ACTUAL STATE OF PODA PROTECTED AREA USING SAR DATA

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ABSTRACT
Poda Protected Area is a marshy wetland, which is a part of the Bourgas-Mandra firth, located at the seacoast. Management of the vegetation and reedbeds is needed to preserve the area as a key site for the Black Sea coast and the country. In this paper the actual state of Poda Protected Area is shown using combinations of optical and SAR data for the period of three different seasons of the year (winter, spring and summer). NDVI values for each of the seasons were calculated. The aim of the study is to create new approaches and data-processing methods for analyses. The results show spatial distribution of vegetation NDVI and water in Poda Protected Area.

Keyworlds: *satellite, SAR data, wetland, monitoring, reedbeds*

INTRODUCTION

Poda Protected Area (PA) is a marshy wetland with area of 100.7 ha. The location is situated immediately after the southern industrial zone of the city of Bourgas. The coordinates are: 27°27’00”E; 42°27’30”; UTM – grid: NH 30; NG 39. Poda is Protected Area since 20 April 1989; Important Bird Area since 1989; CORINE site since 1994 [1], part of NATURA2000 Network since 2012 [2]. This site is a marshy wetland, located at the seacoast and originates as a part of the Bourgas-Mandra firth. Then, it forms the easternmost lagoon part of Mandra Lake. Due to human impact the area changes its natural appearance after the 1960s but later on it recovers. Nowadays a mosaic of different habitats – freshwater, brackish, saline, hyper-saline pools, flooded areas, etc. – have been formed in spite of the small area. Poda is a typical representative of a lagoon with natural habitats, although with secondary origin [1]. 249 bird species have been recorded in Poda PA with the size of only 1 km^2, which makes the site one of those with the highest species concentration in Europe. It is of great importance to preserve the area as a key site for the Black Sea coast and the country, supporting a diversity of plant and animal species. In the near future Poda should become a territory ensuring the sustainable conservation of rare and threatened species [1].

