Applying radar and optical images to create Copernicus High Resolution layers: case studies in Hungary

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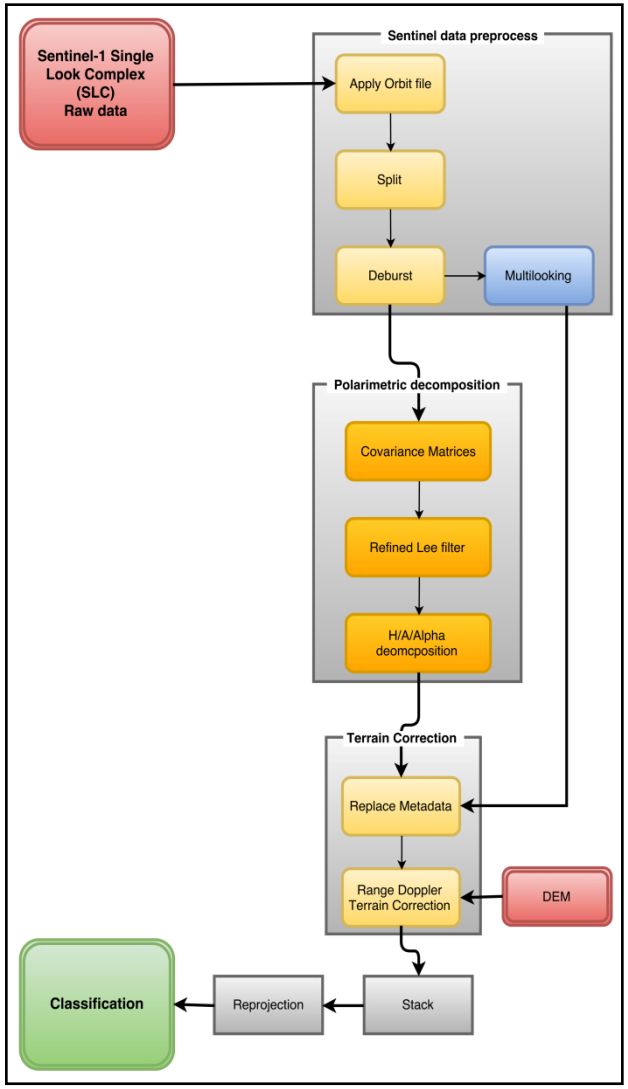
Objectives

- **SAR data can bring high added value to optical data in Earth Observation,**
- **requires methodological adaptation (different nature of SAR compared to optical data),**
- **It requires the analysis of SAR-based imagery within the COPERNICUS land context,**
- **preparation of case studies to demonstrate the benefits of the use of SAR.**

