# UNIVERSITY COURSE APPLIED RADAR REMOTE SENSING



# EXERCISE 6 – TUTORIAL

Crop Classification with S1 time series data using the SNAP software





FUNDED BY EUROPEAN SPACE AGENCY UNDER THE PLAN FOR EUROPEAN COOPERATING STATES, 7TH CALL FOR SLOVAKIA

# 1 | Exercise outline

In this exercise, we will:

- Use radar Sentinel-1 data to classify and analyse time-series for different types of crop fields
- Data pre-processing will be perfomed, an then the crop types will be estimated by classification of the data, based on the Random Forest algorithm
- Land crops growth and health will be observed using RGB composites and backscatter values of different crop types using time series





# 2 | Background

### Crop classification using Sentinel-1 time-series

Crop classification using Sentinel-1 data involves the analysis of radar backscatter signals to differentiate between different types of crops based on their unique radar signatures.

Sentinel-1 data, with its frequent revisit times and all-weather capability, is particularly useful for crop classification as it provides consistent and reliable information regardless of weather conditions.

Crop classification using Sentinel-1 data relies on the radar backscatter signals obtained from the satellite. The backscatter intensity, polarization, and texture of the radar imagery are analyzed to distinguish between different crop types.



These images show the same multi-temporal radar composite acquired over the Flevoland test site in the Netherlands. The grainy appearance of the left image is characteristic of radar images and often a limiting factor in using them at high resolution. The right image demonstrates how a new mathematical technique based on multiple images, which was improved in the campaign, can dramatically enhance the appearance of the image and data quality.







#### 2.1 Study area and data used

For this exercise, we will use three Sentinel-1 images to explore fields in Orleans, France, downloaded for year 2023 from the Dataspace Copernicus Open Access Hub [@https://dataspace.copernicus.eu/].



#### 2.2. SNAP - Open and explore products

Open SNAP Desktop, click Open Product and open three Sentinel-1 GRDH downloaded products with HH and HV polarizations acquired on 11 July 2023 by double click on the zipped folders. The opened products will appear in Product Explorer window:

S1A\_IW\_GRDH\_1SDV\_20230308T174046\_20230308T174111\_047556\_05B5EA\_6563.SAFE S1A\_IW\_GRDH\_1SDV\_20230519T174049\_20230519T174114\_048606\_05D890\_2249.SAFE S1A\_IW\_GRDH\_1SDV\_20230730T174053\_20230730T174118\_049656\_05F897\_BEA3.SAFE

ය 🖫 🦻 🥙 🞜 🐰	🚚 Þ 🗟 🔍 🗁 🖉 φ.λ	🛦 🕲 🌆 🜆	$\mathbb{Z}$
Product Explorer × Pixel Info			_
<ul> <li></li></ul>	30308T174046_20230308T174111_047556_05B5EA 30519T174049_20230519T174114_048606_05D890 30730T174053_20230730T174118_049656_05F897	_6563 _2249 _BEA3	
Navigation - [7] LabeledClasses	Colour Manipulation - [7] LabeledClasses	World View ×	_
1 Salar	3 2 1 1	1-A	







### 3. Pre-processing

#### 3.1 Create subsets

There is no need to process the whole image, instead, we can begin by narrowing down the scene to a more manageable size – creating subset. This approach will decrease processing time in subsequent stages, especially when the analysis is concentrated on a specific area rather than the entire scene.

Go to the Subset tab and at "Geo Coordinates" set:

North latitude bound: 48.10 West longitude bound: 1.40 South latitude bound : 48.20 East longitude bound : 1.50

Note: There is no need to wait till thumbnail image will be created when entering coordinates.

Save the output subsets to your folder – we will need them for the next step.

🞆 Specify Pro	oduct Subset								×
Spatial Subset	Band Subset	Tie-	Point Grid Subset	Me	tadata Subset	:			
			Pixel Coordina North latitude West longitude South latitude East longitude Scene step X: Scene step Y: Subset scene w Source scene w Source scene he Use F	ites bour bour bour bour idth: eight idth:	Geo Coordina nd: und: nd: nd: t: t: t: t:	ates	x full width x full height	48.10 1.40 48.20 1.50 1 1 2039 236 26 16	<ul> <li>↓</li> <li>↓</li></ul>
					Est	imated	, raw storage	size: 1	84. 1M







OK

Cancel

4

Help

# 3.2 Build a pre-processing graph

Use the graph builder tool to create workflow for data processing:

Go to Tools > GraphBuilder Right click and add, in the order below, each of the preprocessing steps:

- The first tool is Read
- Add>Radar>Radiometric>Calibration
- Add>Radar>Speckle Filtering>Speckle-Filter
- Add>Radar>Geometric>Terrain Correction>Terrain Correction
- Add>Raster>Data Conversion>LinearToFromdB
- The last tool is Write

Click on each tool, and connect them by dragging the red arrows from one tool to the next, respecting the order above.







