

→ 6th ESA ADVANCED TRAINING COURSE ON LAND REMOTE SENSING

Floods & Lakes Monitoring

Practical



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With the collaboration of Robin FAIVRE

D4P1a

Wenesday 16 of September 2015









Challenging...

Diversity of :

- Size
- Landscapes
- Dynamics
- Scale of analysis

Lot of approaches both in optical and Sar domain



Detecting gater surfacestit

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Water bodies

- Unique target by complex target
- Water bodies as observed at a T time
- EO Ressources (all !!!)
 - •SAR MR/HR/THR
 - •Optical MR/HR/ THR
- Tools
 - Thresholding and screen validation
 - Auto processing (Otsu /VSM / change detection, snake..)
- •Analyze of the accuracy depending of data's types and resolution

EO data Resolution and detected surfaces

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Large influence of resolution on detected target's observed size



Passager Vegetation/ Modis :1KM / 250m 60-70 % of common water

osa

Worse when comparing ASAR GMM and MODIS: 36 to 56 % of common water



Aims of Flood mapping and monitoring training course

Thematic goals:

- Flood extent
- Flood monitoring exploiting EO time series
- Flood analysis

Synergy assessment between

- Medium resolution SAR and medium optical image
- Medium resolution and high optical image
- Approach of time series

Prepare the exploitation

- Sentinel1
- Sentinel2
- HJ1 A&B
- Cosmo Skymed



Example- the 2006 Danube flood event





Example- the 2006 Danube flood event

Major floods began in Roumania since the 14 of April 2006 and water stayed in some place for more than 6 months Main dike breaks :

- Rast : 14 April 11h30 (local time)
- Bistret Nedeia 24 April 2006 à 7h50 LT;
- Bechet Dabuleni, 24 April .2006, 7h15 LT;
- Dabuleni Corabia, 27 April 2006, 11:00 LT.

Voluntary break of levees in order to allow the flow escape:

- Nedeia, 3 May 2006
- Orlea Corabia, 9 May

Input from Corina Alecu & Anisoara Irimescu,

Heteo Roumanie
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Damages of the 2006 Danube flood event

	Duration	People	Damage [million €]	Cause	Annuality
1 Upper Dapube		5 dead,			Lower Morava and
	28.3 17.4.	4,000 displaced	~ 110	Snowmelt/rain	Dye about 100 years
(DE, AT, 02)		(mostly in CZ)			event
					About 100 years event
2. Middle Danube	283 - 284	3 dead,	~ 30	Snowmelt and rain and	for the lower reaches
(SK, HU)	20.0. 20.4.	6,000 displaced	00	locally dike breaks	of Bodrog and Tisza
					and the Danube
				Concurrent high	
3. Middle Danube	44-284	2 dead,	~ 60	discharges of the	At least 100 years
(CS, HR)	4.4. 20.4.	3,000 displaced	00	Danube, Tisza and	event
				Sava	
1795at 173 64747				Water from middle	
4. Lower Danube	74-156	14 000 displaced	~ 400	Danube,	About 100 years event
(CS, HR)	7.4. 10.0.	14,000 010010000	400	Several dike breaks and	About 100 yours event
				controlled flooding	

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Flood products





























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Aims of Flood mapping and monitoring training course

Image Procesing part: Image Visualisation and Manipulation Flood water extraction

- Optical and Radar
- Mono-date and Multidate

Thresholding

Change detection





Preparing exploitation of the Sentinel series



Sentinel 1 : SAR



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Sentinel 2 : Optical



Short term goal of flood mapping and monitoring T.C. Preparing the exploitation Sentinel series



Sentinel 2

Resolution same as SPOT5 (10m)

Presence of a SWIR band

Large swath (MERIS)

Revisiting time





Sentinel 2 like: Applicable to others optical sensors



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Water extraction

Flood mapping based on thresholding of raw channel

Fundamentals: Spectral signature of water

NIR and SWIR are absorbed



NIR -

SWIR

visible



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



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Saturation/brightness Histogrammecomputation and analysis Threshold definition Threshold

WATER

INDIVIDUALISATION

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

Flood mapping based on optical data : combination of indices

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

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Extraction of water bodies from:

- Brightness
 Standard or
 Tasseled Cap
- First component of a PCA,

 Saturation indices of a HIS transformation



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Flood mapping based on classification

Classification can be performed on:

- Raw flooded data
- Combination of indices

Methods of classification

- Supervised
- None supervised
- Oriented object methods
- •SVM



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Example of processing chaine

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14-18 September 2015 | University of Agrona my Smeate and Veterinary Maritine Rucharest / Bucharest /



Flood mapping based on classification from test areas

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Flood mapping based on classification from test areas

esa



Performance analysis: a jungle

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Multi source & multiscale optical and SAR



SPOT4/ HJ/Deimos and Pleiades HR TerraSAR, Wide ScanSAR to Staring Spot Light

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

• 6th ESA ADVANCED TRAINING COURSE ON LAND REMOTE SENSING 14–18 September 2015 | Vickersity of Advancember Science and Veterinary Methics Rudnarest / Bitch arest Rumanin ES, Toulouse, 6-01-2015



