NATURAL ENVIRONMENT CHANGE DETECTION IN DANUBE DELTA, BASED ON HRV - SPOT IMAGES

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ABSTRACT:

The Danube Delta is an area with a unique ecological signification, which present accentuated interest from scientific, tourist and even economically. His complex and varieties ecosystems have remained unspoiled for centuries, natives integrating in preserving of natural balance. In the last 3-4 decades, a dramatic alteration be cause of accentuated human intervention in Danube area, inside Danube Delta's and in coastal area of Black Sea.
In this context, a study on change-detection occurred at the level of principal morphological elements and vegetation has been achieved in a site, which contain approximate 70% of delta's surface. The study is based on two HRV SPOT images, acquired in May 27, 1986 and April 27, 1993.
Two different methods have been used for change detection: vegetation index comparison and post-classification achieved based on the composite images. A Normalized Difference Vegetation Index (NDVI) has been computed for each image; then the new images have been compared by difference in first case. Using the second method, composite images are generated from the two principal components on which are added Normalized Difference Vegetation Index (NDVI). Furthermore, these images are submitted a hybrid classification process, followed by a modal type filtering. Finally, the classified and filtered images are compared by difference.
The study first revealed the utility of HRV SPOT images for delta's environment monitoring. Between two methods used, more accurately results give comparison post classification of composite images. The accuracy is improved significantly if the threshold value of mode filters is choused according.

1. INTRODUCTION

After declaring in august 1990 of the Danube Delta's as Biosphere Reserve, on passed at effecting a couple of projects of national and international research having as main purpose, establishing the solutions for protection and ecological reconstruction of nature delta's environment. In this context, a study on change-detection occurred at the level of principal morphological elements and vegetation has been achieved. The study of environments and change-detection require using of the efficiency evaluation methods. The remote sensing offer one global view of phenomenon and is in same time the privileged study means, which can facilitated the best environment administrations.

2. STUDY ZONE AND DATA SOURCE

The Danube Delta and the coastal zone of the Black Sea represent areas of high scientific interest, which contain a unique series of interrelated ecosystems. This cover about 564,000 ha of which 442,000 ha (82%) lie within Romania. Inside the delta some main ecosystems are to be found among which we can mention: running water, stagnant water, wetland and flooded areas, fluvial and marine levees, the amended areas (for agriculture, forestry and fish culture).
Ecosystem of running waters comprises in the first place the Danube's arms, bat also a series of more important streamlets and channels.
Ecosystem of stagnant waters includes in the first place lakes, to which ponds, streamlets and channels are added. They are characterised by a rich floating and submersed flora.
Ecosystem of marshy and flooding surfaces (of reed plats and floating reed islet) is dominated by emerged vegetation prevalent constituted of common reed. Floating reed islet formation, which is a mixture of reed roots herbs and soil, usually floating or fixed on the bottom of depressions, has a peculiar place within the ecosystem.
Fourth main ecosystem is river banks and levees ecosystem. This is centred on the riverbanks which had been the domain of all kind of trees which had been broke up in their greatest part and instead, Canadian poplars had been cultivated.
Based on the HRV SPOT scenes had been realised a study of environments evolution in the Danube Delta. The study areas cover approximate 70% of delta's surfaces. Is very important of underline its neighbourings in the east side with Black Sea, which a specifically series problems creating.