5

Leave the default parameters for individual tools, except Speckle-Filter: - here, select Filter: Lee

Then got to File>Save Graph to save the workflow as a XML file ",crops\_graph".

🎆 SNAP - Save	Graph				×
Save in:	exercise_6	i		v 🗈 💣	• 🔢 🕶
Namedady a	Názov	of_S1A_IW_GRDH_1SDV_20230711T050035_20	Veľkosť	Typ položky Priečinok sú…	Dátum úpravy 29. 2. 2024 20:24
	File name:	crops_graph.xml			Save
Pracovna plo	Files of type:	Graph (*.xml)		~	, Cancel

#### Batch processing

SHAP

Navigate to Tools > Batch Processing: Using the Add opened symbol select the files you want to process.

Batch Processing					X
File Graphs					
I/O Parameters					
File Name	Туре	Acquisition	Track	Orbit	÷
subset_0_of_S1A_IW_GRDH_1SDV_20230308	GRD	08Mar2023	59	47556	
subset_1_of_S1A_IW_GRDH_1SDV_20230519	GRD	19May2023	59	48606	
subset_2_of_S1A_IW_GRDH_1SDV_20230730	GRD	30Jul2023	59	49656	
					- 22
					٠
					3 Products
		Run remote	Load Graph	Run Close	Help

# Using the Load Graph button, load the .xml-file you just saved

Batch Processing						×
File Graphs						
Load Graph						
Save Graph					_	
View Graph XMI		Туре	Acquisition	Track	Orbit	
	sdv_20230308	GRD	08Mar2023	59	47556	
subset_1_of_S1A_IW_GRDH	_1SDV_20230519	GRD	19May2023	59	48606	57
subset_2_of_S1A_IW_GRDH	_1SDV_20230730	GRD	30Jul2023	59	49656	







# Adjust the output folder, click Run.

Batch Processing : crops\_graph.xml

#### File Graphs

I/O Parameters	Calibration	Speckle-Filter	Terrain-Correctio	on LinearToFromdB	Write				
File Name			Туре	Acquisition	Tra	ack	Orbit		÷
subset_0_of_S1A	_IW_GRDH_	1SDV_20230308	B GRD	08Mar2023	59		47556		
subset_1_of_S1A	_IW_GRDH_	1SDV_20230519	9 GRD	19May2023	59		48606		
subset_2_of_S1A	_IW_GRDH_	1SDV_20230730	0 GRD	30Jul2023	59		49656		_
									*
									-
									₹
									*
									3 Products
				Dur	remete	Load Craph	Due	Class	Hele
				Run	remote	Load Graph	кun	Ciose	нер

Note: this step might take several minutes to run.

When the process finishes it opens all of the output products in the Product Explorer window.

Produ	ct Explorer ×	Pixel Info	-
🕀 🗐	[1] S1A_IW_G	RDH_1SDV_2023	30308T174046_20230308T174111_047556_05B5EA_6563
÷ 🗟	[2] S1A_IW_GF	RDH_1SDV_2023	30519T174049_20230519T174114_048606_05D890_2249
÷ 🗟	[3] S1A_IW_GP	RDH_1SDV_2023	30730T174053_20230730T174118_049656_05F897_BEA3
۵. 🗐	[4] subset_0_o	f_S1A_IW_GRD	H_1SDV_20230308T174046_20230308T174111_047556_05B5EA_6563
۵. 🗐	[5] subset_1_o	f_S1A_IW_GRD	H_1SDV_20230519T174049_20230519T174114_048606_05D890_2249
۵. 🗐	[6] subset_2_o	f_S1A_IW_GRD	H_1SDV_20230730T174053_20230730T174118_049656_05F897_BEA3
÷ 🗟	[7] subset_2_o	f_S1A_IW_GRD	H_1SDV_20230730T174053_20230730T174118_049656_05F897_BEA3_Cal_Spk_TC_dB
۵. 🗐	[8] subset_1_o	f_S1A_IW_GRD	H_1SDV_20230519T174049_20230519T174114_048606_05D890_2249_Cal_Spk_TC_dB
÷ 🛢	[10] subset_2_	of_S1A_IW_GR	DH_1SDV_20230308T174046_20230308T174111_047556_05B5EA_6563_Cal_Spk_TC_dB

#### Create stack

Go to Radar > Coregistration > Stack Tools > Create Stack In the Product-Set-Reader tab select the last three products from the previous step.