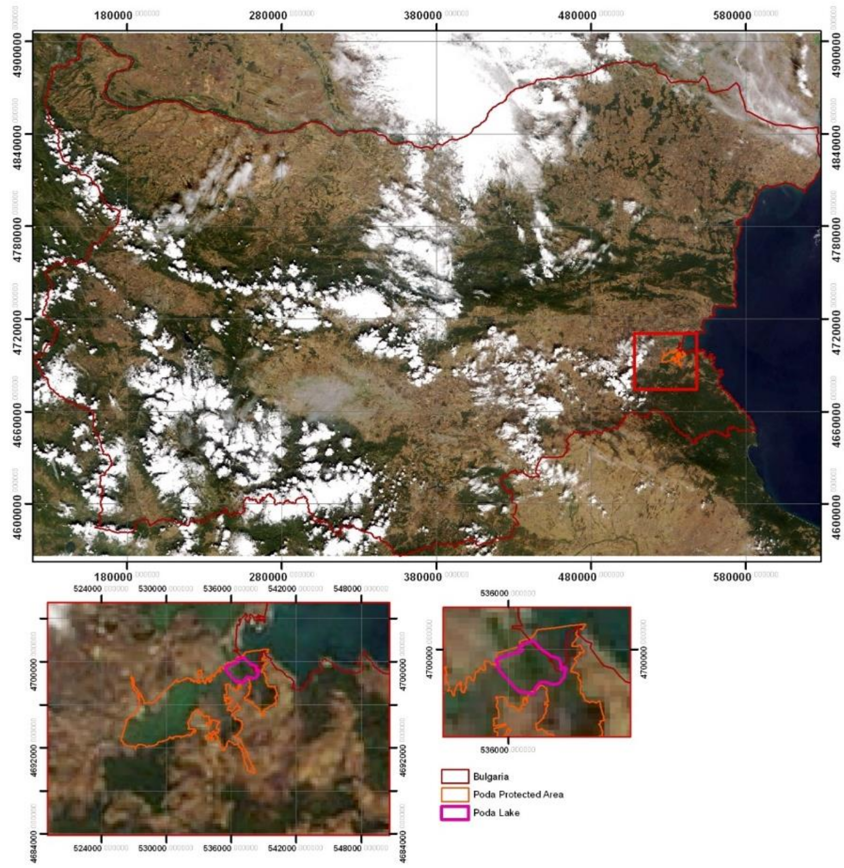

Fig.1. Location of Poda Protected Area, acquired by Terra MODIS, 258/2016

Management of the vegetation and reedbeds in particular is needed and protecting the existing equipment and building a new one to support birds nesting (floating and reed islands; heron nests, duck platforms and hides, etc.).

The aim of the study is to investigate the possibilities for application of a new approach in vegetation monitoring, based on the use of aerospace data from different sensors.

STUDY AREA

In spite of the small area of Poda PA, its territory is not homogeneous neither in ecological, nor in functional aspect. The different parts of the protested area have different conservation importance and require different regimes in order to fulfill their ecological and socio-economic functions. The study area is the zone with high conservation status in Poda PA. This zone is defined in order to protect the main values of Poda PA – the mixed colony of rare bird species (Spoonbills, Glossy Ibises and Herons) [1]. Due to the exceptional sensitivity of these species to the human factor, the zone is with the highest level of protection. The most concentration of vegetation and reedbeds can be observed in this zone.