Methodology



SLC processing chain

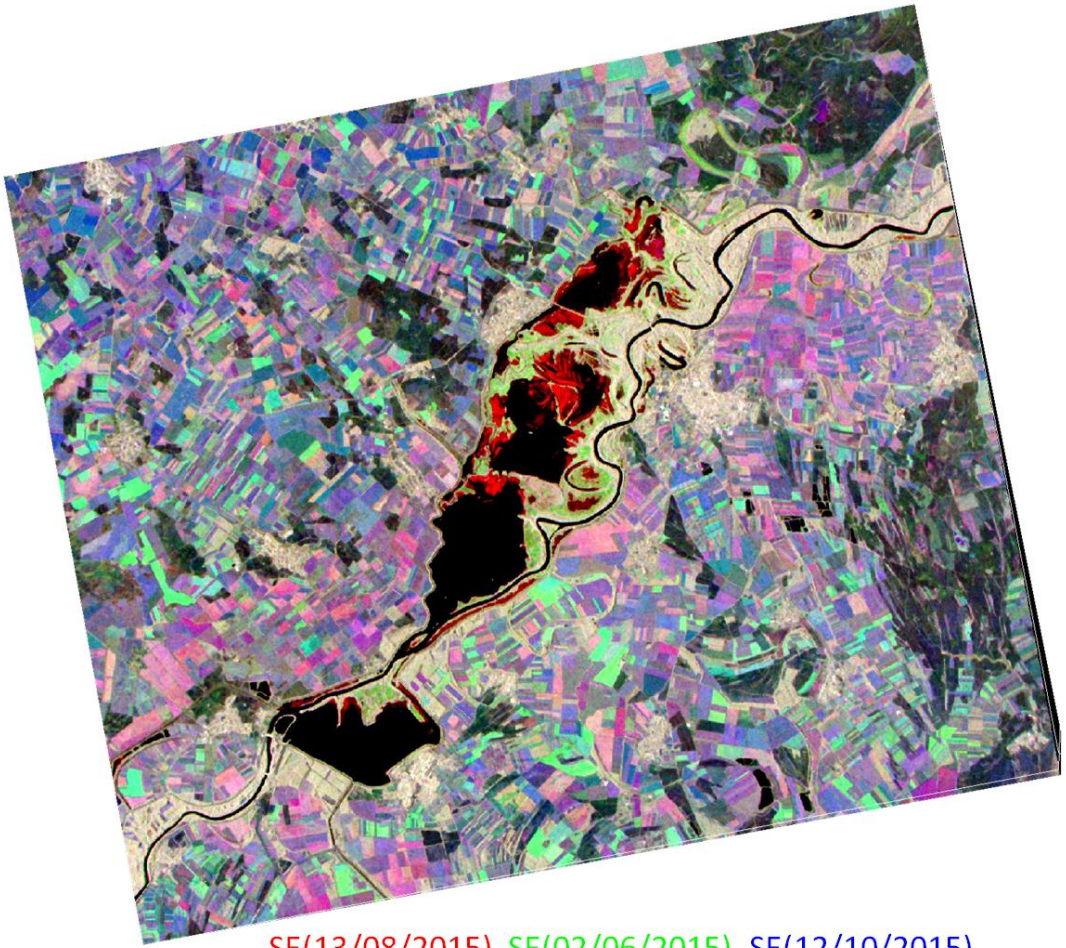
- Preprocess
- Polarimetric decomposition
- Terrain correction
- Stack layers
- Reprojection
- Classification

Lake Tisza site

The Lake Tisza site is situated on the Great Hungarian Plain in the Eastern part of Hungary the largest artificial lake in the country. The lake and its surroundings is merely formed by the river Tisza. Lake Tisza study area is a mosaic of landscape patches, consisting of flatlands, a variety of large open water surfaces and shallow water, countless dead-end channels, scattered by several small islands, sand dunes and narrow active floodplains.

Lake Tisza site

Multitemporal composite of Shannon Entropy derived from SAR data



SE(13/08/2015), SE(02/06/2015), SE(12/10/2015)

SE: Shannon entropy

Lake Tisza site

Radar time series

Time series of SENTINEL-1 SLC (ascending, VV+VH) images

acquisition date	bands used
03/04/2015	SE, SE_i
21/05/2015	SE, SE_i
02/06/2015	SE, SE_i
14/06/2015	SE, SE_i
26/06/2015	SE, SE_i
20/07/2015	SE, SE_i
13/08/2015	SE, SE_i
25/08/2015	SE, SE_i
06/09/2015	SE, SE_i
18/09/2015	SE, SE_i
30/09/2015	SE, SE_i
12/10/2015	SE, SE_i