Create Stack					×
1-ProductSet-Reader 2-CreateStack 3-Write					
File Name	Туре	Acquisition	Track	Orbit	1
subset_2_of_S1A_IW_GRDH_1SDV_20230308T174046_20230308T174111_047556_05B5EA_6563_Cal_Spk_TC_dB	GRD	08Mar2023	59	47556	
subset_1_of_S1A_IW_GRDH_1SDV_20230519T174049_20230519T174114_048606_05D890_2249_Cal_Spk_TC_dB	GRD	19May2023	59	48606	1
subset_2_of_S1A_IW_GRDH_1SDV_20230730T174053_20230730T174118_049656_05F897_BEA3_Cal_Spk_TC_dB	GRD	30Jul2023	59	49656	규
					1







×

In the CreateStack tab, select Product Geolocation as Initial Offset Method (Note: we did not use apply orbit file function, but the product geolocation is accurate enough for the purpose of our analysis)

📀 Create Stack			×
1-ProductSet-Reader	2-CreateStack	3-Write	
Reference: Resampling Type:	subset_2 NONE	2_of_S1A_IW_GRDH_1SDV_20230730T174053_20230730T174118_049656_05F897_BEA3_Cal_Spk_TC_dB	~
Initial Offset Method:	Product	Geolocation	$\sim$
Output Extents:	Master		$\sim$
Find Optimal Referen	nce		

In the Write tab, adjust the stack name if needed, adjust the output folder and click Run. This step will might take few minutes.

After the process is finished, we can see the new final "Stack" product in the Product Explorer window.

#### Display RGB time series

Now we can look at some RGB composites of this time series Right-click on the last "Stack" product – Open RGB Image Window and select different band combinations to see the change of backscatter between one-day acquisition.

Firstly, we can look at polarimetric composite of the same day. For this, select:

Red: Sigma0\_VV\_db\_mst\_08Mar2023 Green: Sigma0\_VH\_db\_mst\_08Mar2023 Blue: Sigma0\_VH\_db\_mst\_08Mar2023-Sigma0\_VV\_db\_mst\_08Mar2023

Selec	t RGB-Image Channels	×	Edit Blue Expression		×
Profile:			Product: [11] subset_2_of_S1A_IW_GR	RDH_2023_Stack	×
			Data sources:		Expression:
	· · · · · · · · · · · · · · · · · · ·		\$11.Sigma0_VH_db_mst_08Mar2023	@ + @	\$11.Sigma0_VH_db_mst_08Mar2023-
Red:	\$11.Sigma0_VV_db_mst_08Mar2023	×	\$11.Sigma0_VV_db_mst_08Mar2023	@ - @	\$11.Sigma0_VV_db_mst_08Mar2023
			\$11.Sigma0_VH_db_slv1_19May2023		
	fixed range min max		\$11.Sigma0_VV_db_slv2_19May2023		
Green:	\$11 Sigma0 VH db mst 08Mar2023	×	\$11.Sigma0_VH_db_slv3_30Jul2023	@/@	
			\$11.Sigma0_VV_db_slv4_30Jul2023	(@)	
	fixed range min max			Constants ~	
Blue:	\$11.Sigma0_VH_db_mst_08Mar2023- \$11.Sigma0_VV_db_mst_08Mar2023	~		Operators ~	
	fixed range min max			Functions V	
			Show bands		
	Express	ions are valid	Show masks		
Stor	e RGB channels as virtual bands in current product		Show tie-point grids		
			Show single flags		📑 📋 🏹 🎦 🖉 Ok, no errors.
	OK Cancel	Help			OK Cancel Help







Another RGB composition we can generate is to look at images of the same polarisation but for different dates:

Right-click on the last "Stack" product – Open RGB Image Window and select different band combinations to see the change of backscatter for different acquisitions. For this, select:

# Red:

# Sigma0\_VH\_db\_mst\_08Mar2023

Green: Sigma0\_VH\_db\_slv\_18May2023

Blue: Sigma0\_VH\_db\_slv\_30Jul2023

ÚSTAV GEOGRAFIE

Profile:			× 🗃 💾	
Red: \$1	1.Sigma0_VH_	db_mst_08Mar2023	~	
	fixed range	min	max	¢.
Green: \$1	1.Sigma0_VH_	db_slv1_19May2023	~	
	fixed range	min	max	1
Blue: \$1	1.Sigma0_VH_	db_slv3_30Jul2023	~	
	fixed range	min	max	t -
Store R	GB channels as vir	tual bands in current produc	Expressions ar	e valid



#### [11] RGB × [11] RGB (2) ×



#### Time Series Analysis (using single scenes, not a stack)

Tool cannot use a stack, it needs single images instead

Navigate to View > Tool Windows > Radar > Time Series to open the Time Series tab at the bottom left of your SNAP window.

Click on Settings (top right of Time Series tab) and add individual (preprocessed) images. Click Apply.









( ) < </p>

Select also polarisation for which you want to explore time-series and dick OK.



Using the time series tab, hover your mouse over the area to see the behaviour of single pixels over or use Pin Manager (View-Tool Windows-Pin Manager) to see the behaviour of the selected Pins.



Explore backscatter values of different crop types within the time range.

For more information, see the lecture: <u>6. SAR and optical remote sensing</u> for precision agriculture 2

# THANK YOU FOR FOLLOWING THE EXERCISE!