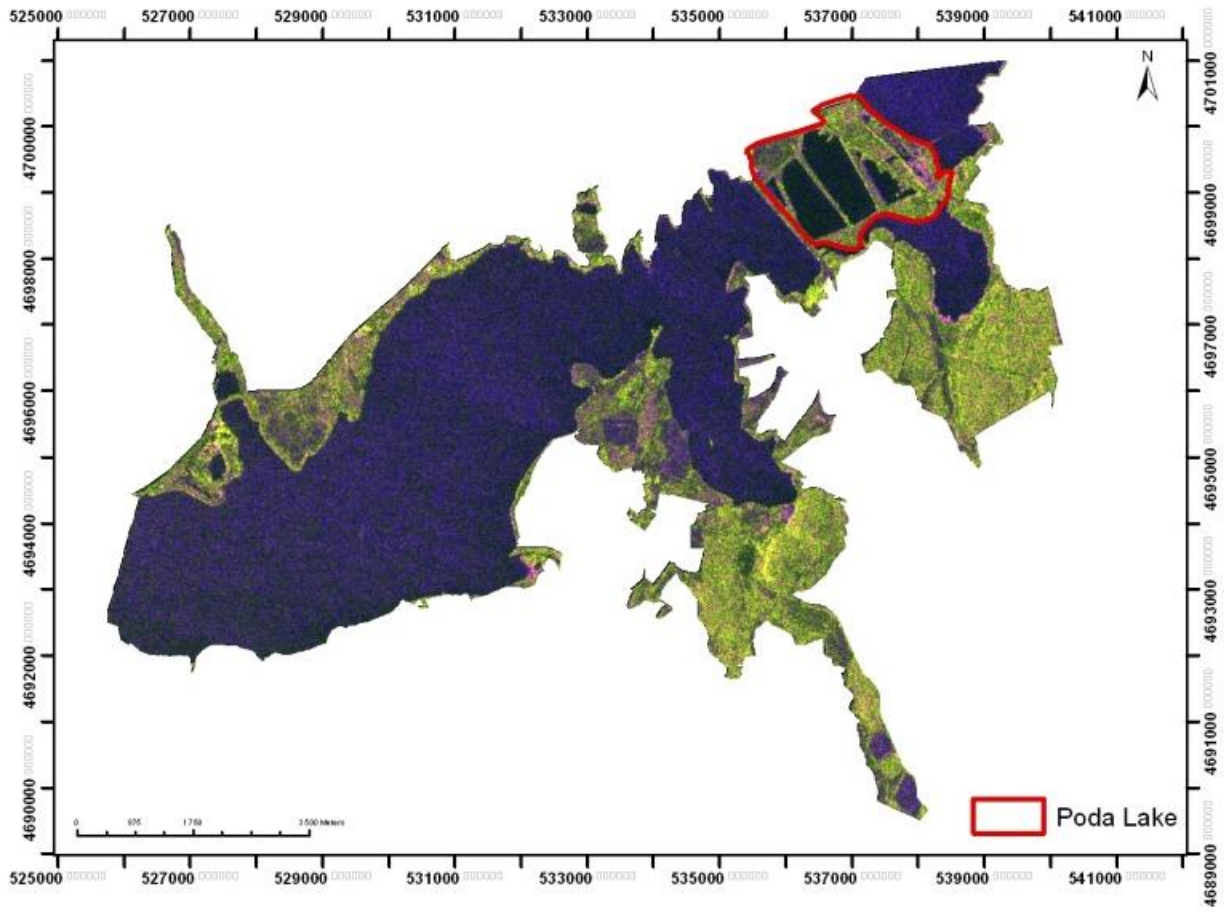

Fig.2. Study area – Poda

METHODOLOGY

Data

Data from the European Space Agency (ESA) satellites from the Copernicus missions "Sentinel-1-A" and "Sentinel-2-A" were used [3,4]. The "Sentinel-1-A"(C-band with wavelength of ~5,6 cm) is a Synthetic Aperture Radar (SAR) of the sensor. The "Sentinel-2-A" Multi-Spectral Instrument (MSI) registers data in optical bands with different resolutions. MSI's 13 spectral bands from the visible (VIS) and the near infra-red (NIR) spectrum regions to the short wave infra-red (SWIR) one were used. Their different spatial resolutions at the Earth surface range from 10 to 60 m [5].

Table 1. Image acquisition dates

Satellite	Date	Spectral Band, wavelength	GSD*, m
Sentinel-1-A	13.02.2016 18.04.2016 16.08.2016	λ=5,6 cm, Polarization: HV,VV	10x10**
Sentinel-2-A	23.12.2015 15.02.2016 28.04.2016 16.08.2016	2.19µm 0.865µm 0.665 µm 0.49 µm	20

*Ground Sample Distance (GSD)

** Pixel Spacing Resolution (rg x az) [5]

Image processing methods

Image processing methods are different for SAR and optical data due to the different principles of registration of electro-magnetic energy from the sensors.

Images of one and the same area collected from different sources (SAR and MSI images) can be used together. The MSI images are in UTM, Zone 35N, WGS84 coordinate system. This requires reprojection of SAR images to UTM, Zone 35N, WGS84.