SE: Shannon entropy

Se_i: i component of SE

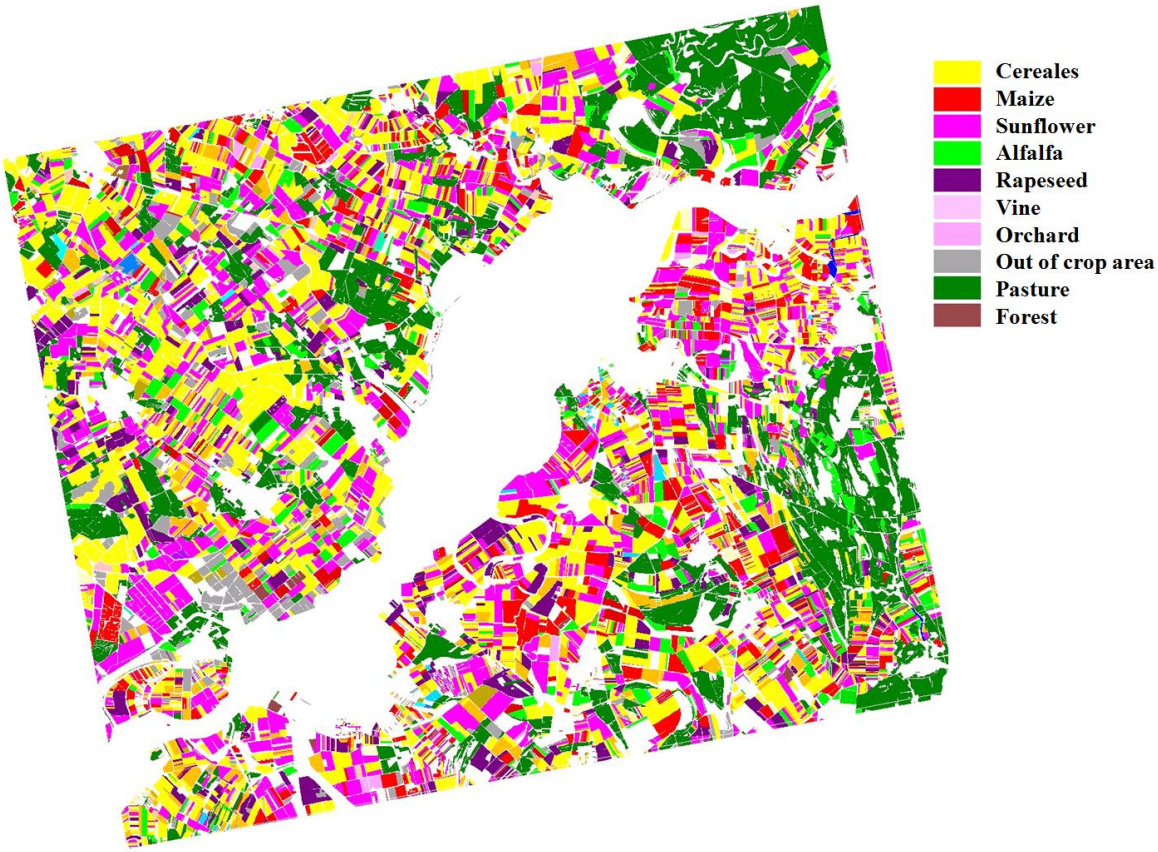
Optical time series

Time series of Landsat TM8 images

Aquisition date	bands used
2015.05.18	Red, NIR,SWIR1
2015.06.03	Red, NIR,SWIR1
2015.07.05	Red, NIR,SWIR1
2015.07.21	Red, NIR,SWIR1
2015.08.06	Red, NIR,SWIR1
2015.09.23	Red, NIR,SWIR1

