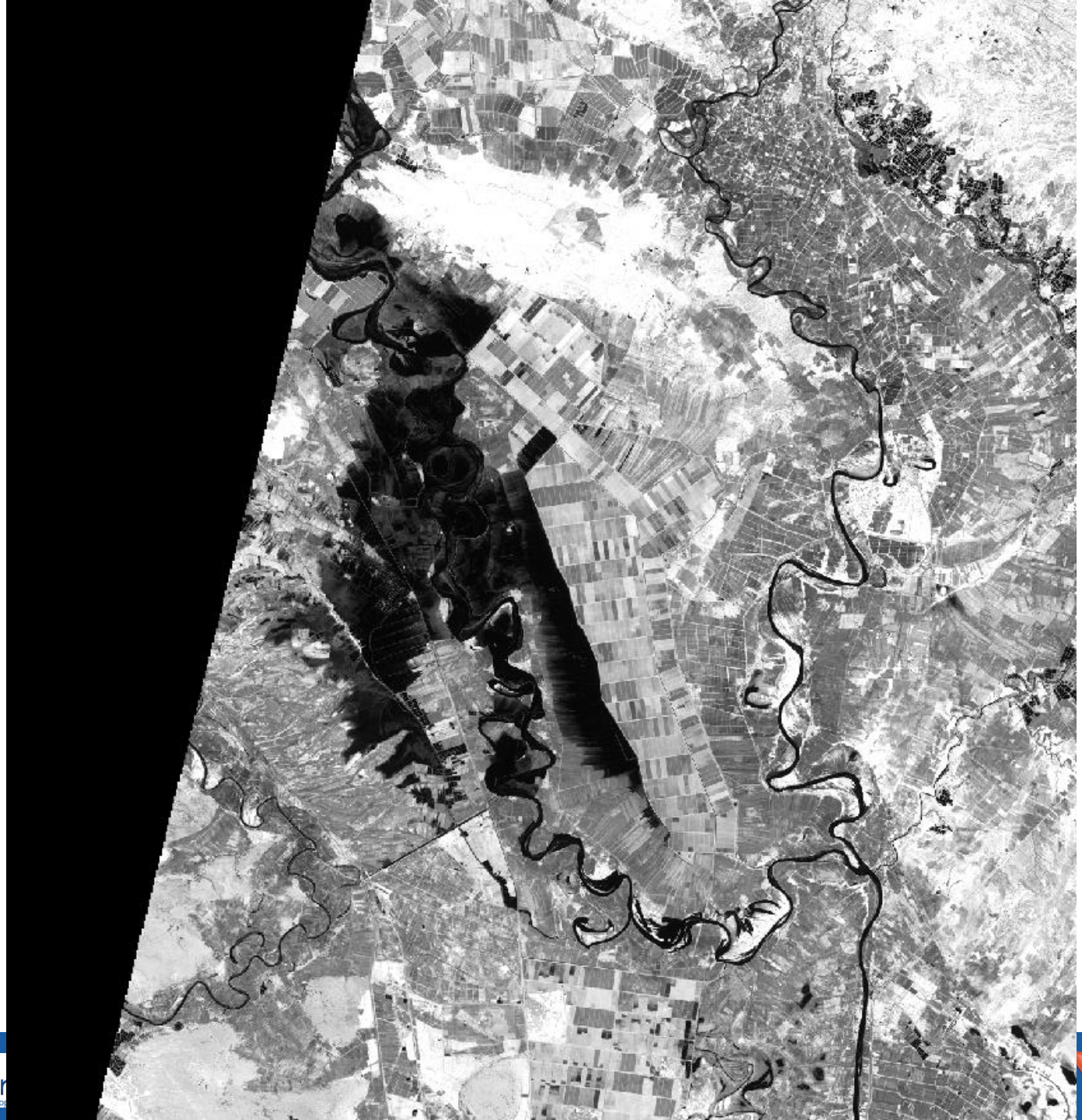
Water bodies mapping based on optical data : combination of indices