After the reprojection, SAR image coregistration follows and the MSI image is used as a reference image. The next step is SAR composite images generation using data from different time-series and different polarization types. Using pseudo-colors increases the contrast and sharpens the contours [5, 6]. The result is a more precise selection of the identical points for the SAR images coregistration.

Composite SAR image were generated using images with different polarizations (horizontal-vertical - HV and vertical- vertical - VV) (Fig.3). Images acquired from different dates were used for one and the same combination R-VH, G- VV, B- VH/VV of the composite images. Generation of these composite images aims a better interpretation of the vegetation cover, water areas and wetness variations to be achieved (Fig.2).

The integrated composite images are based on data received from Sentinel-1-A and Sentinel-2-A from the visible (VIS) spectral bands – 2-3-4 and the near infra-red (NIR) spectral band - 8A (Fig.4). The latter gives the best results for vegetation and water areas [5].

Although NDVI is one of the oldest, it is one of the most frequently used vegetation indices. It is defined by the following equation:

$$\mathrm{NDVI} = \frac{\rho_{NIR} - \rho_{RED}}{\rho_{NIR} + \rho_{RED}} \quad (1) \quad [7, 8]$$

where ρ_{NIR} and ρ_{RED} indicate the reflectance of the near infrared and red bands, respectively. The spectral behavior of vegetation in the visible and near infrared region in contrast to soils justifies the use of NDVI in vegetation cover discrimination. In addition, NDVI partly normalizes the influence of external factors in the canopy reflectance, i.e. the errors associated with illumination fluctuations or atmospheric scattering.