Objectives of training course

- Open SPOT-5 images in ESA S-2 Toolbox
- Edit different RGB views
- Interpretation of the surface's spectral behaviour based on the reference image
- Identify the spectral signature of permanent water bodies
- Creation of an image subset
- Extraction of permanent water bodies
- Identify the spectral signature of flooded areas
- Extraction of flooded areas



SPOT 5 image opening in ESA S-2 Toolbox

- Open the ESA S-2 Toolbox software



- Open the SPOT-5 image directory by clicking the folder icon and a second second
- Then open the SPOT5_HRG2_XS_20150808 folder and select the .TIF image file

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SPOT 5 image opening in ESA S-2 Toolbox

- Unfold the list of bands

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False color composition with SPOT 5 MS channels

View > Open RGB Image View

Profile:		
Red:	band_4	•
Green:	band_3	•
Blue:	band 2	• .



False color composition with SPOT-5 MS channels

Bands : 4-3-2



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False color composition with SPOT-5 MS channels

Bands : 3-2-1





False color composition with SPOT-5 MS channels

Bands : 3-4-2





Image interpretation and spectral behaviour

- Can you identify different kind of land surfaces ?
- Using the Pixel Info tab, can you detail the general spectral behaviour of green vegetation, bare soils, urban areas and water bodies ?
- What is the most sensible SPOT-5 channel to the green vegetation ? Why ?
- How to separate a single kind of surface, such as water ?

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Creation of an image subset

- File > New Product
- Click Define subset and set the pixel coordinates as follow :





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Creation of an image subset

- Ensure that all bands are selected in the Band Subset tab
- Click OK (two times)
- The new subset appears in Products View list, then display a RGB view (3-2-1)

Specify Product Subset		
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OK Cancel Help		

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- Go to Utilities> Create Band from Math Expression

Band Maths		x
Target product:	1	
[2] subset_1_SP	POT5_HRG2_XS_20150808_N1	TUILE_BrailaCazasuRomaniaD0000B0000 👻
Name:	mask_water	
Description:		
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Band maths expr	ession:	
		Edit Expression
		OK Cancel Help



- Click on Edit Expression

Data sources:		Expression:
band_1	0 + 0	
band_2	0 - 0	
band_3		
band_4	@ * @	
	0/0	
	(@)	
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Show masks	Functions 🔹	
Show tie-point grids		
Show single flags		



 Create a conditional expression on SPOT-5 spectral bands in order to generate a binary mask. Surfaces corresponding to water have to be coded by a 1, and to nonwater by a 0.

Data sources:		Expression:	
band_1	0 + 0	if band_4 <= 110 and band_3 <= 110 t	then
band_2	0 - 0	1 else 0	
band_3			
band_4	6 ~ 6		
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AD.



! Right clic on new band to « convert to band »



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- Right click on the subset product in the list and choose Save Product AS ...
- Choose a target directory, a name and save the subset file (which includes the binary mask



- Then open a New Product and choose the SPOT5_HRG2_XS_20150410 folder and select the .TIF image file
- Create an image subset following the previous pixel coordinates
- Open several RGB views (4-3-2, 3-2-1, 3-4-2)
- Can you identify different the flooded areas ?
- Check the spectral behaviour of these surfaces, based on the four SPOT-5 channels
- Create a binary mask of the flooded areas, but a little bit complex !



 First, compute a bighting index as follow. It allows to better discriminate water, flooded and wet areas. Name it B_Index

Product: [4] subset_2_S	POT5_HRG2_XS_20150410_N1_1	UILE_BrailaCazasuRomaniaD0000B00000
Data sources:		Expression:
band_1	0 + 0	sqrt((band_3 * band_3) + (band_4 *
band_2	0 - 0	band_4))
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band_4	@ * @	
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		OK Cancel Help

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 Then, use this index to define a threshold, and find a second threshold to apply on the first band (it allows to discriminate bare soil and most of urban areas). Name it mask_flood.

Data sources:		Expression:
band_1	0 + 0	if B_Index <= 250 and band_1 <= 120 th
band_2	0 - 0	1 else 0
band_3		1
band_4	(d * (d	
B_Index	0/0	
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- Save the second subset with related computed bands (index & mask)
- Some issues : extraction of few urban areas or shaded pixels (relief, cloud, etc)
- Can be avoid by subtracting urban areas using a land cover classification
- Use of a DEM for eliminating high lands



MIR normalized ??

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NDVI difference ??





Sentinel 1 Constellation





esa

- Sentinel 1 A : 03-April 2014
- Operational since beginning of October
- Sentinel 1 B, 2016
- Resolution same as actual VHR strip map
- Band and Pol same as ENVISAT (C band)
- Large swath
- **Revisiting time 5 days**



serti

First Sentinel1 over Poyang Lake





- ✓ Two satellites in a 12 day orbit
- Repeat frequency: 6 days (important for coherence)
- ✓ Revisit frequency: (asc/desc & overlap): 3 days at the equator, <1 day at high latitudes (Europe ~ 2 days)

Sit

rosa ++ space st

SAR 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







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Floods & Lakes Monitoring



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Wenesday 16 of September 2015





