





TRAINING KIT – HAZA08

DAMAGE ASSESSMENT WITH SENTINEL-1 & SENTINEL-2 – AUGUST 2020 (Beirut, LEBANON)











Research and User Support for Sentinel Core Products

The RUS Service is funded by the European Commission, managed by the European Space Agency and operated by CSSI and its partners.

Authors would be glad to receive your feedback or suggestions and to know how this material was used. Please, contact us on <u>training@rus-copernicus.eu</u>

Cover image produced by RUS Copernicus

The following training material has been prepared by Serco Italia S.p.A. within the RUS Copernicus project.

Date of publication: October 2020

Version: 1.1

Suggested citation:

Serco Italia SPA (2020). *Lebanon Damage Assessment with Sentinel-1 & Sentinel-2. (version 1.1).* Retrieved from RUS Lectures at <u>https://rus-copernicus.eu/portal/the-rus-library/train-with-rus/</u>



This work is licensed under a <u>Creative Commons Attribution-NonCommercial-ShareAlike 4.0</u> International License.

DISCLAIMER

While every effort has been made to ensure the accuracy of the information contained in this publication, RUS Copernicus does not warrant its accuracy or will, regardless of its or their negligence, assume liability for any foreseeable or unforeseeable use made of this publication. Consequently, such use is at the recipient's own risk on the basis that any use by the recipient constitutes agreement to the terms of this disclaimer. The information contained in this publication does not purport to constitute professional advice.

Table of Contents

1	In	troduct	ion	. 5
2	2 Training			. 5
	2.1	Data	used	. 6
	2.2	Softv	ware in RUS environment	. 6
3	Re	egister t	o RUS Copernicus	. 6
4	Re	equest a	RUS Copernicus Virtual Machine to repeat a Webinar	. 8
5	St	tep by st	ep	10
	5.1	Data	download – ESA SciHUB	10
	5.2	SNA	P – open and explore data	13
	5.3	Sent	inel-1 Processing – Part 1	15
	5.	.3.1	Graph Builder	15
	5.	.3.2	Read the input products	15
	5.	.3.3	TOPS Split	16
	5.	.3.4	Apply Orbit File	17
	5.	.3.5	Back Geocoding	17
	5.	.3.6	Enhanced Spectral Diversity	18
	5.	.3.7	Write – create the output	18
	5.	.3.8	Repeat chapters 5.3.2 to 5.3.7	19
	5.4	Sent	inel-1 Processing – Part 2	22
	5.	.4.1	Graph Builder	22
	5.	.4.2	Coherence Estimation	22
	5.	.4.3	TOPS Deburst	23
	5.	.4.4	Mulitlooking	23
	5.	.4.5	Geocoding – Terrain Correction	23
	5.	.4.6	Subset	24
	5.	.4.7	Write – create the output	25
	5.	.4.8	Repeat chapters 5.4.2 to 5.4.7	25
	5.5	Sent	inel-1 Processing – Part 3	28
	5.	.5.1	Create Stack	28
	5.	.5.2	Change Detection	29
	5.	.5.3	Export Sentinel-1 product	32
	5.6	Sent	inel-2 Processing – Part 1	33
	5.	.6.1	Create RGB image	33
	5.	.6.2	Graph Builder	34
	5.	.6.3	Read inputs	34

	5.6.	4	Resample	34
	5.6.5		Subset	35
	5.6.6		Write – create the outputs	35
	5.6.7		Repeat chapters 5.6.3 to 5.6.6	36
5	5.7	Sen	tinel-2 Processing – Part 2	37
	5.7.	1	Collocation	37
	5.7.2		Sea Mask	38
	5.7.3		Band Maths	39
	5.7.	4	Reprojection	41
	5.7.	5	Export Sentinel-2 product	42
5	5.8	QGI	S Visualization	42
6	Extr	ra Ste	ps	45
6	5.1	Dov	vnload files from VM	45
7 Further reading and resources				

1 Introduction

The Research and User Support for Sentinel core products (RUS) service provides a free and open scalable platform in a powerful computing environment, hosting a suite of open source toolboxes preinstalled on virtual machines, to handle and process data acquired by the Copernicus Sentinel satellites constellation.



View of the Beirut port and surroundings in Lebanon, before (image above) and after (image below) the explosion, on August 4th, 2020. (Source: Google Earth)

On 4 August 2020 in Lebanon, at around 17:55 local time (14:55 UTC), a fire broke out in Warehouse 12 at the Port of Beirut, where a cargo of 2,750 tonnes of ammonium nitrate was stored, followed by 2 explosions a few minutes later.

The first explosion produced a large cloud of smoke, damaging heavily the warehouse, while the second that was caused by nitrogen dioxide, a byproduct of ammonium nitrate decomposition, produced a red-orange cloud surrounded by a white condensation cloud.

The consequences were severe in many fields and levels. It is estimated that more than 200 people lost their lives, 6,500 were injured and 300,000 people went homeless since homes as far as 10 km away were damaged. The blast affected over half of Beirut, with the cost to be above \$15 billion in property damages.

Within the port area, the explosion destroyed a section of shoreline leaving a crater around 124m in diameter and 43m in depth. Experts estimated that the explosion was one of the biggest non-nuclear explosions in history, it was detected as a seismic event of magnitude 3.3.

It was felt in many countries such as Turkey, Syria, Israel, Palestine and parts of Europe, and was heard in Cyprus, more than 240 km away. The Lebanese government declared a two-week state of emergency in response to the disaster.

2 Training

Approximate duration of this training session is **two** hours.

The Training Code for this tutorial is HAZA08. If you wish to practice the exercise described below within the RUS Virtual Environment, register on the <u>RUS portal</u> to request a Virtual Machine. Go to Your RUS Service \rightarrow Your training activities and *Request a Webinar Training*.

2.1 Data used

• Three Sentinel-1 IW SLC images acquired on 25 July 2020, 31 July 2020 and 6 August 2020 [downloadable at <u>https://scihub.copernicus.eu/]</u>

 S1B_IW_SLC__1SDV_20200725T033445_20200725T033512_022622_02AEEE_A0BA

 S1A_IW_SLC__1SDV_20200731T033531_20200731T033558_033693_03E7B2_D1A9

 S1B_IW_SLC__1SDV_20200806T033445_20200806T033512_022797_02B43D_3A0B

 Two Sentinel-2 Level 2A images (Tile ID: T36SYC) acquired on 24 July 2020 and 18 August 2020 [downloadable at <u>https://scihub.copernicus.eu/]</u>

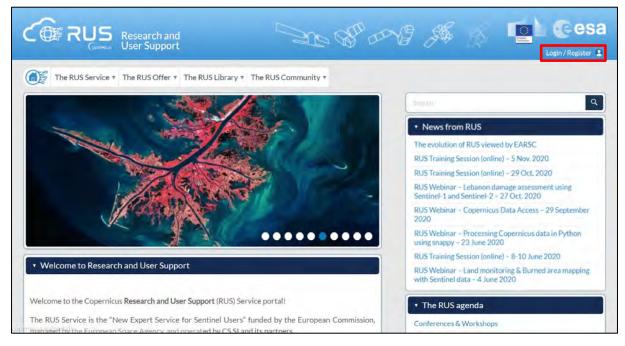
S2A_MSIL2A_20200724T081611_N0214_R121_T36SYC_20200724T110803 S2B_MSIL2A_20200818T081609_N0214_R121_T36SYC_20200818T110855

2.2 Software in RUS environment

Internet browser, SNAP + Sentinel-1 and Sentinel-2 Toolboxes, QGIS.

3 Register to RUS Copernicus

To repeat the exercise using a RUS Copernicus Virtual Machine (VM), you will first have to register as a RUS user. For that, go to the RUS Copernicus website (<u>www.rus-copernicus.eu</u>) and click on *Login/Register* in the upper right corner.



Select the option *Create my Copernicus SSO account* and then fill in ALL the fields on the **Copernicus Users' Single Sign On Registration**. Click *Register*.

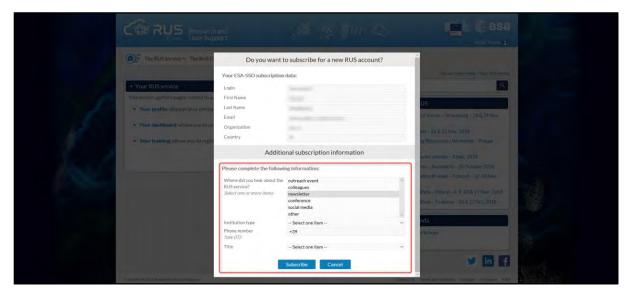
Login / Register	Cesa cds-sso	EAQ
Registered RUS users, as well as persons who already own a Copernicus SSO account, can directly access our service.	Copernicus Users' Single Sign On Registration	
a copernicas soo account, can an eery access our service.	Registration form	
	T'm already registered 🗇 🛛 🗿	
Login	CDS SSO ID	
	Secret question Solid sound question •	
	Answer	
	Password	
Newcomers shall first create an account on the Copernicus Single Sign-On (SSO)	Confirm password	
authentication server used to support registration to the RUS service.	Enal 0	
	First name	
	Last name	
Create my Copernicus SSO account	Institution	
	Country of residence	
NB : persons using a Google e-mail address for registration shall check their mailbox spam folder regularly as Google tends to filter RUS e-mails.	Type the disrates	
Close	Register	

Within a few minutes you will receive an e-mail with activation link. Follow the instructions in the e-mail to activate your account.

You can now return to <u>https://rus-copernicus.eu/</u>, click on *Login/Register*, choose *Login* and enter your chosen credentials.

Login / Register	Credentials			1
The registration system to access the RUS service platform has moved toward the COPERNICUS Single Sign On authentication server. • New Users who have not yet registered to the RUS portal shall first create a COPERNICUS SSO account. Note that your Copernicus SSO account will be activated only after the reception of the third email sent by the Copernicus service. We advise you to consult this document and this page to facilitate your registration procedure. REGISTER COPERNICUS SSO account will be activated only after the reception of the state of a consult this document and this page to facilitate your registration procedure. REGISTER COPERNICUS SSO account will be activated only after the reception of the state of the st	CDS-SSO ID Password Max Idle Time Max Session Time	half a day Until browser close	Reset	0 0 0
Close		Forgot your password?		

Upon your first login you will need to enter some details. You must fill all the fields.



4 Request a RUS Copernicus Virtual Machine to repeat a Webinar

Once you are registered as a RUS user, you can request a RUS Virtual Machine to repeat this exercise or work on your own projects using Copernicus data. For that, log in and click on **Your RUS Service** → **Your training activities**.

CORRUS Research and User Support	NG 🍂 🌾 💼 @es		
The RUS Service * The RUS Offer * The RUS Library * The RUS Community * 👫 Your RUS se	rvice 1		
	You are here: Home > Your RUS ser		
▼ Your RUS service	Same		
This section gathers pages related to your RUS services:	News from RUS		
Your profile: displays your personal information linked to your ESA SSO and RUS accounts,	The evolution of RUS viewed by EARSC RUS Training Session (online) – 5 Nov. 2020		
Your dashboard: allows you to access your private dashboard,			
	RUS Training Session (online) - 29 Oct. 2020 RUS Webinar - Lebanon damage assessment using Sentinel-1 and Sentinel-2 - 27 Oct. 2020		
 Your training activities allows you to request one or several webinars you are interested in or to register to a training session you have been invited to attend. 			
	RUS Webinar – Copernicus Data Access – 29 Septembe 2020		
	RUS Webinar – Processing Copernicus data in Python using snappy – 23 June 2020		
	RUS Training Session (online) - 8-10 June 2020		
	RUS Webinar – Land monitoring & Burned area mapping with Sentinel data – 4 June 2020		

Select HAZA08 - Lebanon Damage Assessment with Sentinel-1 & Sentinel-2, check the field "I have read and agree to the Terms and conditions of RUS Service" and then click on **Request Webinar Training** to request your RUS Virtual Machine.