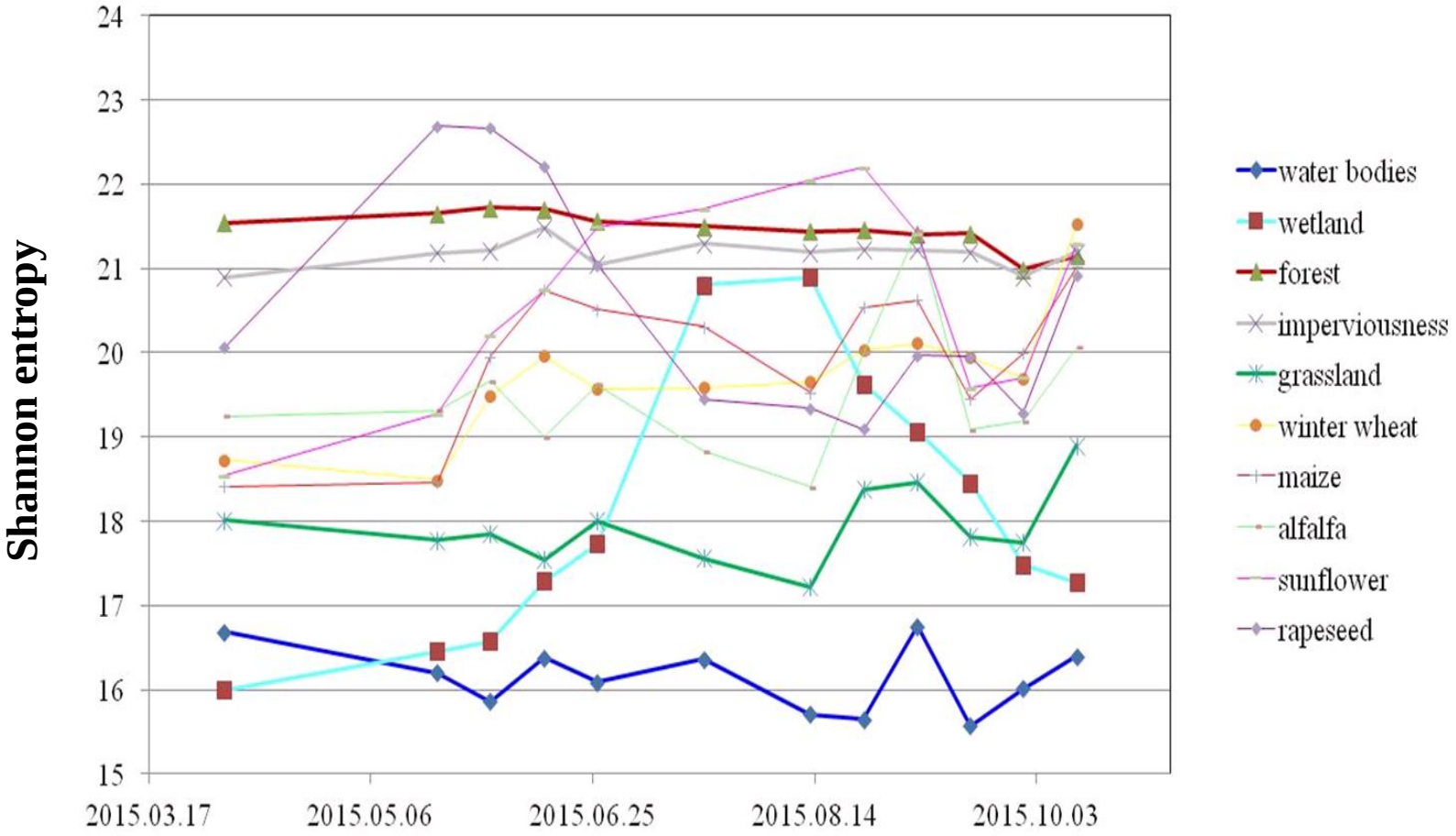
Reference data for Lake Tisza site

source: anonymized agriculture subsidy claim database



Lake Tisza site

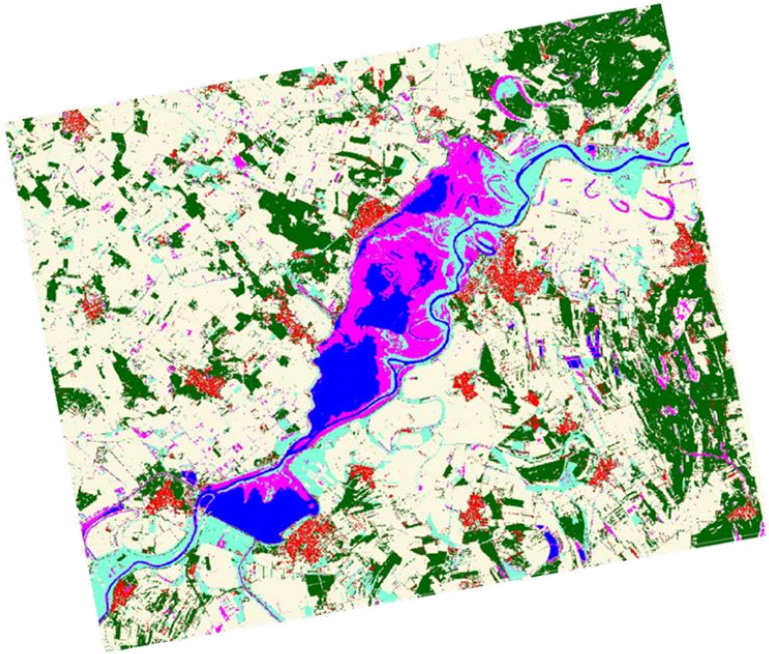
Average temporal development of Shannon entropy for different categories