Fundamentals: water areas can be very bright if containing suspended materials

Extraction of water bodies from:

- **Brightness Standard or Tasseled Cap**
- **First component of a PCA,**
- **Saturation indices of a HIS transformation**
- **Indices**

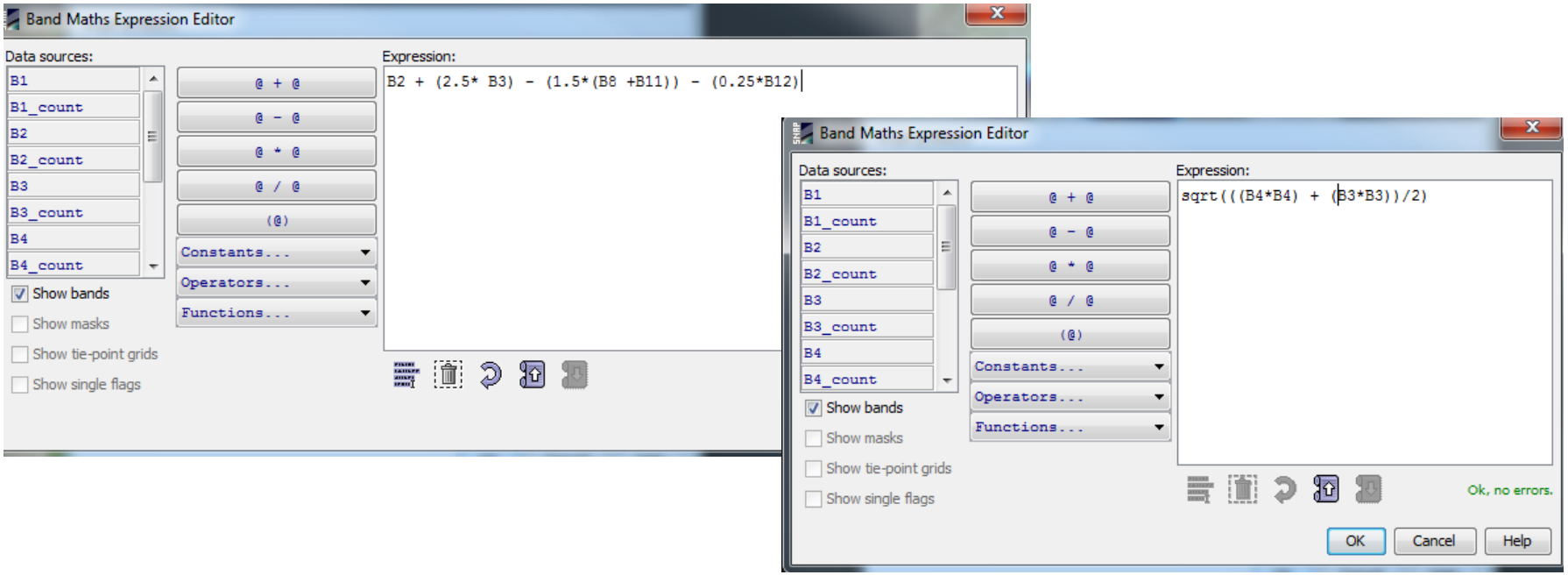




Selected indices: AWEI and Brightness indices

$$AWEI_{sh} = Blue_{band} + (2.5 * Green_{band}) - 1.5 * (NIR_{band} + SWIR1_{band}) - (0.25 * SWIR2_{band})$$

B2 + (2.5 * B3) - (1.5 * (B8 + B11)) - (0.25 * B12)