RESULTS AND DISCUSSION

The generated composite SAR images using combination of different polarizations (VV_VH_VV/VH) indicate areas where vegetation was observed (Fig. 3)

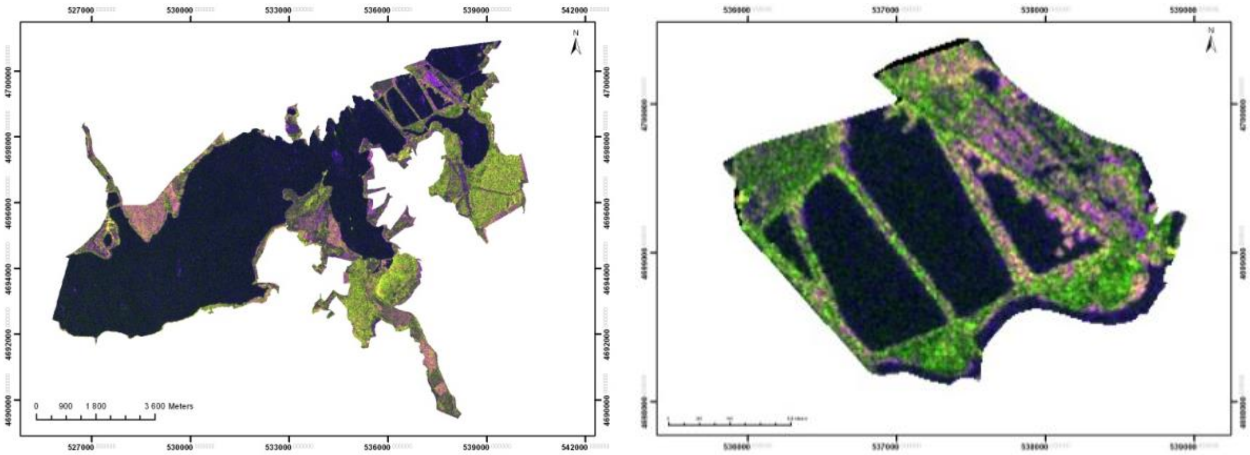

Fig.3a. Composite image
S1_c_vv_vh_vv_div_vh_13/01/16

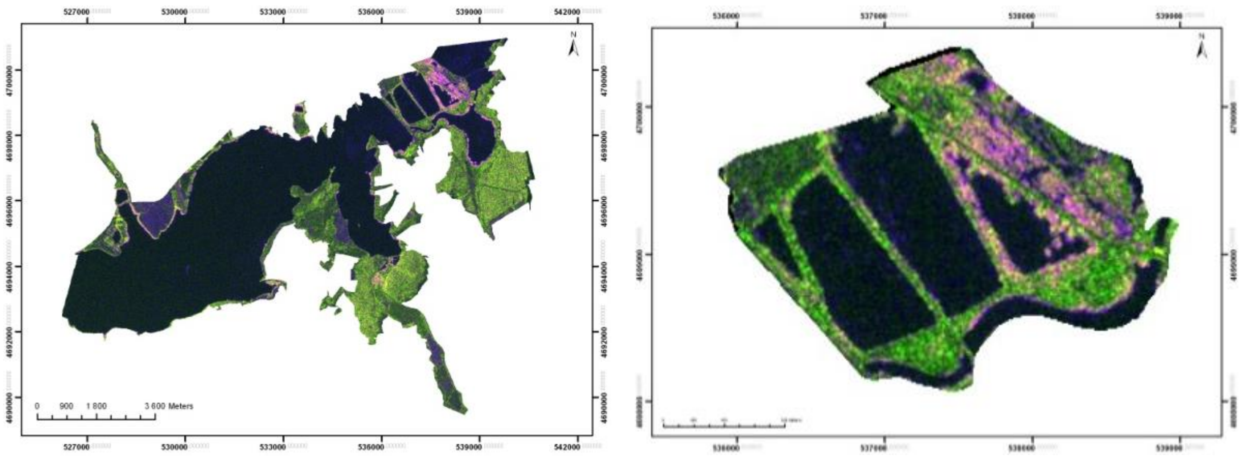

Fig.3b. Composite image
S1_c_vv_vh_vv_div_vh_18/04/16

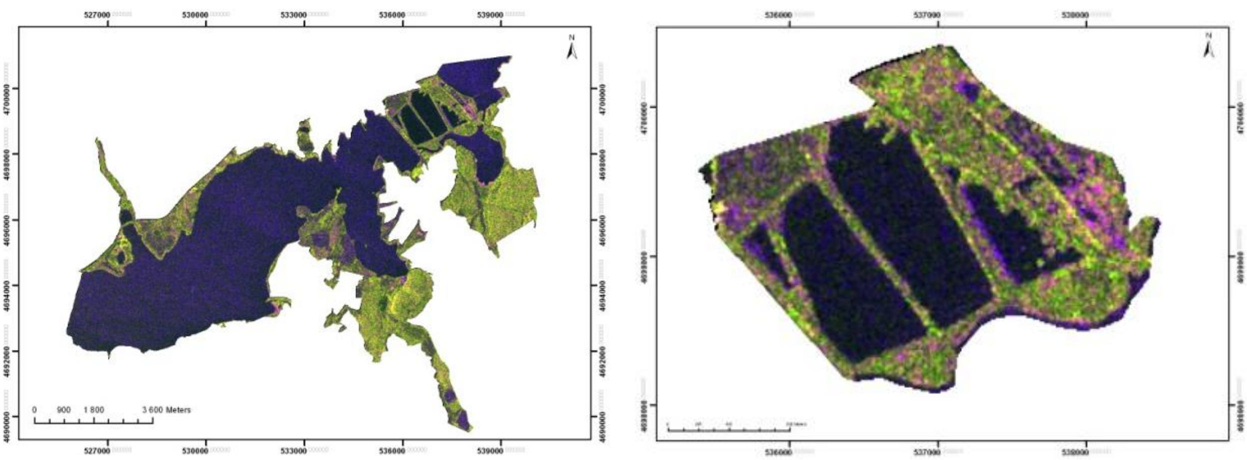

Fig.3c. Composite image
S1_c_vv_vh_vv_div_vh_16/08/16