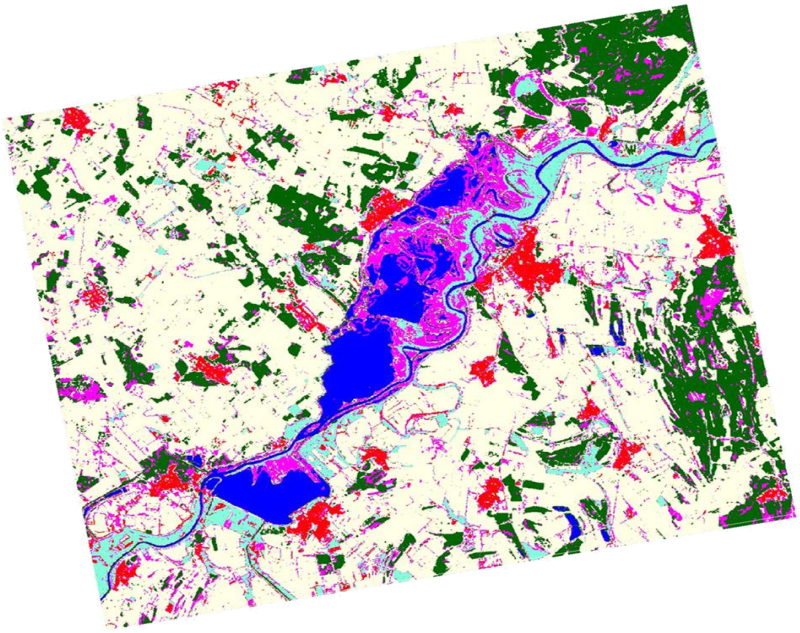
Lake Tisza site

Classified maps

Derived from Optical(6)



Derived from fusion of Radar(12) & Optical(1)