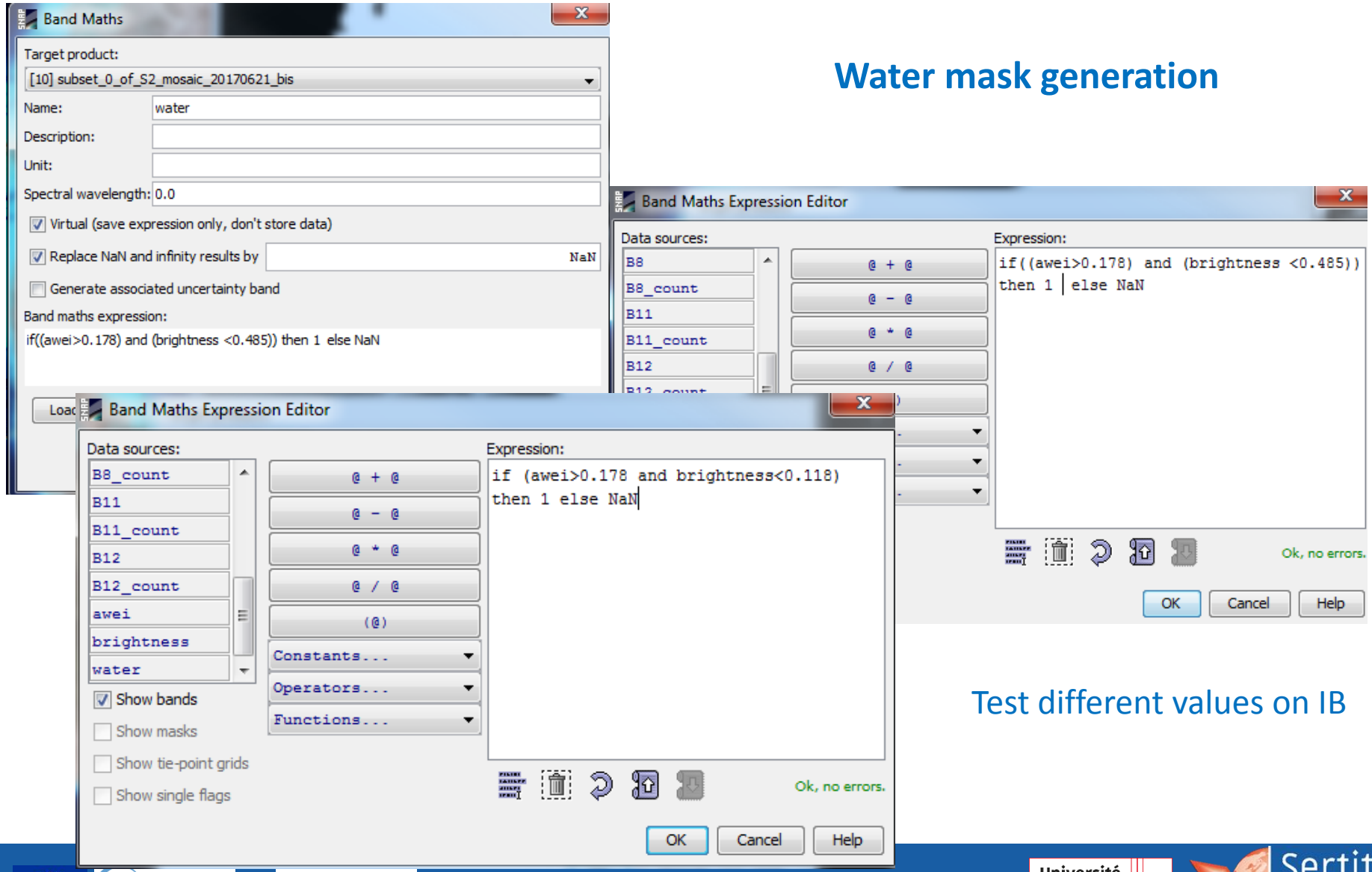


$$BI = \sqrt{\frac{(Red_{factor} * Red_{band}) + (Green_{factor} * Green_{band})}{2}}$$

sqrt (((B4 * B4) + (B3 * B3)) / 2)

Water bodies mapping based on optical data : combination of indices

Water mask generation



Test different values on IB

Flood mapping in a desertic context based on Sentinel1 and Sentinel 2

Case of the 2016 Irak flood

Herve YESOU

June 2022