ເອົາສະບຸລ	Research and User Support	De Contrato	# #	Helio, Georgia 😫
The RUS Service *	The RUS Offer * The RUS Library *	The RUS Community * 👫 Your RUS service •		
			You are here: Home > You	ur RUS service > Your training activities
	 Your training activities 			
	Webinar Training Request			
	You wish to practice a tutori » Please select your choice	al exercise shown in a RUS webinar?		
	Select one or more Items:			
	HAZAOS - Earthquake defo HAZAO6 - Watching a Typh	rmation using InSAR with Sentinel-1 oon using Sentinel-1 Describes with Sentinel-1	*	
	HYDR01 - Water Bodies Ma	e Assessment with Sentine -1 and Sentine -2 apping over Northern Poland Ity Monitoring with Sentinel-2 Seadle		
	Constant - Crop Mapping in			
	I have read and agree to	o the Terms and conditions of RUS Service.	nar Training	

Further to the acceptance of your request by the RUS Helpdesk, you will receive a notification email with all the details about your Virtual Machine.

To access it, go to **Your RUS Service** → **Your Dashboard** and click on **Access my Virtual Machine**.

							You are here: Home >	Your RUS service > Your dashbo
Your dashboard								
Constant and							6	Chat with Support Desk.
Request a new U	iser servi	ce					-	Chat with Support Desk.
Project Name	ID	Date of submission	Status		Actions		Virtua	Environment
				Follow my project	Get support	Close my service	Access my Virtual Machine(s)	Access my CPU monitoring dashboard
RUS_training1			Open			Rate my service	Freeze my Virtual	Report a technical

Fill in the login credentials that have been provided to you by the RUS Helpdesk via email to access your RUS Copernicus Virtual Machine.



This is the remote desktop of your Virtual Machine.

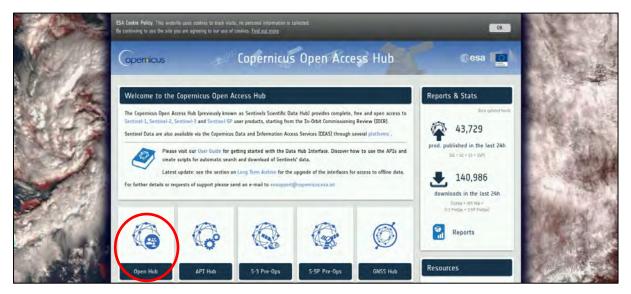


5 Step by step

5.1 Data download – ESA SciHUB

In this step, we will download the Sentinel-1 and Sentinel-2 scenes we will use for the exercise, from the Copernicus Open Access Hub using the online interface. Go to **Applications** → **Network** → **Firefox Web Browser** or click the link below.

Go to https://scihub.copernicus.eu/

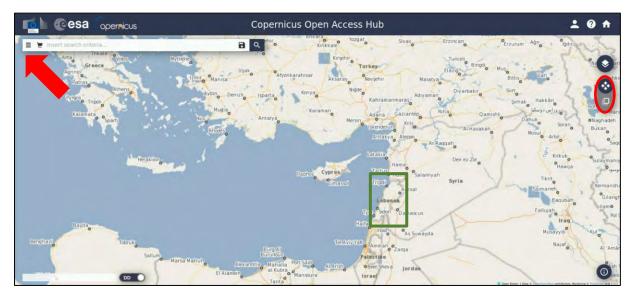


Go to "**Open HUB**", if you do not have an account please register by going to "**Sign-up**" in the LOGIN menu in the upper right corner.



Register ne	ew account	199
		0.0
me field accepts only lowercase alphanumeric characters plus ** ** and * *		
ane	Castaaros	
anik-		
unud	1. Denilized Decodering	
	(Compute Entrum	
lem Altr		
• ages		
our country		
	pletion of the legislation form below you will receive an e-trait with a link to valid me field accepts only lowercase alphanemeric characters plus "" " and " " " " and " " de Blaccepts only lowercase alphanemeric characters plus " " " " " " " " " " " " " " " " " " "	petition of the registration form below you will recover an e-trait with a link to validate your e-mail address. Following this you can start to download the data. The field acception by towercase aphaamines characters plus "", "" and "," the field acception by aphaamines characters plus ", "", " and "," the field acception by aphaamines characters plus ", "," and "," the field acception by aphaamines characters plus ", "," and "," the field acception by aphaamines characters plus ", "," and "," the field acception by aphaamines characters plus ", "," and "," the field acception by aphaamines characters plus ", "," and "," the field acception by aphaamines characters plus ", "," and "," the field acception by aphaamines characters plus ", "," and "," the field acception by a characters. and the field acception by a characters. the field accept

After you have filled in the registration form, you will receive an activation link by e-mail. Once your account is activated or if you already have an account, "LOGIN".



Navigate over Lebanon, eastern Mediterranean Sea (approximate area - green rectangle).

We need to download 3 Sentinel-1 images over the area of interest, two before the event and one after it.

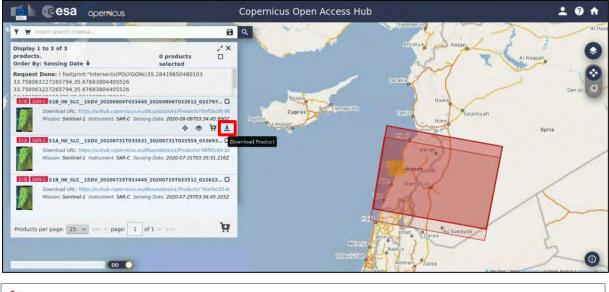
Zoom in a bit more, switch to "**drawing mode**" and draw a search rectangle approximately as indicated below. Open the search menu by clicking to the left part of the search bar. We will specify at once the parameters for both products before the date of the explosion and for the one afterwards as well:

For Sentinel-1:

Sensing period: From 2020/07/25 to 2020/08/06 Select: Mission: Sentinel-1 Product Type: SLC Sensor Mode: IW Relative Orbit Number: 21

	JS	Copernicus Open Access Hub	± 0 A
🗧 🗑 Insert search criteria		BQ	Al-Hast
Advanced Search		. × Clear	Antakya, Aleppo, Ar Raggah
* Sort By: Sensing Date	» Order By: Descending		Lataita
* Sensing period	2020/08/06	Bachos	Tartu: Hons Salamiyah
 Ingestion period Mission: Sentinel-1 		Cyprus Daphos Limator	Tritol Aarsa
Satellite Platform	Product Type	-	Damasus
Polarisation Relative Orbit Number (from 1 to	Sensor Mode	The state of the s	
Mission: Sentinel-2		- Netanya	Nablus
DD	•	Tel Aviv-Yato	Amman, ⁹ Zarqa

Then click on the "**Search**" icon. The search returns 3 results for the time period we set. We need to download them all, so we click on the "**Download Product**" icon of each one: $S1B_IW_SLC_1SDV_20200725T033445_20200725T033512_022622_02AEEE_A0BA$ $S1A_IW_SLC_1SDV_20200731T033531_20200731T033558_033693_03E7B2_D1A9$ $S1B_IW_SLC_1SDV_20200806T033445_20200806T033512_022797_02B43D_3A0B$



NOTE 1: Please keep in mind that you cannot download more than 2 products at the same time, per account from SciHub.

Return to the search menu and set the parameters for the two Sentinel-2 products we will need, one before and one after the explosion. **Deselect** Sentinel-1 mission and apply the following steps.

For Sentinel-2:

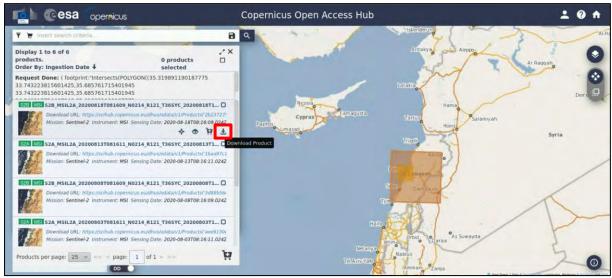
Sensing period: From 2020/07/24 to 2020/08/18 Select: Mission: Sentinel-2 Product Type: S2MSI2A

	Copernicus Open Access Hub	201
Insert search criteria.	E Q	
 Sensing period 2020/07/24 2020/08/18 		Ar Raggah
Ingestion period	Latavia	Der.
O Mission: Sentinel-1	Papiers Limaso	Hama Salamiyah
Satellite Platform Product Type	- Tripole	Syria
Polarisation Sensor Mode Relative Orbit Number (from 1 to Collection	- Britting Labour	
175)	Story Damäscus Tyre	2
Bission: Sentinel-2 Satellite Platform Product Type	Hato	./>
Relative Orbit Number (from 1 to 143)	9.4]) Vetanyo Mabius	Pas Suwayda
	Tel Avivyab Amman - Zan	qa 🔶 💿

Then click on the **"Search**" icon. The search returns 6 results for the time period and the area we set. If you draw a larger rectangle, you will have more results when searching. Download only the two

following images by clicking on the "**Download Product**" 上 icon:

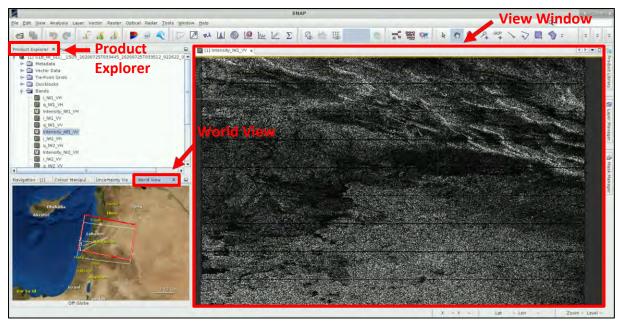
S2A_MSIL2A_20200724T081611_N0214_R121_T36SYC_20200724T110803 S2B_MSIL2A_20200818T081609_N0214_R121_T36SYC_20200818T110855



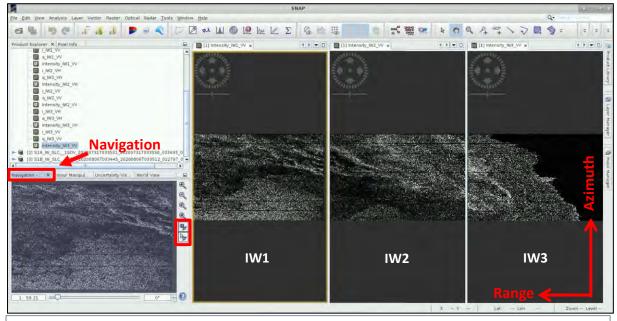
The products will be downloaded at */home/rus* as zip files. Move them to: */shared/Training/HAZA08_LebanonDamageAssessment/Original* folder.

5.2 SNAP – open and explore data

Open SNAP software from the icon located on the desktop or go to Applications \rightarrow Processing \rightarrow SNAP Desktop. Click the Open Product icon \frown , navigate to: /shared/Training/HAZA08_LebanonDa mageAssessment/Original folder and open all Sentinel-1 products (from oldest to the most recent). Alternatively, open a folder in your VM, navigate to the path mentioned above, drag the products from the folder one by one and drop them to the Product Explorer Window (first the 20200725, then the 20200731 and last the 20200806). The opened products will appear in Product Explorer window. Click + or \frown to expand the contents of product [1] from 25 July 2020, then expand Bands folder and double click on Intensity_IW1_VV band to visualize it in the View window. You can go to the World View tab and zoom in to see the location of the opened product on the globe (See \frown NOTE 2).



Open the *Intensity_IW2_VV* and *Intensity_IW3_VV* bands as well, and go to Window \rightarrow Tile Horizontally. Go to the Navigation tab and click on the two icons shown within the red rectangular below, to synchronize the views and the cursor position between the views. (See $\stackrel{\frown}{=}$ NOTE 3).