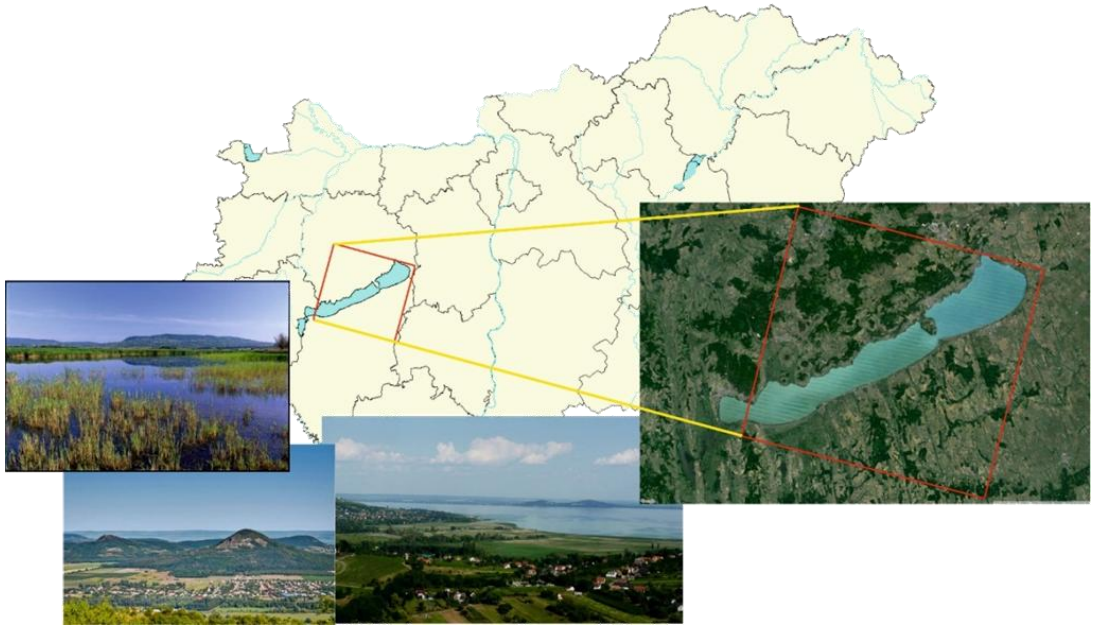


Lake Tisza site
Comparison of optical and radar class-maps

	grassland	forest	water	wetland	imperv.	other	total
grassland	15925	185	187	686	403	2949	**20335**
forest	208	6682	1	228	39	434	**7592**
water	0	11	4948	1008	0	10	**5977**
wetland	1502	802	139	3753	141	1323	**7661**
imperv.	330	506	0	134	2283	1649	**4903**
other	6461	2581	26	2088	1897	64039	**77091**
total	**24427**	**10767**	**5300**	**7897**	**4763**	**70404**	**123558**

overall accuracy: 79%

Lake Balaton site



The Lake Balaton study site separated by Lake Balaton, a shallow lake located in the western part of Hungary. The northern region is not a typical agricultural area due to the *unfavorable* agro-ecological *conditions* excluding viniculture or reed growing. Unlike the southern part of the scene which has a rather agriculturally dominant landscape.

The different landscape structures, relief and the vegetation cover result in different land cover, land use and land management. The separation of homogeneous sub-regions in the area implies different approaches.

Lake Balaton site

Multitemporal composite of Shannon Entropy derived from SAR data

SE(01/05/2015), SE(12/07/2015), SE(10/09/2015)

SE: Shannon entropy

Lake Balaton site

Radar time series

Time series of SENTINEL-1 SLC (descending, VV+VH) images

acquisition date	bands used
02/03/2015	SE, σ_0
14/03/2015	SE, σ_0
26/03/2015	SE, σ_0
01/05/2015	SE, σ_0
13/05/2015	SE, σ_0
25/05/2015	SE, σ_0
06/06/2015	SE, σ_0
18/06/2015	SE, σ_0
30/06/2015	SE, σ_0
12/07/2015	SE, σ_0
24/07/2015	SE, σ_0
29/08/2015	SE, σ_0
10/09/2015	SE, σ_0
04/10/2015	SE, σ_0

Optical time series

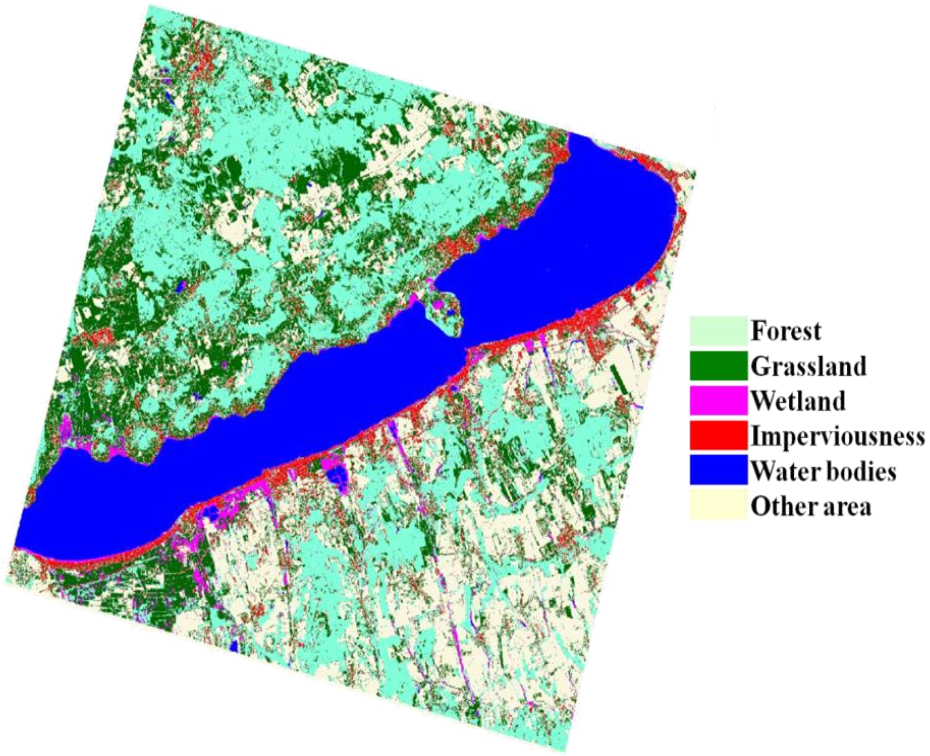
Acquisition date	satellite image	bands used
2015.04.13	SPOT5	Red, NIR,SWIR1
2015.04.23	SPOT5	Red, NIR,SWIR1
2015.06.12	SPOT5	Red, NIR,SWIR1
2015.07.22	SPOT5	Red, NIR,SWIR1
2015.08.31	SPOT5	Red, NIR,SWIR1
2015.09.21	Landsat TM8	Red, NIR,SWIR1
2015.11.01	Landsat TM8	Red, NIR,SWIR1