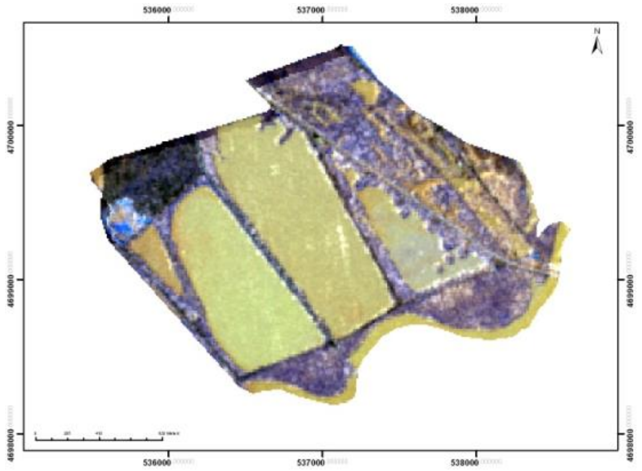

Fig.4a. s1_130116_s2_23/12/15

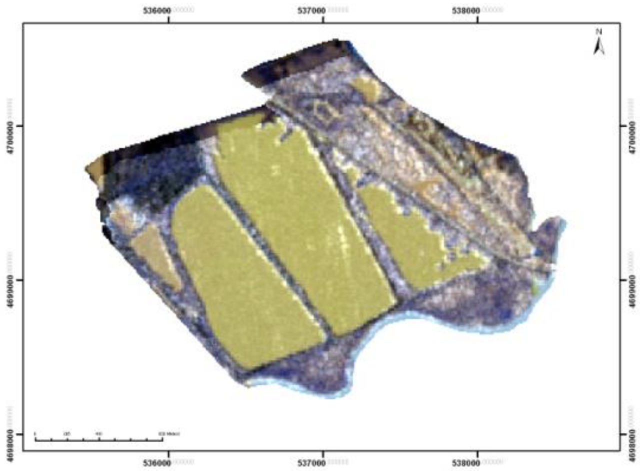

Fig.4b. s1_13/01/16_s2_15/02/16

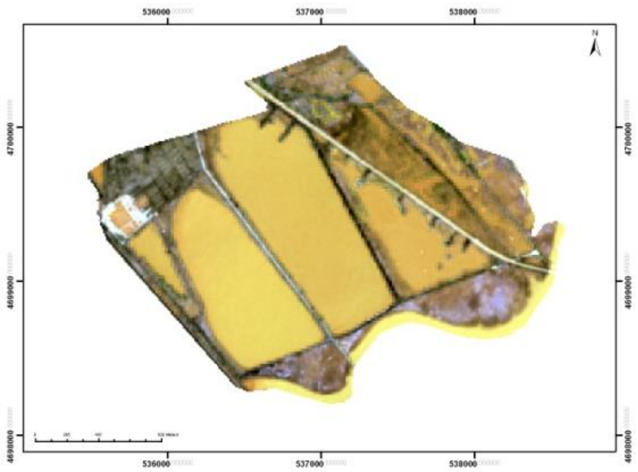

Fig.4c. s1_30/04/16_s2_28/04/16

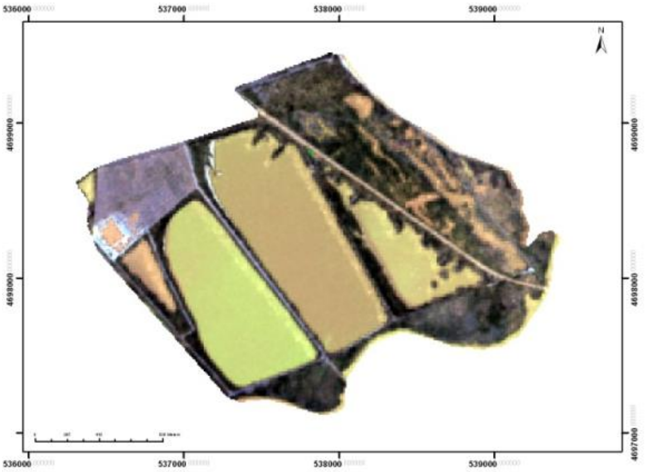

Fig.4d. s1_s2_16/08/16

Integrated composite images using MSS and SAR data with different polarizations (VV_VH_ VV/VH) are shown on Figure 4.

Vegetation indices

NDVI values of each of the seasons were calculated.