NOTE 2: The Interferometric Wide (IW) swath mode captures three sub-swaths using Terrain Observation with Progressive Scans SAR (TOPSAR). IW SLC products contain one image per sub-swath and one per polarisation channel, for a total of three (single polarisation) or six (dual polarisation) images in an IW product. Each sub-swath image consists of a series of bursts, where each burst has been processed as a separate SLC image. The images for all bursts in all sub-swaths are resampled to a common pixel spacing grid in range and azimuth while preserving the phase information. (Source: https://sentinel.esa.int/web/sentinel/user-guides/sentinel-1-sar/acquisition-modes/interferometric-wide-swath) The Beirut port is located on the IW3 sub-swath of the selected images.

NOTE 3: The RADAR instrument onboard Sentinel-1 carries an antenna that is looking always to the right during its pass. These two scenes were acquired during **descending** pass (the satellite was moving in direction from north to south). That is why we see that the view of the image appears as if "mirrored", because the view shows the pixels in order of the data acquisition.

5.3 Sentinel-1 Processing – Part 1

We will use the **GraphBuilder** tool, to create a chain with the steps of the processes we want to apply and at the end, only the final product will be physically saved (this way we will also save disk space since the products of the intermediate steps will not be stored).

In this part, we will reach up to the step where we will use two pairs of Sentinel-1 images, in order to create two coregistered products. The first pair will consist of the two images before the event, and the second pair will consist of the one image right before the event and the other one after it.

5.3.1 Graph Builder

Go to **Tools** \rightarrow **GraphBuilder** to build our graph.

We can see that the graph has only two operators: **Read** (to read the input) and **Write** (to write the output). Below there also are the corresponding to the operators' tabs.

Right-click on the **Write** operator and **Delete** it. The corresponding tab will be removed as well. This is to avoid confusion to the sequence of the graph. The **Write** operator will be added again at the end.

For now, we will not define any parameters in the tabs, we will first create the graph and then we will go tab by tab to insert the desired parameters. Follow the instructions written in **black** to build the graph and once it is ready, go back and insert the parameters written in purple. There will be a reminder and further instructions when you reach that step.

8	SHAP	1.24
Ele Edit View Analysis Layer Vector Raster Optical Radar Iools Windr	Graph Builder 🛛 🕫 🖂 🗙	Q. Santh-Ethick
	File Graphs	A MAATINDES :::
Broduct Explorer X Presi Info ID ■ ■ [1] 1518_1M, SLC_150V_00200725T033645_20200725T033512_022620, 20 ■ ■ [1] 1518_1M, SLC_150V_00200713T033513_20200731T033556_038649_008 ■ [2] 1518_1M, SLC_150V_00200806T033645_20200066T033512_022797_028 ■ [3] 1518_1M, SLC_150V_00200806T033645_20200066T033512_022797_028	Right-click on the operator and delete it	Product Ubravy
	Read Write Hight click here to add an operator	Lurer Hunager
I Navigation Colour Manipul. Uncertainty Vis World View X		in Maski Managari
Ohakalia (1990) Akrobit (1990) Tapat	Rand: Write Source Product Name: [1] S18_IM_SLC_1SDV_20200725T033445_20200725T039512_022422_02AEEE_A0BA	
Lanana	Data Fermat Any Fermat 💌	
of Sand Formed 100 Ry	💼 Load	X Y Lat Lon Zoom Level

5.3.2 Read the input products

There is only one **Read** operator in the graph (for the first product of the pair) and we will add one more, for the second product of the pair. Right-click at the empty white space below the **Read** operator and go to **Add** \rightarrow **Input-Output** \rightarrow **Read**. The **Read(2)** operator will be created. Place it below **Read**.

Read	
Read	
Read(2)	

In the **Read** tab, as Source Product, select the product with Name: S1B_IW_SLC__1SDV_20200725T033445_20200725T033512_022622_02AEEE_A0BA

Reau	Read(2)	TOPSAR-Split	TOPSAR-Split(2)	Apply-Orbit-File	Apply-Orbit-File(2)	Back-Geocoding	Enhanced-Spectral-D
Source P	Product						
Name:							
[1] SIB	IW SLC	1SDV_20200725	T033445_20200725	T033512_022622_	DZAEEE_AOBA		▼

In the **Read(2)** tab, as Source Product, select the product with Name: S1A_IW_SLC__1SDV_20200731T033531_20200731T033558_033693_03E7B2_D1A9

Read	Read(2)	TOPSAR-Split	TOPSAR-Split(2)	Apply-Orbit-File	Apply-Orbit-File(2)	Back-Geocoding	Enhanced-Spectral-D
Source	Product						
Name:							
[2] 51	A_IW_SLC_	1SDV_20200731	033531_20200731	T033558_033693_0	03E7B2_D1A9		
100000000							
Data F	ormat:	Any Format	1				

5.3.3 TOPS Split

Every Interferometric Wide swath (IW) consists of 3 sub-swaths and each one of maximum 9 bursts. In SNAP we can process only one swath at a time until the **Deburst** step. Our area of interest is located in the IW3 swath and is covered sufficiently by processing 2 bursts. We will use the **TOPSAR-Split** operator; this way we will reduce the total processing time.

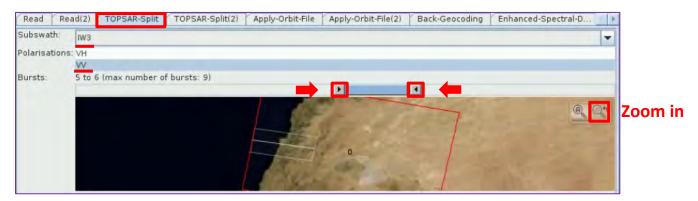
To add the **TOPSAR-Split** operator for the first product, right-click right of the **Read** operator and go to **Add** \rightarrow **Radar** \rightarrow **Sentinel-1 TOPS** \rightarrow **TOPSAR-Split**. Connect the **Read** operator to it by dragging the red arrow from the right side of **Read** operator towards the **TOPSAR-Split** operator.

Read TOPSAR-Split		
Read(2)		

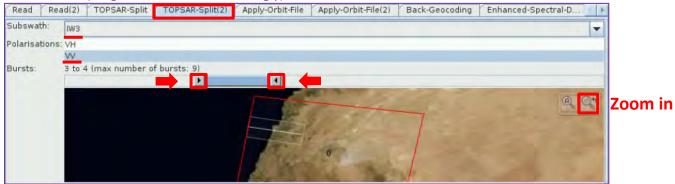
Repeat the same to add the TOPSAR-Split(2) operator and connect it with the Read(2) operator.

Read TOPSAR-Split	
topsar-split(2)	

In the **TOPSAR-Split** tab, **Zoom in** to the product and select: **Subswath:** IW3, **Polarisations:** VV, **Bursts:** 5 and 6 (drag the two sliders accordingly).



In the **TOPSAR-Split(2)** tab **Zoom in** to the product and select: **Subswath:** IW3, **Polarisations:** VV, **Bursts:** 3 to 4 (drag the two sliders accordingly).

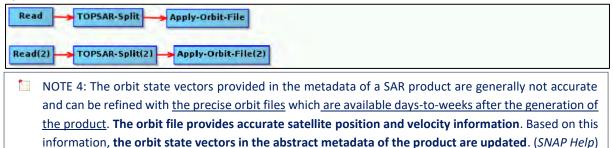


5.3.4 Apply Orbit File

Next, we will apply the updated orbits to the products (See \square NOTE 4). Right-click and go to Add \rightarrow Radar \rightarrow Apply-Orbit-File. Connect the TOPSAR-Split operator to it.

Read TOPSAR-Split Apply-Orbit-File	
Read(2) TOPSAR-Split(2)	

Repeat the same to add the **Apply-Orbit-File(2)** operator and connect it with the **TOPSAR-Split(2)** operator.



In both the **Apply-Orbit-File** tab and the **Apply-Orbit-File(2)** tab, we will keep the default settings, and make sure that you will **select** the "**Do not fail if new orbit file is not found**" option.

Read	Read(2)	TOPSAR-Split	TOPSAR-Split(2)	Apply-Orbit-File	Apply-Orbit-File(2)	Back-Geocoding	Enhanced-Spectral-D	F			
Orbit State Vectors		Sentinel Precise	e (Auto Download)					-			
Polynomial Degree:		3									
		Do not fail if	new orbit file is no	t found							
Read	Read(2)	TOPSAR-Split	TOPSAR-Split(2)	Apply-Orbit-File	Apply-Orbit-File(2)	Back-Geocoding	Enhanced-Spectral-D	*			
Orbit Sti	ate Vectors:	Sentinel Precise (Auto Download)									
Polynom	ial Degree:	3	3								
		Do not fail if	Do not fail if new orbit file is not found								

5.3.5 Back Geocoding

Now we will coregister the two products. Image coregistration is the alignment of master and slave images, the pixels of the slave images correspond to those of the master and represent an identical area. To add the **Back-Geocoding** operator right-click and go to **Radar** \rightarrow **Coregistration** \rightarrow **S-1 TOPS Coregistration** \rightarrow **Back-Geocoding**. Connect both **Apply-Orbit-File** and **Apply-Orbit-File(2)** operators to it.



In the **Back-Geocoding** tab set: **Digital Elevation Model:** SRTM 1Sec HGT (Auto Download), **select** the "**Output Deramp and Demod Phase**" option as well and leave the rest parameters as by default.

Read	Read(2)	TOPSAR-Split	TOPSAR-Split(2)	Apply-Orbit-File	Apply-Orbit-File(2)	Back-Geocoding	Enhanced-Spectral-D	F	
Digital Elevation Model: DEM Resampling Method:		SRTM 1Sec HGT	SRTM 1Sec HGT (Auto Download)						
		BICUBIC_INTERP	OLATION				-		
Resamp	Resampling Type:		BISINC_5_POINT	BISINC_5_POINT_INTERPOLATION					
Mas	k out areas	with no elevation							
V Outp	out Deramp	and Demod Phas	e						
🗌 Disa	ble Reramp	e							

5.3.6 Enhanced Spectral Diversity

This operator follows the **Back-Geocoding** operator, it first estimates a constant range offset for each burst using a small block of data in the center of the burst and then it estimates a constant azimuth offset. Finally, the estimates from all bursts are averaged to get the final constant range and azimuth offset for the whole image.

To add the **Enhanced-Spectral-Diversity** operator right-click and go to **Radar** \rightarrow **Coregistration** \rightarrow **S-1 TOPS Coregistration** \rightarrow **Enhanced-Spectral-Diversity**. Connect the **Back-Geocoding** operator to it.

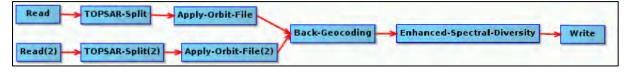


In the **Enhanced-Spectral-Diversity** tab keep all the default parameters.

d Read(2) TOPSAR-Split TOPSAR-Split) Apply-Orbit-File Apply-	Orbit-File(2) Back-Geoco	ding Enhanced-Spectral-Diversity
Registration Window Width:	512		-
Registration Window Height:	512		
Search Window Accuracy in Azimuth Direction:	16		-
Search Window Accuracy in Range Direction:	16		~
Window oversampling factor:	128		-
Cross-Correlation Threshold:			0.1
Coherence Threshold for Outlier Removal:			0.15
Number of Windows Per Overlap for ESD:			10
🔲 Use user supplied range shift (please entr	r it below)		
The overall range shift in pixels:			0.0
Use user supplied azimuth shift (please en	ter it below)		
The overall azimuth shift in pixels:			0,0

5.3.7 Write – create the output

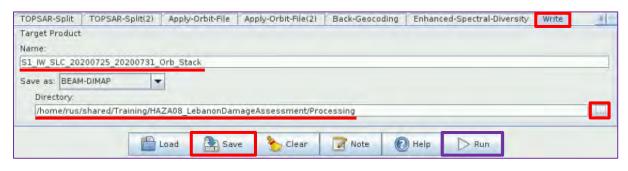
To add the Write operator right-click and go to Add \rightarrow Input-Output \rightarrow Write. Connect the Enhanced-Spectral-Diversity operator to it.