SPOT5 scenes from SPOT5-take5

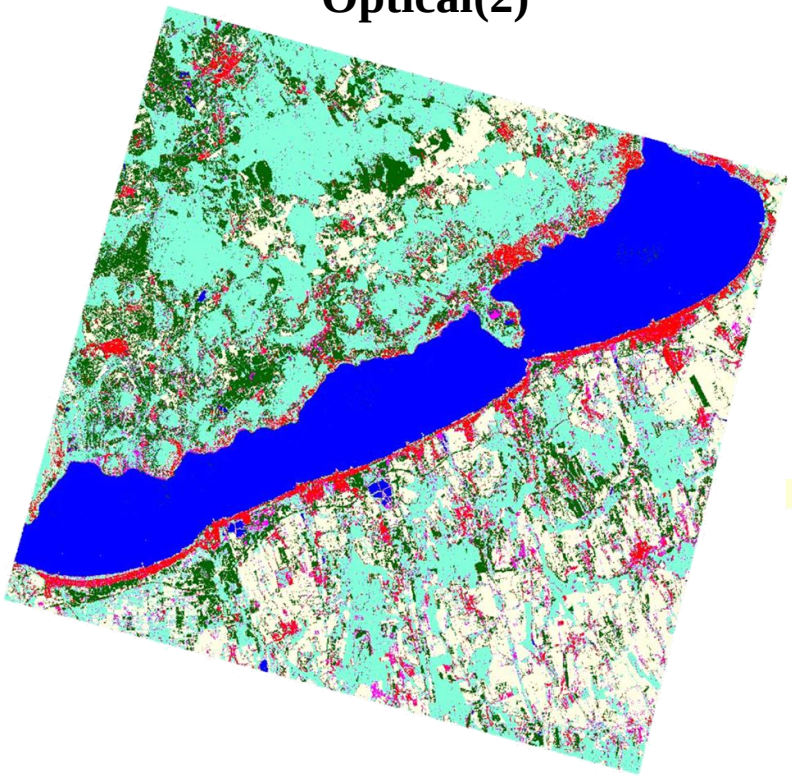
Lake Balaton site

Classified maps

Derived from Optical(7)



Derived from fusion of Radar(14) & Optical(2)



Lake Balaton site
Comparison of optical and radar class-maps

	grassland	forest	water	wetland	imperv.	other	total
grassland	26581	2787	408	872	1568	13311	**45527**
forest	12237	73666	13	2896	2133	5356	**96300**
water	5	3	54734	45	4	3	**54794**
wetland	3916	2800	94	1420	1270	3532	**13030**
imperv.	3930	1181	29	486	6143	5037	**16806**
other	14524	1996	232	1106	1753	54643	**74253**
total	**61266**	**82432**	**55509**	**6824**	**12871**	**81881**	**300711**

overall accuracy: 72%

Conclusion

- These two case studies also confirmed that the radar time series are at least as accurate as the optical in HRL generation.
- It was a simple classification, using a minimum number of descriptors per dates.
- An important result of the study is that higher accuracy can be achieved if the area is divided into homogeneous zones like north and south part of the Balaton site.