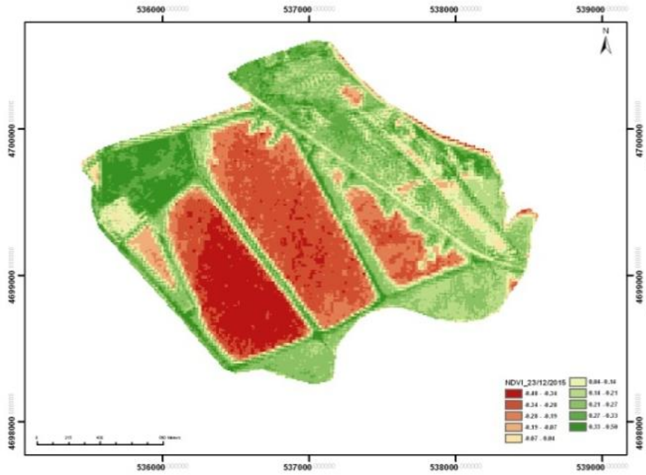

Fig.5a. NDVI_23/12/15

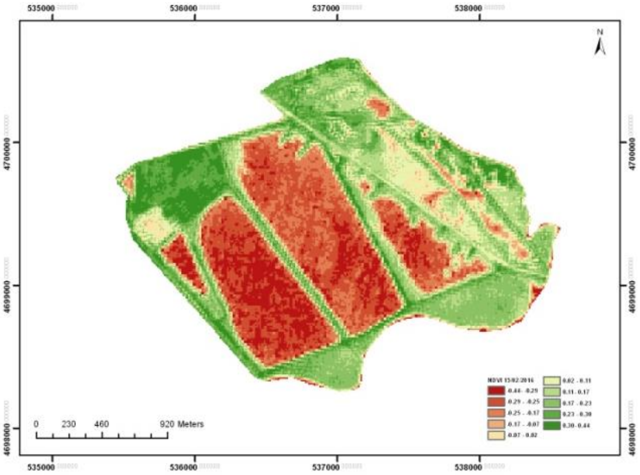

Fig.5b. NDVI_15/02/16

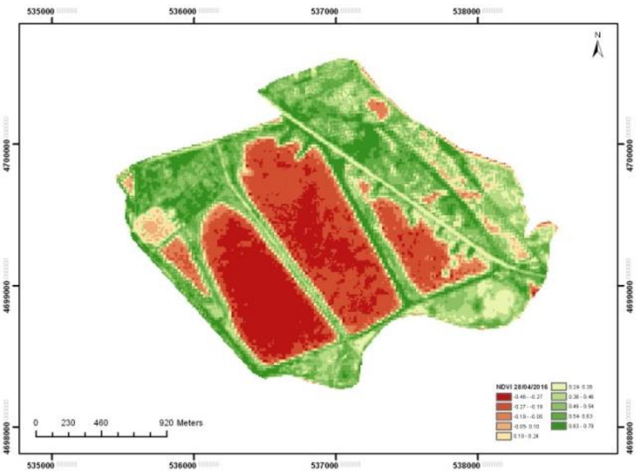

Fig.5c. NDVI_28/04/16

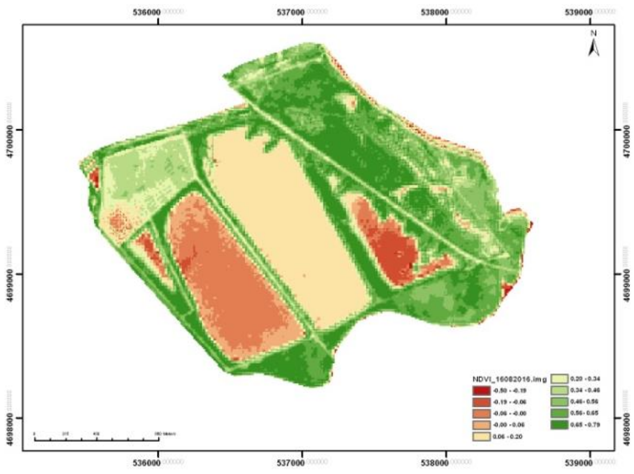

Fig.5d. NDVI_16/08/16

Based on the obtained results distribution of vegetation in different seasons was done, which shows the status of the vegetation and water body of the Poda Lake (Fig.5). The varying coverage of water and vegetation in different seasons was shown in Fig.6. The highest overgrowth of the vegetation in the lake was seen in the spring and in the summer. In December the vegetation has not disappeared but also overlaps part of the water body that can be seen by using SAR data. Overall overgrowth of green vegetation in the water body of the Poda Lake is large during the spring (Fig.6c)