In the **Write** tab set the following:

Name: S1_IW_SLC_20200725_20200731_Orb_Stack

Directory: */shared/Training/HAZA08_LebanonDamageAssessment/Processing* (Click on the icon to set the appropriate path).



Click on the click on the click on the graph for future use.

Go to the: /shared/Training/HAZA08_LebanonDamage Assessment/AuxData folder and save it with the name: Graph_S1_part1.

Now go all the way up to the purple parts of the chapters
5.3.2 to 5.3.7, fill the tabs with the appropriate parameters
and finally click Run .

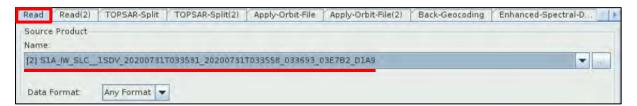
	SNAP - Save Graph	- E X
Save In:	AuxData	- a 88 5-
File Name:	Graph_S1_part1.xml	
Files of Type:	Graph (*.xml)	•
		Save Cancel

Once the processing is completed, the coregistered product will appear at the **Product Explorer** Window.

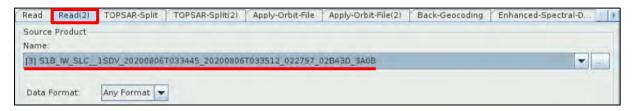
5.3.8 Repeat chapters 5.3.2 to 5.3.7

We will now keep the same graph we have built, opened, and we will go again tab by tab, to set the new parameters in each one, so that we create the coregistered product of the second pair of images.

In the **Read** tab, as Source Product, select the product with Name: S1A_IW_SLC__1SDV_20200731T033531_20200731T033558_033693_03E7B2_D1A9



In the **Read(2)** tab, as Source Product, select the product with Name: S1B_IW_SLC__1SDV_20200806T033445_20200806T033512_022797_02B43D_3A0B



In the **TOPSAR-Split** tab **Zoom in** to the product and select: **Subswath:** IW3, **Polarisations:** VV, **Bursts:** 3 to 4 (drag the two sliders accordingly).

Read	Read	() TOPSAR-Sp	t TOPSAR-Split(2)	Apply-Orbit-File	Apply-Orbit-File(2)	Back-Geocoding	Enhanced-Spectral-D	1 B
Subswat	th: IW	3						-
Polarisa	tions: VH							
	W	1						
Bursts:	31	o 4 (max numbe						
	-				and the second second			
							R.	🔣 🛛 Zoom i
				2.5				
					4			
					1000			10
					L JER			
				100	0			

In the **TOPSAR-Split(2)** tab **Zoom in** to the product and select: **Subswath:** IW3, **Polarisations:** VV, **Bursts:** 4 to 5 (drag the two sliders accordingly).

Read	Read(2)	TOPSAR-Split	TOPSAR-Split(2)	Apply-Orbit-File	Apply-Orbit-File(2)	Back-Geocoding	Enhanced-Spectral-D		
Subswat	h: IW3							-	
Polarisat	tions: VH								
	W								
Bursts:	4 to	5 (max number o	of bursts: 9)						
	20.				the second s	and the second	(R)	Zo	i.
							(ef	200	om iı
				- 3		7			
				A Shall	0				
				A 18	the second				

In both the **Apply-Orbit-File** tab and the **Apply-Orbit-File(2)** tab, we will keep the default settings, and make sure that you will **select** the **"Do not fail if new orbit file is not found"** option.

Read	Read(2)	TOPSAR-Split	TOPSAR-Split(2)	Apply-Orbit-File	Apply-Orbit-File(2)	Back-Geocoding	Enhanced-Spectral-D	F				
Orbit St	tate Vectors:	Sentinel Precise	e (Auto Download)					-				
Polynor	Polynomial Degree:	3										
		Do not fail if	new orbit file is no	t found								
Read	Read(2)	TOPSAR-Split	TOPSAR-Split(2)	Apply-Orbit-File	Apply-Orbit-File(2)	Back-Geocoding	Enhanced-Spectral-D	*				
Orbit St	tate Vectors:	Sentinel Precis	Sentinel Precise (Auto Download)									
Polynor	nial Degree:	3	3									
		✔ Do not fail if new orbit file is not found										

In the **Back-Geocoding** tab set again: **Digital Elevation Model:** SRTM 1Sec HGT (Auto Download), **select** the "**Output Deramp and Demod Phase**" option as well and leave the rest parameters as by default.

Read	Read(2)	TOPSAR-Split	TOPSAR-Split(2)	Apply-Orbit-File	Apply-Orbit-File(2)	Back-Geocoding	Enhanced-Spectral-D.	F		
Digital E	levation Mo	del:	SRTM 1Sec HGT	(Auto Download)				-		
DEM Re	sampling M	ethod:	BICUBIC_INTERP	OLATION				-		
Resamp	EM Resampling Method: esampling Type: Zi Mask out areas with no elevatio		BISINC_5_POINT_INTERPOLATION							
Mas	k out areas	with no elevation	-							
V Out	put Deramp	and Demod Phas	e							
Disa	able Reramp	3								

In the **Enhanced-Spectral-Diversity** tab keep all the default parameters.

d Read(2) TOPSAR-Split TOPSAR-Split(2) Apply-Orbit-File	Apply-Orbit-File(2)	Back-Geocoding	Enhanced-Spectral-Diversity	10 10
Registration Window Width:	512				-
Registration Window Height:	512				-
Search Window Accuracy in Azimuth Direction:	16				-
Search Window Accuracy in Range Direction:	16				-
Window oversampling factor:	128				-
Cross-Correlation Threshold:					0.1
Coherence Threshold for Outlier Removal:				G	3.15
Number of Windows Per Overlap for ESD:					10
🔲 Use user supplied range shift (please entr	er it below)				
The overall range shift in pixels:					0.0
Use user supplied azimuth shift (please er	nter it below)				
The overall azimuth shift in pixels:	[0.0

In the Write tab set the following:

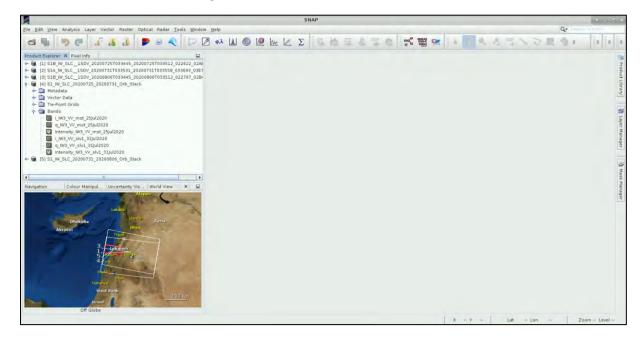
Name: S1_IW_SLC_20200731_20200806_Orb_Stack

Directory: /shared/Training/HAZA08_LebanonDamageAssessment/Processing

TOPSAR-Split	TOPSAR-Split(2)	Apply-Orbit-File	Apply-Orbit-File(2)	Back-Geocoding	Enhanced-Spectral-Diversity	Write	.4 1
Target Product	91 A						
Name:							
S1_IW_SLC_20	200731_20200806_	Orb_Stack					
Save as: BEAM	I-DIMAP						
Directory:							
/home/rus/	/shared/Training/HA	ZA08 LebanonDar	mageAssessment/Pro	cessing			1000
	-5						
		Load Sa	ve 🍾 Clear	🖉 Note 🛛 💽	Help Run		

Click **Run**. Once the processing is completed, the coregistered product will appear at the **Product Explorer** Window as well.

If we now expand the **Bands** folder of both the coregistered products, we will see that they contain the information of both the images used.



5.4 Sentinel-1 Processing – Part 2

In this part of the Sentinel-1 processing, we will create another graph where we will apply the necessary steps on the two coregistered products, in order to have them ready to extract the information showing the damage caused at the area due to the explosion. First, we will perform it for the coregistered product with the images before the event, and then for the coregistered product with the one after the event.

5.4.1 Graph Builder

Let's go again to **Tools** \rightarrow **GraphBuilder**, right-click on the **Write** operator and **Delete** it. This time we can set the parameters in each tab, along with the creation of the corresponding operator.

In the Read tab, as Source Product, select the product with Name:

S1_IW_SLC_20200725_20200731_Orb_Stack

Read	Coherence	TOPSAR-Deburst	Multilook	Terrain-Correction	Subset	Write	
Source	e Product						
Name:							
[4] 51	IW_SLC_2020	0725_20200731_Orb	Stack				▼
	-						
Data	Format: A	ny Format					

5.4.2 Coherence Estimation

Since we are having in the coregistered product the *Intensity* bands of both products, we will use the **Coherence** operator, to estimate how well "correlated" the pixels between the master and slave images used, are. Right-click and go to Add \rightarrow Radar \rightarrow Interferometric \rightarrow Products \rightarrow Coherence. Connect the Read operator to it.

Read Coherence

In the **Coherence** tab, set as **Coherence Range Window Size**: 20 and the **Coherence Azimuth Window Size** will automatically turn to 5.

Read	Coherence	TOPSAR-Deburst	Multilook	Terrain-Correction	Subset	Write	
Sing	le Master						
Subt	tract flat-earth	phase					
Degree	of "Flat Earth"	polynomial					-
Number	of "Flat Earth"	estimation points	-				-
Orbit int	erpolation deg	ree					
Subt	tract topograph	nic phase					
Digital E	levation Model:						-
Tile Exte	ension [%]	5	0				
Squa	are Pixel	E	Independe	nt Window Sizes			
Coheren	ice Range Wind	low Size 2	0				
Coheren	ice Azimuth Wir	ndow Size 5					

5.4.3 TOPS Deburst

Now we will remove the "black space" between the two bursts (See \square NOTE 5). To add the **TOPSAR-Deburst** operator right-click and go to Add \rightarrow Radar \rightarrow Sentinel-1 TOPS \rightarrow TOPSAR-Deburst. Connect the **Coherence** operator to it.

In the TOPSAR-Deburst tab keep the default settings (Polarizations: VV).



NOTE 5: There is overlapping information in every burst with its neighbouring ones, both in range and azimuth direction in order to provide contiguous coverage of the ground. Until now each burst has been processed as a separate SLC image We will merge the bursts (in azimuth direction) and preserve the phase information as well. For the overlapping region in range, merging is done between subswaths.

5.4.4 Mulitlooking

By applying this operator, we will reduce the inherent speckle noise that originally appears to the SAR images and we will obtain square pixels. To add the **Multilook** operator right-click and go to Add \rightarrow Radar \rightarrow SAR Utilities \rightarrow Multilook. Connect the **TOPSAR-Deburst** operator to it.

Read - Coherence - TOPSAR-Deburst - Multilook

In the **Multilook** tab keep the "**GR Square Pixel**" option selected and set **Number of Range Looks**: 8. The **Number of Azimuth Looks** will change to 2 and the **Mean GR Square Pixel** to 27.348389.

Read	Coherence	TOPSAR-Deburst	Multilook	Terrain-Correction	Subset	Write			
Source E	Bands:	coh_IW3_VV_25J	ul2020_31Jul;	2020					
GR S	iquare Pixel	Independent Looks							
Number	of Range Looks:	8							
Number	of Azimuth Look	5: 2							
Mean GR	R Square Pixel:	27.348389							
Outp	ut Intensity	Note: Detection is done without		data					

5.4.5 Geocoding – Terrain Correction

We will apply the **Terrain Correction** operator, to convert the RADAR coordinates into geographic. To add the **Terrain-Correction** operator, right-click and go to **Radar** \rightarrow **Geometric** \rightarrow **Terrain Correction** \rightarrow **Terrain-Correction**.



In the **Processing Parameters** tab keep the default parameters.

ť	Coherence	TOPSAR-Deburst	Multilook	Terrain-Correction	Subset	Write					
	Source Band	ls:	coh_IW	coh_IW3_VV_25Jul2020_31Jul2020							
	Digital Eleva	tion Model:	SRTM :	3Sec (Auto Download)							
	DEM Resamp	oling Method:	BILINE	AR_INTERPOLATION			-				
	Image Resar	mpling Method:	BILINE	AR_INTERPOLATION			-				
		ixel Spacings (az x rg): 27,83(r	27.83(m) x 26.86(m)							
	Pixel Spacing		13.92								
	Pixel Spacing	g (deg):	1.2504	1.2504548754943738E-4							
	Map Projecti	on:		WGS	(84(DD)						
	Output ban	: areas without elevat ds for: d source band	ion 🔲 Out	put complex data	atitude & L	ongitude					
		e angle from ellipsoi	d 🗌 Local	incidence angle 🔲 P	rojected lo	cal incide	ence angle				
	Apply rad	diometric normalizatio	in								
	Save	Sigmaŭ band		1.0.1.0.0.0.0	10	- 0.E)	-				
	Save	Gammaŭ band	1000	y to the thereber	0.0	0.511	-				
	Save	Betat band	-								
	Aurilliary File	LANTAR CALLS	1				1-				

5.4.6 Subset

We will now create a Subset of the product, since we do not need the whole extent of it. You can set a different area according to your needs, or even skip the Subset step and keep the whole extent. To add the **Subset** operator, go to Add \rightarrow Raster \rightarrow Geometric \rightarrow Subset.

```
Read - Coherence TOPSAR-Deburst - Multilook - Terrain-Correction - Subset
```

At the **Subset** tab, select the **Geographic Coordinates** option. Copy the WKT (well know text) shown below from the */shared/Training/HAZA08_LebanonDamageAssessment/AuxData/Expressions* folder and paste it to the text window below the map.

```
POLYGON ((35.46431271053535 33.92680438517669, 35.57418094686884
33.92680438517669, 35.57418094686884 33.85970773162247, 35.46431271053535
33.85970773162247, 35.46431271053535 33.92680438517669))
```

1				Expressions	- Mousepad	• = = ×
file	Edit	Search	View	Document	Help	
35	5.5741 3.8597	8094686	884 33 247,	.9268043851 35.4643	33.9268043851 7669, 35.57 1271053535 0438517669))	52247,

Click **Update** and then click the **Zoom-in** icon to see your subset on the map.

Read	Coherence	TOPSAR-Deburst	Multilook	Terrain-Correction	Subset	Write			
Source E	Bands:	coh_IW3_VV_25Jul202	20_31jul2020						
	y Metadata I Coordinates ce band:	Geographic Coor		in the second				1-	
			•		C.	No.		Q. C.	Zoom i
35.4643	1271053535	33.8597077	3162247.	35.464312710	53535	33.92	68043	Update	

5.4.7 Write – create the output

To create the output of this processing, we will add the **Write** operator. Right-click and go to $Add \rightarrow$ **Input-Output** \rightarrow **Write**. Connect the **Subset** operator to it.

Read Coherence TOPSAR-Deburst Multilook Terrain-Correction Subset Write

In the Write tab set the following:

Name: S1_IW_SLC_20200725_20200731_Orb_Stack_Coh_Deb_ML_TC_Subset **Directory:** /shared/Training/HAZA08_LebanonDamageAssessment/Processing

Target Product Name: S1_IW_SLC_20200725_20200731_Orb_Stack_Coh_Deb_ML_TC_Subset Save as: BEAM-DIMAP Directory: //home/rus/shared/Training/HAZA08_LebanonDamageAssessment/Processing	Read	Coherence	TOPSAR-Deburst	Multilook	Terrain-Correction	Subset	Write	
S1_IW_SLC_20200725_20200731_Orb_Stack_Coh_Deb_ML_TC_Subset Save as: BEAM-DIMAP Directory:	Target	Product						
Save as: BEAM-DIMAP Directory:	Name:							
Directory:	S1_IW	SLC_20200725	20200731 Orb Sta	ck_Coh_Deb	ML_TC_Subset			
	Save a	s: BEAM-DIMA	p 👻					
/home/rus/shared/Training/HAZA08 LebanonDamageAssessment/Processing	Dire	ectory:						
	/ho	me/rus/share	d/Training/HAZA08_L	ebanonDam	ageAssessment/Proce	essing		
		P .	oad Save	Cle	ar 📝 Note	Help	> Run	3
📄 Load 🔍 Save 🍾 Clear 🏹 Note 🕥 Help 🕞 Run						9		

Click on the control icon to save the graph for future use. Go to the: /shared/Training/HAZA08_Leba nonDamageAssessment/AuxData folder and save it with the name: **Graph_S1_part2**.

Click **Run**. Once the processing is completed, the product will appear at the **Product Explorer** Window.

5.4.8 Repeat chapters 5.4.2 to 5.4.7

We will now keep the same graph we have built, opened, and we will go again tab by tab, to set the new parameters in each one, so that we will extract the information showing the damage caused at the area due to the explosion, of the second coregistered product (with the one image before and the one after the event). Let's go all the way up to the chapters 5.4.1 to 5.4.7.

In the **Read** tab, as Source Product, select the product with Name: *S1_IW_SLC_20200731_20200806_Orb_Stack*

Read	Coherence	TOPSAR-Deburst	Multilook	Terrain-Correction	Subset	Write	
Source	Product						
Name:							
[5] 51	IW_SLC_2020	0731_20200806_Orb	Stack				-
-	F	ny Format 💌					

In the **Coherence**, **TOPSAR-Deburst**, **Multilook** and **Terrain-Correction** tabs, keep the same parameters as before. Check each one to make sure they have not been modified.

Read Coherence TOPSAR-Deburst M	ultilook Terrain-Correction Subset Write	
Single Master		
Subtract flat-earth phase		
Degree of "Flat Earth" polynomial		-
Number of "Flat Earth" estimation points		-
Orbit interpolation degree		
Subtract topographic phase		
Digital Elevation Model:		1-
Tile Extension [%]		1.
Square Pixel	dependent Window Sizes	
Coherence Range Window Size 20		
Coherence Azimuth Window Size 5		
Read Coherence TOPSAR-Deburst M	ultilook Terrain-Correction Subset Write	
Polarisations: WV		
Read Coherence TOPSAR-Deburst M	ultilook Terrain-Correction Subset Write	
Source Bands: coh IW3 VV 31Jul20		
	Come and the second sec	
GR Square Pixel Independent Loo	ks	
Number of Range Looks: 8		
Number of Azimuth Looks: 2		
Mean GR Square Pixel 27.341093		
Output Intensity		
Note: Detection for is done without resa		
Read Coherence TOPSAR-Deburst M	ultilook Terrain-Correction Subset Write	
Source Bands.	coh 1W3 VV 25jul2020 31jul2020	1
DECKS ZANZEN	con_ms_vv_zsjaizozo_szjaizozo	
Digital Elevation Model:		
	SRTM 3Sec (Auto Download)	- I
DEM Resampling Method:	BILINEAR_INTERPOLATION	-
Image Resampling Method:	BILINEAR_INTERPOLATION	-
Source GR Pixel Spacings (az x rg):	27.83(m) x 26.86(m)	
Pixel Spacing Im!	13.92	
Pixel Spacing (deg):	1.2504548754943738E-4	
Map Projection:	WGS84(DD)	
Mask out areas without elevation	Output complex data	

In the **Subset** tab, keep the same parameters as before. Copy again the WKT (well know text) from the /shared/Training/HAZA08_LebanonDamageAssessment/AuxData/Expressions folder and paste it to the text window below the map.

Read
Coherence
TOPSAR-Deburst
Multilook
Terrain-Correction
Subset
Write

Source Bands:

Coh_IW3_VV_25Jul2020_31Jul2020

Copy Metadata

Pixel Coordinates

Geographic Coordinates
Reference band:

Control

Source Deburst

Source Bands:

Source Bands:

Copy Metadata

Source Deburst

Pixel Coordinates

Second Integration

Source Deburst

Source Bands:

Copy Metadata

Source Deburst

Source Deburst

Source Deburst

Source Deburst

Source Deburst

Write

Source Deburst
Write
Source Deburst
Write
Source Deburst
Write
Source Deburst
Write
Source Deburst
Write
Source Deburst
Write
Source Deburst
Write
Source Deburst
Write
Source Deburst
Write
Source Deburst
Write
Source Deburst
Write
Source Deburst
Write
Source Deburst
Write
Source Deburst
Write
Source Deb

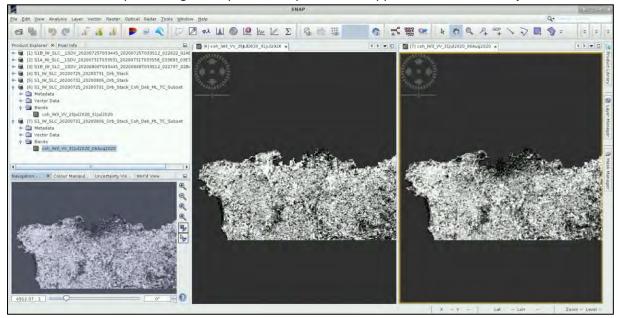
Click **Update** and then click the **Zoom-in** icon see your subset on the map.

In the Write tab set the following:

Name: S1_IW_SLC_20200731_20200806_Orb_Stack_Coh_Deb_ML_TC_Subset **Directory:** /shared/Training/HAZA08_LebanonDamageAssessment/Processing

Read	Coherence	TOPSAR-Deburst	Multilook	Terrain-Correction	Subset	Write	
Target	Product					-	
Name:							
S1_IW	SLC_2020073	_20200806_Orb_Sta	ack_Coh_Deb	_ML_TC_Subset			
Save a	s: BEAM-DIMA	P 🔻					
Dire	ectory:						
/ho	me/rus/share	d/Training/HAZA08_L	ebanonDam	ageAssessment/Proce	essing		
_			3. F T				
	P L	oad Save	Cle	ar 🛛 🖉 Note	() Help	> Run	
			1 100		e	K	

Click **Run**. Once the processing is completed, the product will appear at the **Product Explorer** Window.



5.5 Sentinel-1 Processing – Part 3

Now that we have created both final products that include the bands with the estimated coherence, we need to put them into one, in order to be allowed to apply the Change Detection operator. To do so, we will use the Create Stack operator.

5.5.1 Create Stack

Go to Radar \rightarrow Coregistration \rightarrow Stack Tools \rightarrow Create Stack.

In the **1-ProductSet-Reader** tab, click on **Add Opened**, and all the products that are opened in the **Product Explorer** Window will be loaded. We need to keep only the last two. Select all the previous ones, and click on the sicon to remove them.

Once there are only the 2 products that we want to stack, click on the Refresh elicon. The relative information will appear at the rest fields as shown below.