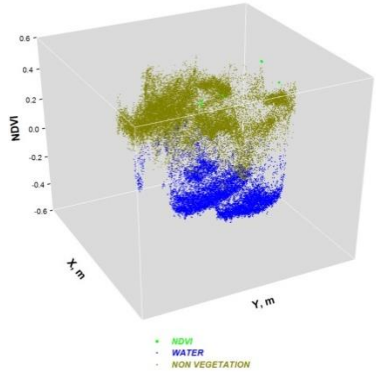

Fig.6a. Space distribution of NDVI in Poda Lake, 23/12/2015

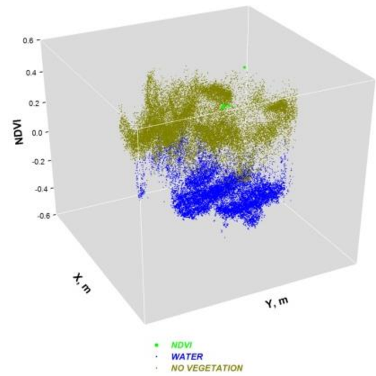

Fig.6b. Space distribution of NDVI in Poda Lake, 15/02/2016

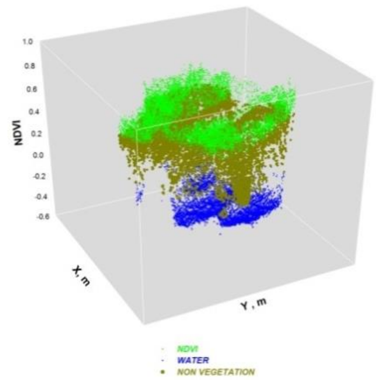

Fig.6c. Space distribution of NDVI in Poda Lake, 28/04/2016

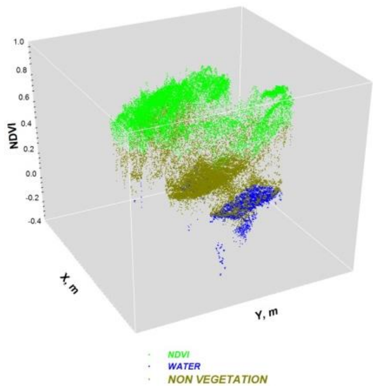

Fig.6d. Space distribution of NDVI in Poda Lake, 16/08/2016

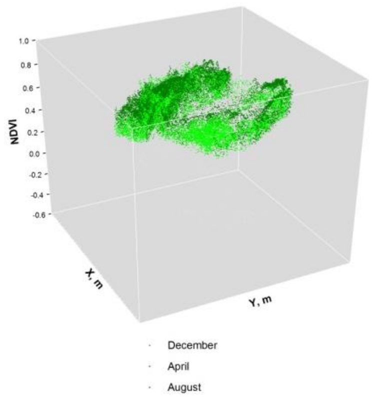

Fig.6e. Space distribution of vegetation in Poda Lake

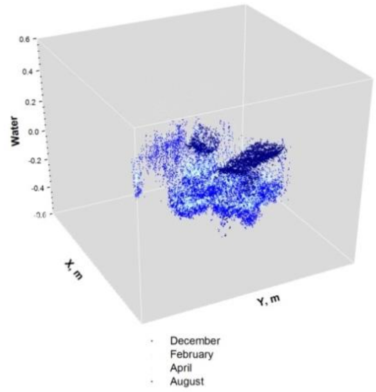

Fig.6b. Space distribution of water in Poda Lake

CONCLUSION

In general, the proposed approach for vegetation monitoring, wetlands and wetness is better than the classical ones. The combined use of satellite data in optical and radio bands increases the objectivity and comprehensiveness for the vegetation cover monitoring, water areas and wetness. SAR images give the opportunity for monitoring of vegetation in wetlands. Monitoring of vegetation overgrowth in wetlands can be done using SAR data. This is important for decision making in order to limit these processes. If necessary some measures for reducing vegetation overgrowth should be taken before the spring. Then a study counting the relationship between vegetation and water body of the lake need to be done.

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