0		Create Stack			1 0 E 3
1-ProductSet-Reader 2-	-CreateStack	3-Write			
File Name	Туре	Acquisition	Track	Orbit	
S1_IW_SLC_20200725_20		25Jul2020	21	22622	음
S1_IW_SLC_20200731_20	SLC	31Jul2020	21	33693	
					국
					-
					不
					-
					-
					٠
					*
					*
					*
					* * *
					*
					ے ب ک ک 2 Products

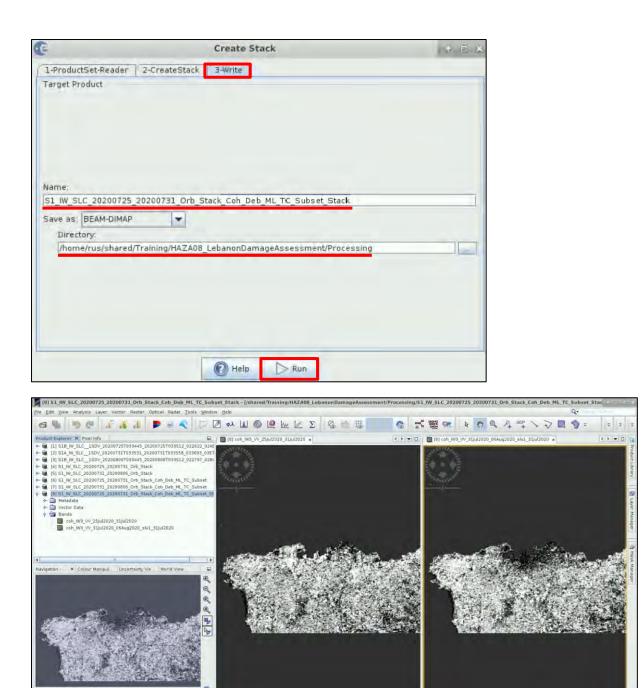
In the **2-CreateStack** tab, set as **Initial Offset Method**: Product Geolocation, and keep the rest parameters as by default.

e		Create Stack	* E X
1-ProductSet-Reader	2-CreateStack	3-Write	
Master:	S1_IW_SLC_202	00725_20200731_Orb_Stack_Coh_De	b_ML_TC_Subset
Resampling Type:	NONE		T
Initial Offset Method:	Product Geolo	ation	•
Output Extents:	Master		*
Find Optimal Master			

In the Write tab set the following:

Name: S1_IW_SLC_20200725_20200731_Orb_Stack_Coh_Deb_ML_TC_Subset_Stack **Directory:** /shared/Training/HAZA08_LebanonDamageAssessment/Processing

Click **Run**. The Stack product that will contain the coherence bands of both final products, will appear at the **Product Explorer** Window.



5.5.2 Change Detection

This is the final step, where we will detect the changes between the two coherence images, and the result of it will show us the damage caused due to the explosion.

Go to Radar → SAR Applications → Change Detection.

In the I/O Parameters tab set the following:

Source: S1_IW_SLC_20200725_20200731_Orb_Stack_Coh_Deb_ML_TC_Subset_Stack Name: S1_IW_SLC_20200725_20200731_Orb_Stack_Coh_Deb_ML_TC_Subset_Stack_change Directory: /shared/Training/HAZA08_LebanonDamageAssessment/Processing

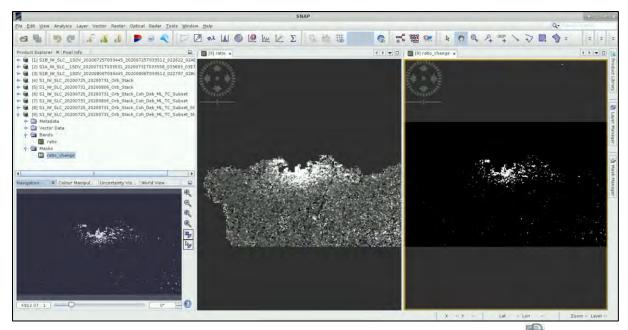
e	Change Detection	* *
ile Help		
I/O Parameters	Processing Parameters	
Source Product source:		
[8] S1_IW_SLC_	20200725_20200731_Orb_Stack_Coh_Deb_ML_TC_	Subset_Stack
Target Product Name: S1_IW_SLC_202 Save as: B Directory:	200725_20200731_Orb_Stack_Coh_Deb_ML_TC_Sub	oset_Stack_change
-	shared/Training/HAZA08 LebanonDamageAssessn	nent/Processing
Open in SN		
-		
		<u>R</u> un <u>C</u> lose

In the **Processing Parameters** tab keep the default parameters and click **Run**.

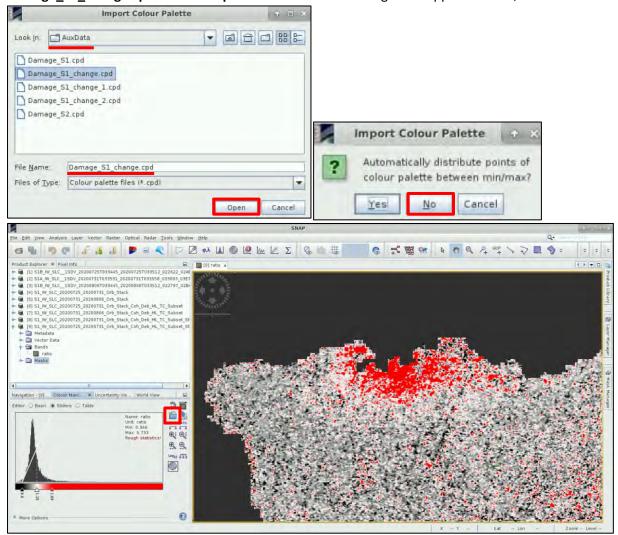
e	Change Detection	* = ×
File Help		
I/O Parameters Pro	cessing Parameters	
	coh_IW3_VV_25jul2020_31jul2020 coh_IW3_VV_31jul2020_06Aug2020_slv1_31jul2020	
Source Bands:		
Mask upper threshold:		2.0
Mask lower threshold:		-2.0
Include source ban	ds	
Output Log Ratio		
	<u>R</u> ur	<u>C</u> lose

The product with the change detection result will appear at the **Product Explorer** Window. Expand the *Bands* folder and double click on the *ratio* band to open it at the **View** Window. You can also expand the *Masks* folder and open the *ratio_change* band.

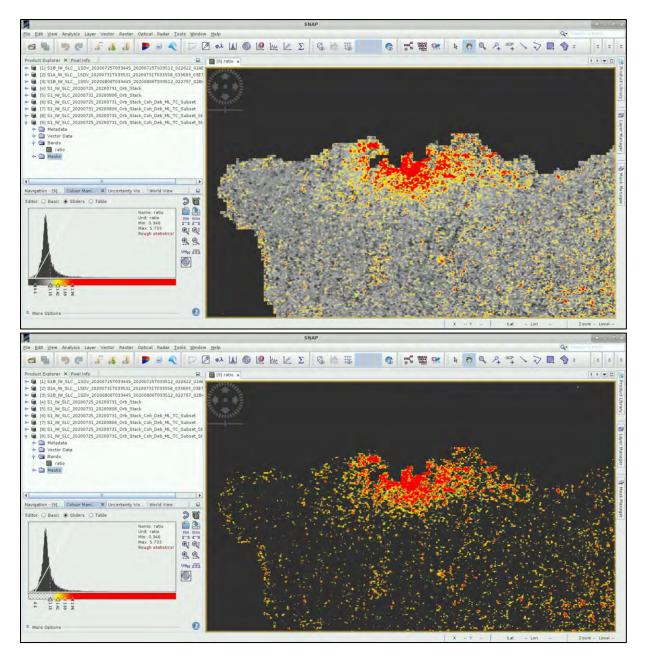
We will work with the *ratio* band, but you can apply the following steps to the *ratio_change* band if you wish as well.



Go to the Colour Manipulation tab on the left and click on the **Import Colour Palette** icon. Then, navigate to the */shared/Training/HAZA08_LebanonDamageAssessment/AuxData* folder, select the **Damage_S1_change.cpd** and click **Open**. At the window message that appears below, click **No**.



Repeat the last step. Open the palettes Damage_S1_change_1.cpd and Damage_S1_change_2.cpd.



5.5.3 Export Sentinel-1 product

A	SNAP - Export Product	+ = ×
Save in:	Processing	
S1_IW_SLC S1_IW_SLC S1_IW_SLC	_20200725_20200731_Orb_Stack.data _20200725_20200731_Orb_Stack_Coh_Deb_ML_ _20200725_20200731_Orb_Stack_Coh_Deb_ML_ _20200725_20200731_Orb_Stack_Coh_Deb_ML_ _20200731_20200806_Orb_Stack.data	TC_Subset_Stack.data
	_20200731_20200806_Orb_Stack_Coh_Deb_ML_	TC_Subset.data
S1_IW_SLC	_20200731_20200806_Orb_Stack_Coh_Deb_ML_	TC_Subset.data
S1_IW_SLC		

Select the S1_IW_SLC_2020 0725_20200731_Orb_Stack _Coh_Deb_ML_TC_Subset_ Stack_change product and go to File → Export → GeoTIFF.

The **File Name** will be set to S1_IW_SLC_20200725_2020 0731_Orb_Stack_Coh_Deb_ ML_TC_Subset_Stack_chang e.tif.

At the **Save in** field, set the Click **Export Product**

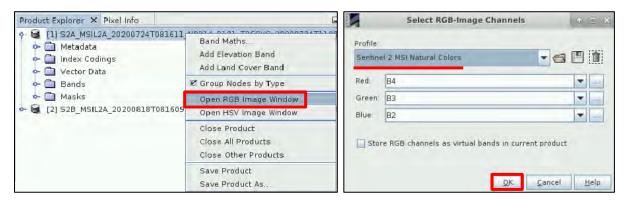
/shared/Training/HAZA08_LebanonDamageAssessment/Processing path. Click Export Product.

5.6 Sentinel-2 Processing – Part 1

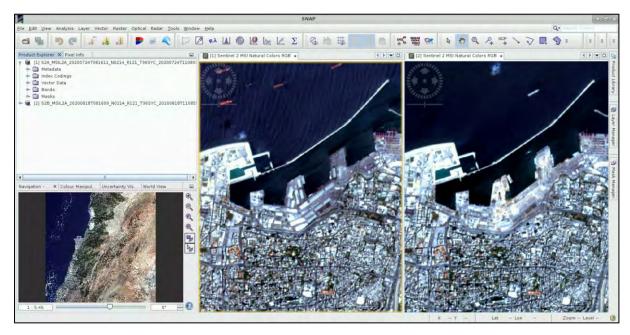
Close SNAP and reopen it, to load the Sentinel-2 products this time. First load the product before the event, *S2A_MSIL2A_20200724T081611_N0214_R121_T36SYC_20200724T110803* and then the one after the event, *S2B_MSIL2A_20200818T081609_N0214_R121_T36SYC_20200818T110855*.

5.6.1 Create RGB image

Right click on the first product and select **Open RGB Image Window**. At the Profile, select: **Sentinel 2 MSI Natural Colours**. The B4, B3 and B2 bands will be selected. Click **OK**. Right click at the second product as well and open another RGB image.

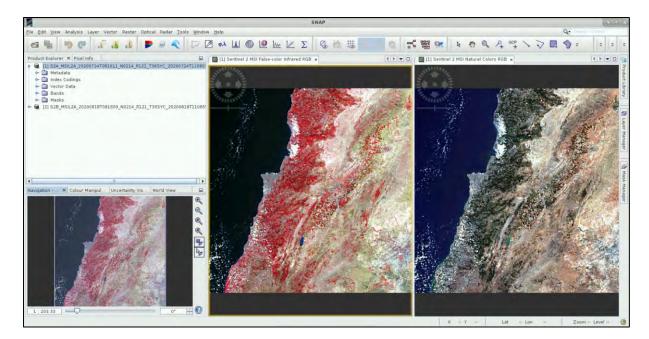


Go to **Window** \rightarrow **Tile Horizontally** to see the two RGB images created side by side. If we zoom in over the area of the port, we can clearly see the damages on the right one.



We can close the second image, and right click again on the first one to create another RGB image. This time, at the Profile select: **Sentinel-2 MSI False-Colour Infrared**. The B8, B4 and B3 bands will be selected. Click **OK**.

We see the different result B8 (NIR) is giving us and this is the band we will use to detect the changes over the area once we complete all the pre-processing steps.



5.6.2 Graph Builder

We will create again a Graph, where we will insert all the necessary operators, in order to prepare our data for the damage assessment. First, we will apply it for the product before the event and then we will repeat it for the product after the event. Go to **Tools** \rightarrow **GraphBuilder**. Right-click on the **Write** operator and **Delete** it.

5.6.3 Read inputs

We will set the parameters in each tab along with the operators.

Read

In the **Read** tab, as Source Product, select the product with Name: S2A_MSIL2A_20200724T081611_N0214_R121_T36SYC_20200724T110803

Read Resamp	le Subset Write
Source Product-	
Name:	
[1] S2A_MSIL2A_	20200724T081611_N0214_R121_T36SYC_20200724T110803
Data Format:	Any Format

5.6.4 Resample

We then need to resample all the Bands so that they have a common resolution, otherwise we cannot proceed with the next steps. To add the **Resample** operator, right-click and go to Add \rightarrow Raster \rightarrow Geometric \rightarrow Resample. Connect the Read operator to it.

In the **Resample** tab, select under the "Define size of resampled product" select the option: **By reference band from source product** and then select **B2**. This way we will resample all the bands in 20m. If you want to resample them in e.g. 10m, you can select the B1 band.

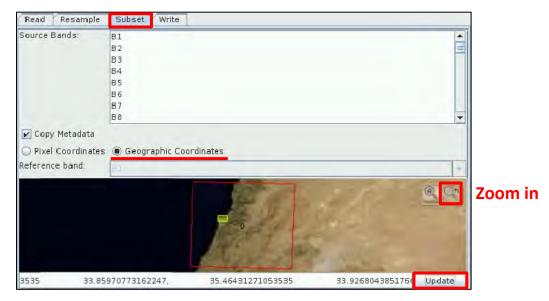
Read	Resample	Subset Write		
Defin	e size of resa	mpled product		
			B2	-
🖲 By	reference ba	nd from source produc	Resulting target width:	10980
			Resulting target height.	10980

5.6.5 Subset

We will now create a Subset of the first product, as we did for the Sentinel-1 product before. To add the **Subset** operator, go to Add \rightarrow Raster \rightarrow Geometric \rightarrow Subset.

Read Resample Subset	
----------------------	--

At the **Subset** tab, select the **Geographic Coordinates** option and copy the WKT (well know text) from the */shared/Training/HAZA08_LebanonDamageAssessment/AuxData/Expressions* folder as mentioned before and paste it to the text window below the map.



Click **Update** and then click the **Zoom-in** icon see your subset on the map.

5.6.6 Write – create the outputs

To create the output of this processing, we will add the **Write** operator. Right-click and go to Add \rightarrow **Input-Output** \rightarrow **Write**. Connect the **Subset** operator to it.

Read Resample Subset Write

In the Write tab set the following:

Name: S2_MSIL2A_20200724_resampled_subset **Directory:** /shared/Training/HAZA08_LebanonDamageAssessment/Processing

Target Produ	uct							
Name:								
S2 MSILZA	20200724_r	esampled	subset					
Save as: BE	EAM-DIMAP	-						
Directory	ĸ							
/home/ru	us/shared/T	raining/HA3	ZA08_Leba	nonDamag	geAssessme	nt/Processin	ġ	

Click on the contoning/HAZA08_Leba icon to save the graph for future use. Go to the: /shared/Training/HAZA08_Leba nonDamageAssessment/AuxData folder and save it with the name: **Graph_S2**.

Click **Run**. Once the processing is completed, the product will appear at the **Product Explorer** Window.

5.6.7 Repeat chapters 5.6.3 to 5.6.6

Now let's repeat the same steps for the second product.

In the **Read** tab, as Source Product, select the product with Name: S2B_MSIL2A_20200818T081609_N0214_R121_T36SYC_20200818T110855

Read Resample Source Product	Subset Write	
Name:		
[2] S2B_MSIL2A_	0200818T081609_N0214_R121_T36SYC_20200818T110855	•

In the **Resample** and **Subset** tabs, keep the same parameters as before. Check each one to make sure they have not been modified.

Read	Resample	Subset	Write							
Defin	e size of resa	mpled prod	luct		B2				-	
By	/ reference ba	and from so	ource pr	oduct:		arget width: arget height.	10980			
					Resulting to	arget neight.	10300			l
Read	Resample	Subset	Write]]
Source	Bands: y Metadata	B1 B2 B3 B4 B5 B6 B7 B8								
	l Coordinates ce band:	Geogr.	aphic Co		9		Startes	۹		Zoom in
3535	33.85	970773162	247.	35.	4643127105353	5	33.9268043	851760 Up	date	

In the **Write** tab set the following:

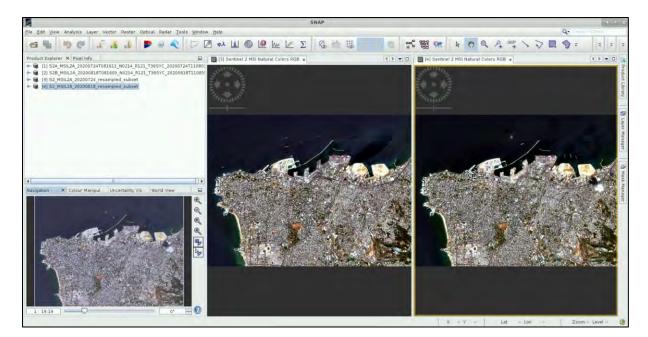
Name: S2_MSIL2A_20200818_resampled_subset

Directory: /shared/Training/HAZA08_LebanonDamageAssessment/Processing

Read Resample Subs	et Write	
Target Product		
Name:		
S2_MSIL2A_20200818_resa	mpled_subset	
Save as: BEAM-DIMAP	v	
Directory:		
/home/rus/shared/Train	ning/HAZA08_LebanonDamageAssessment/Processing	
		-
Load [🔄 Save 🍾 Clear 🍞 Note 🕥 Help 📄 Run	

Click Run. Once the processing is completed, the product will appear at the Product Explorer Window.

You can open both Subset products at the View Window, to see their extent.



5.7 Sentinel-2 Processing – Part 2

Once we have both products subset, we need to put them in one, as we did before with the Sentinel-1 products. For sentinel-2 products, we will use the **Collocation** operator.

5.7.1 Collocation

Go to Raster \rightarrow Geometric Operations \rightarrow Collocation.

As "Master" product, select the S2_MSIL2A_20200724_resampled_subset

As "Slave" Product, click on the Add product(s) and select the S2_MSIL2A_20200724_resampled_ subset and click OK.

	Add product	(÷ = ×
[2] S2B_M [3] S2_MSI	SIL2A_20200724T081611_N0214_R121_T36S SIL2A_20200818T081609_N0214_R121_T36S IL2A_20200724_resampled_subset IL2A_20200818_resampled_subset	
Select all	Select none	<u>D</u> K <u>C</u> ancel

As "Name", set **S2_20200724_20200818_collocate**

Under the "Renaming of Source Product Components", at "Rename master components" set: \${ORIGINAL_NAME}_20200724 and at "Rename slave components" set: \${ORIGINAL_NAME}_20200818.

Click **Run** and once the processing is completed, the collocated product will appear in the **Product Explorer** Window.

-	Collocation	* = *
e Help		
	Products pixel values are conserved):	
[3] 52_N	MSIL2A_20200724_resampled_subset	-
Slave P	Products	
[4] S2_	MSIL2A_20200818_resampled_subset	*
		3
Target P Name:	roduct	
52_2020	00724_20200818_collocate	
	as: BEAM-DIMAP	
us/s	hared/Training/HAZA08_LebanonDamageAssessment/Proc	essing
Ø Oper	n In SNAP	
Renamin	ng of Source Product Components	
Rena	me master components: \${ORIGINAL_NAME}_20200724	
Rena	me slave components: \${ORIGINAL_NAME}_20200818	
	ling	
Resampl		

5.7.2 Sea Mask

We want to remove the pixels that correspond to the Sea. Go to **Raster** \rightarrow **Masks** \rightarrow **Land/Sea Mask**.

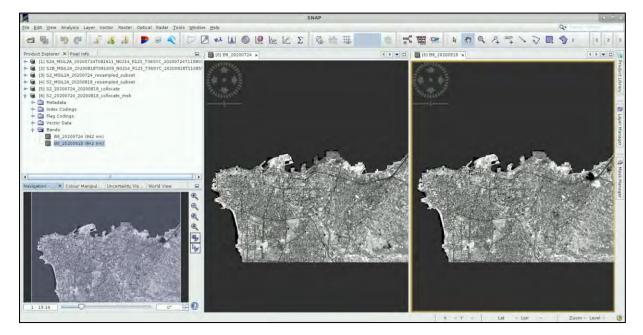
In the I/O Parameters tab set as "Source Product": **S2_20200724_20200818_collocate**, as "Name": **S2_20200724_20200818_collocate_msk** and as directory /*shared/Training/HAZA08_LebanonDama geAssessment/Processing*

6	Land/Sea Mask	1 + E
ile Help		
I/O Paramet	ers Processing Parameters	
Source Prod	uct	
[5] 52_2020	0724_20200818_collocate	*
Save as	BEAM-DIMAP	
Save as	BEAM-DIMAP	
	ng/HAZA08_LebanonDamageAssessme	ent/Processing
P Open in	SNAP	
-		
		<u>R</u> un <u>C</u> lose

e.	Land/Sea Mask	+ = ×	
ïle Help			
I/O Parameters Pr	ocessing Parameters		
Source Bands:	B3_20200818 B4_20200818 B5_20200818 B6_20200818 B7_20200818 B8_20200818 B8A_20200818 B8A_20200818 B9_20200818		Select: B8_20200724 B8_20200818
O Mask out the Land			
Mask out the Sea			
Use SRTM 3sec			
🔘 Use Vector as Ma	sk		
	for more formation		
	invert vestar		
Extend shoreline by [p	pixels]: 0	I	
O Use Vector as Mas Extend shoreline by (p	invert vesser		

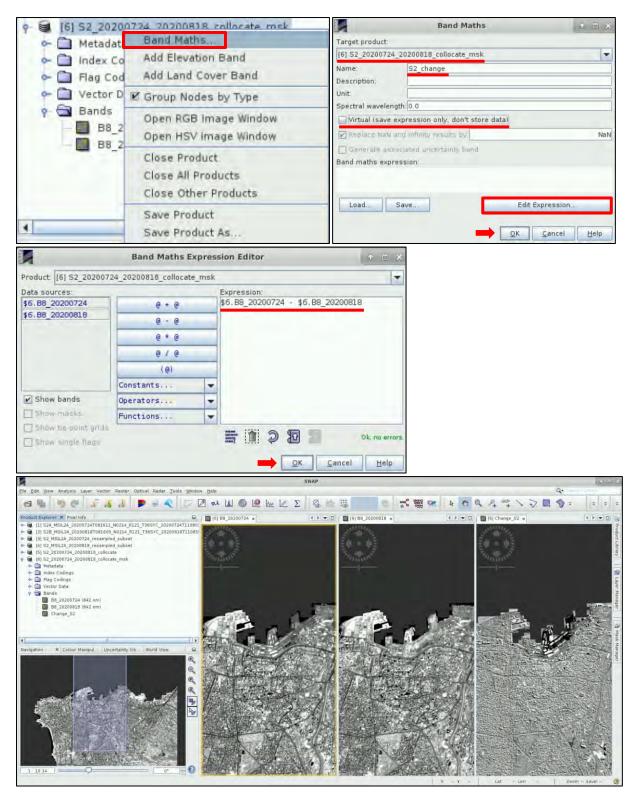
In the **Processing Parameters** tab, at the "Source Bands" keep the **Ctrl** pressed and select only the **B8_20200724** and **B8_20200818** bands. Check the **Mask out the Sea** option and click **Run**.

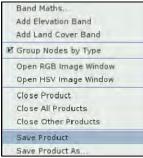
If we open the B8 bands of the masked, collocated product, we will see that the sea has been removed.



5.7.3 Band Maths

Next, we want to create the final band that will show us the areas that have been damaged. For this, we right-click on the **S2_20200724_20200818_collocate_msk** product and click on the "Band Maths". Set as "Name": **S2_change** and **deselect** the "Virtual (save expression only, don't store data) option". Then click on "Edit Expression" and insert the following: **B8_20200724 - B8_20200818**. Click **OK** in both windows. The new band will be created in the product. Double click and open it.

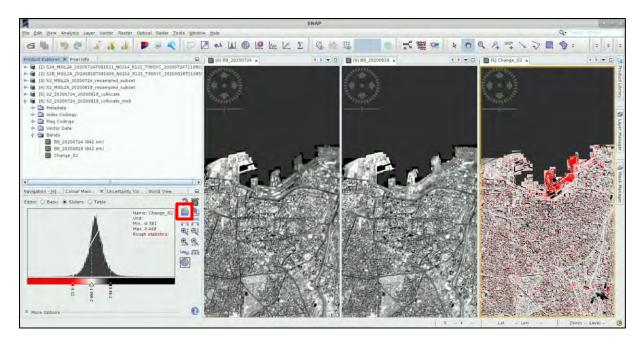




If you want to save this band, right click on the product and click on "Save Product".

Click on the **Import Colour Palette** icon. Then, navigate to the /shared/Training/HAZA08_LebanonDamageAssessment/AuxData folder, select the **Damage_S2.cpd** and click **Open**.

At the window message that appears below, click **No**. In red we can see the areas that have been damaged from the explosion.



5.7.4 Reprojection

The last step is to reproject the product so that we can insert it in QGIS. Go to **Raster** \rightarrow **Geometric Operations** \rightarrow **Reprojection**.

In the I/O Parameters tab set the following:

Source: S2_20200724_20200818_collocate_msk Name: S2_20200724_20200818_collocate_msk_reprojected Directory: /shared/Training/HAZA08_LebanonDamageAssessment/Processing

Reprojection	• E ×
e Help	
VO Parameters Reprojection Parameters	
Source Product	
Name:	
[6] S2_20200724_20200818_collocate_msk	T
Target Product	
Name:	
S2_20200724_20200818_collocate_msk_reprojected	
Save as: BEAM-DIMAP	
Directory:	
/home/rus/shared/Training/HAZA08_LebanonDamage	Assessment/Processing
Open in SNAP	
<u> </u>	

In the **Reprojection Parameters** tab, keep all the parameters as by default.

Click Run.

	Reprojection	• D
le Help		
I/O Parameters Repro	jection Parameters	
Coordinate Reference Sy	ystem (CRS)	
Custom CRS		
Geodetic datum:	end on one of the	-
Projection: G	eographic Lat/Lon (WGS 84)	-
		Projection Parameters.
O Predefined CRS		Select.
Q Use CRS of	10.0.0 min mint	
Output Settings		
Preserve resolution	Reproject tie-point	grids
Output Parameter	No-data value:	NaN
Add delta lat/lon ban	nds Resampling method:	Vearest
Output Information		
Scene width: 1225 pixe		
Scene height: 771 pixe	Center latitude:	33°53'36" N
CRS: WG584(DI	D)	Show WKT
		Run Close
		Euro Close

5.7.5 Export Sentinel-2 product

Select the S2_20200724_20200818_collocate_msk_reprojected product and go to File \rightarrow Export \rightarrow GeoTIFF. Click on Subset and select only the S2_change band. Click OK. The File Name will be set to S2_20200724_20200818_collocate_msk_reprojected.tif. At the Save in field, set the /shared/Training/HAZA08_LebanonDamageAssessment/Processing path. Click Export Product.

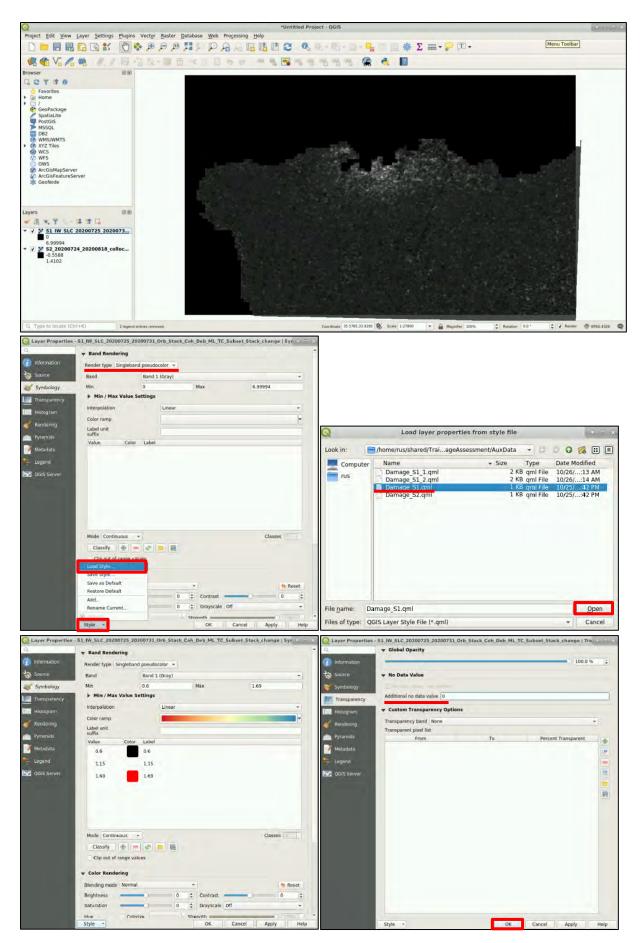
	SNAP - Export Product		e 🗉 🛪	Specify Product Subset	E 8
Save In:	Processing			Spatial Subset Band Subset Metadata Subset	
S1_IW_SLO	C_20200725_20200731_Orb_Stack.data C_20200725_20200731_Orb_Stack_Coh_Deb_ML_TC_J C_20200725_20200731_Orb_Stack_Coh_Deb_ML_TC_J C_20200725_20200731_Orb_Stack_Coh_Deb_ML_TC_J C_20200731_20200806_Orb_Stack.data C_20200731_20200806_Orb_Stack.coh_Deb_ML_TC_J	Subset_Stack.data Subset_Stack_chan	et	<u>is ande</u>	
•	M	Þ			
File <u>Name</u> . Files of <u>Type</u> :	S2_20200724_20200818_collocate_msk_reprojecte GeoTIFF product (*.tif.*.tiff)	d. tif	-	Select all Select none	
	E	xport Product Canc	el	Estimated, raw storage st	ze: 0.9M Help

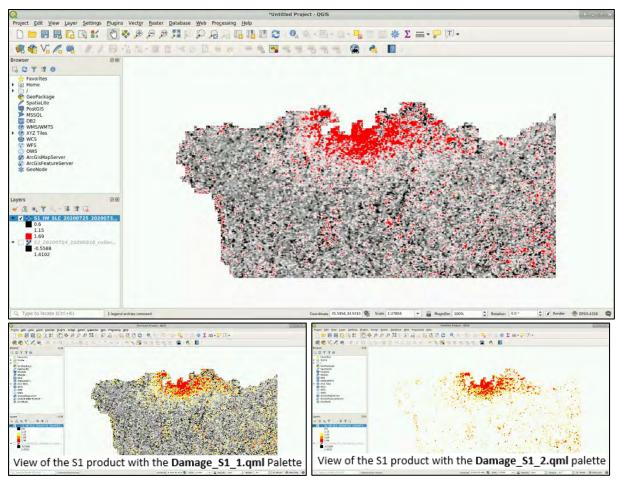
5.8 QGIS Visualization

Open QGIS and load the **S1_IW_SLC_20200725_20200731_Orb_Stack_Coh_Deb_ML_TC_Subset_ Stack_change.tif** and the **S2_20200724_20200818_collocate_msk_reprojected.tif** at the Layers panel. Right-click on the S1 product and go to "Properties".

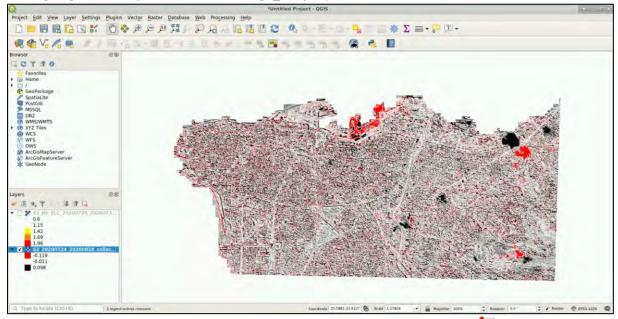
In the "Symbology" tab, set at "Render Type" **Singleband Pseudocolour** On "Style", click and select "Load Style". Navigate to the */shared/Training/HAZA08_LebanonDamage Assessment/AuxData* folder, select **Damage_S1.qml** and click **Open** to load the palette.

We see that there is a black background in both images, so we will remove it by going in the "Transparency" tab and set as "Additional no data value": **0**





Repeat the same steps for the Sentinel-2 product in the *Symbology* and the *Transparency* tabs, and when going at *Load Style*, select the **Damage_S2.qml** palette.

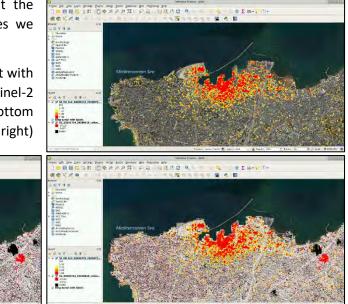


Go to Web \rightarrow OpenLayers plugin \rightarrow Bing Maps \rightarrow Bing Aerial with labels (See \square NOTE 6).

NOTE 6: In case the OpenLayers plugin is not installed, click on Plugins → Manage and Install Plugins. Select the "All" tab on the left side panel and write "OpenLayers plugin" on the search box. If you cannot find it, go to "Settings" and select the "Show also experimental plugins" option. Go back to the "All" tab, select the plugin on the list and click "Install Plugin". Restart QGIS to finalize the installation. Now that we have added a basemap at the background, we can select which tif. files we want to visualize on the top of them.

For example, we see the Sentinel-1 product with the Damage_S1_2 palette (right), the Sentinel-2 product with the Damage_S2 palette, (bottom left) and both S-1 and S-2 products (bottom right)

17 22 10



Den Late Strate State State State States State State State
 Den File State State State State States State
 Den File State State
 Den File State
 Den File State
 Den File State
 Den File
 Den File

Extra Steps 6

200 Yea, Learn Declars, Thank where having Deletant and Throughout And $H = H = \frac{1}{2} M = \frac{1}{2} M$

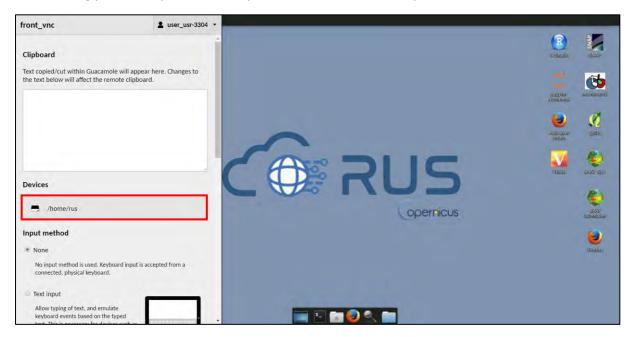
730

....

6.1 Download files from VM

In your VM, press Ctrl+Alt+Shift.

A pop-up window will appear on the left side of the screen. Click on the bar below Devices, navigate to the folders you have saved the files you want to download and double click on them. The downloading process to your local computer will start automatically.



THANK YOU FOR FOLLOWING THE EXERCISE!

Further reading and resources 7

- <u>https://sentinel.esa.int/web/sentinel/missions/sentinel-1</u> Sentinel-1 Mission
- <u>https://sentinel.esa.int/web/sentinel/missions/sentinel-2</u> Sentinel-2 Mission

FOLLOW US!!!



- @RUS-Copernicus
- **in** RUS-Copernicus
- RUS-Copernicus
- **F** RUS Copernicus Training
- RUS-Copernicus website
- www RUS-Copernicus Training website