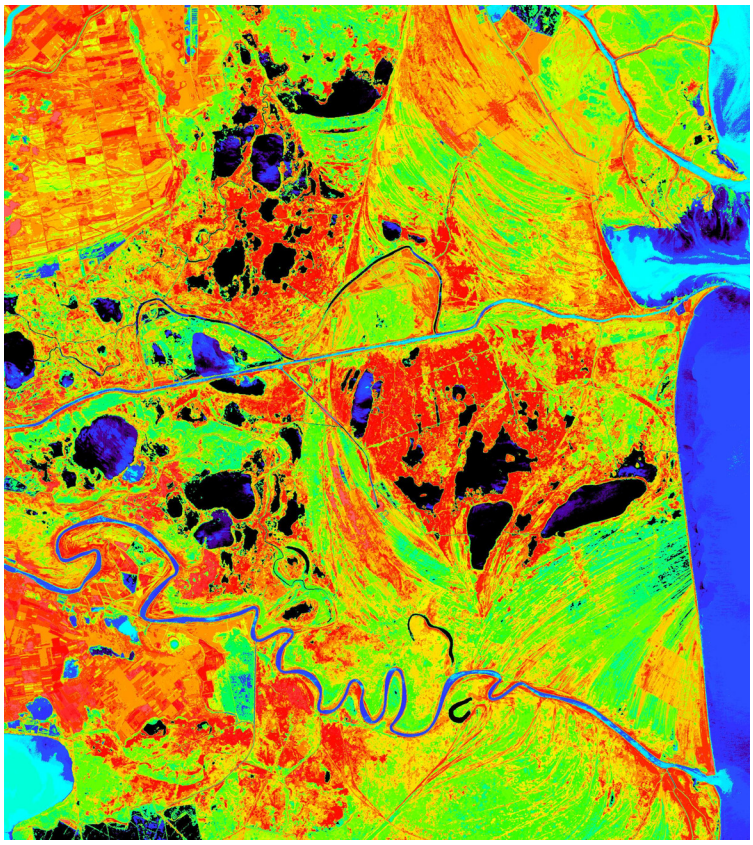


Figure 1. NDVI for SPOT HRV May 27, 1986

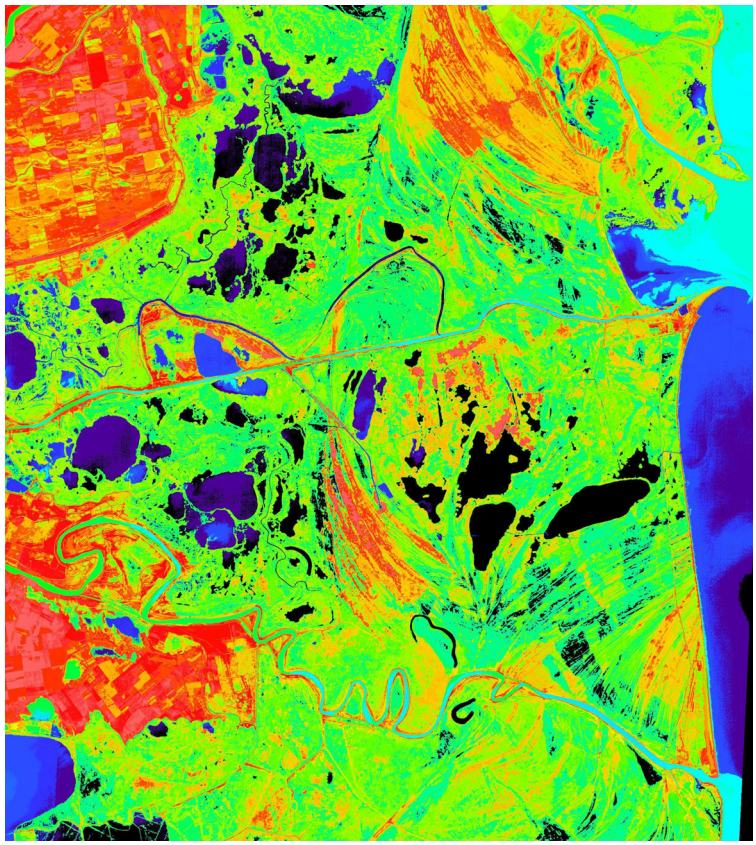


Figure 2. NDVI for SPOT HRV April 27, 1993

Two scenes HRV SPOT from May 27, 1986 and respectively April 27 ,1993 used has been. Their characteristics in table 1. are presented.

Acquired date	May 27, 1986	April 27, 1993
Bands	1 2 3	1 2 3
K / J	98 / 259	98 / 259
Resolution (meters)	20 x 20	20 x 20
Rectification (pixels)	± 0.391	± 0.275

Table 3. The satellites data characteristics

3. METHOD

The change detection realised with aids of multispectral data need: the preliminary processing, classification and specifically proceedings post-classification (Jensen et al., 1995) In this study was applied two methods: normalized difference vegetation index (NDVI) image differencing and a princial component analysis.

3.1 Preliminary processing

One from important temporal reason for change-detection is the acquiring month of the imagery. Images acquired during the period with power sun light, present a very good contrast between various details (Jansen, 1993). For example, in this case, the contrast from covered with vegetation soil and uncovered is very strongly. Using the scene acquired in the same years period are suggested to change-detection with purpose to reduce the problems which appear because sun-angle difference, vegetation-phenology changes and differences in soil-moisture.

In this study for radiometric processing the technique based on reference image are used (Hall et al., 1991). Image of 1986 has been thought, because its minimum values are weakly. These techniques apply the standardisation in respect with reference image and adjust the calibration sensor errors. Also she adjusting the effects due to atmospheric differences and lighting between images. For this the fifteen pixels in each zone more darkness (near to level 0), respectively more brightness (near to 255) has been choose. Radiometric transformation which tie the two values of two images have the form $y(i) = a(i) + b(i) * x(i)$, where y (i) is pixels radiometric value from reference image and x(i) is the correspondent radiometric value pixels of corrected image.

After the radiometric correcting, the geometrically rectified images have been, so that the same pixel at one date overlaps the same pixel for the other date. The accuracy of change-detection is directly conditioned of geometric rectification. For this operation twenty ground control points obtained by aerotriangulation was used. The aerotriangulation is performed on aerial photos at 1:20,000 scale acquired in 1990. The root-mean-square (RMS) error at rectification of the two images was under 0.20 pixels.

For resampling of images was applied the method of the nearest neighbour.

3.2 Composite images generation

In principal component analysis of images stand out restrain of first principal component of each image. In means this is 76% of input data variance. Also, and the second principal component was retained, which the value represent 21% of variance. For each image at this two principal component was added the Normalized Difference Vegetation Index (NDVI), calculated with ecuation:

$$NDVI = (XS3 - XS2)/(XS3 + XS2 + 1) * 128 \qquad (1)$$

Using of this allowed clear to distinguish of vegetation covered zones of the uncovered terrain zones. This index are advantageously for separation between the areas with very rich vegetation and the areas with the mobile and quasi-mobile sand correspondingly to river and sea banks (Letea, C.A.Rosetti, Şchiopu, Răducului, Caraorman, Lumina, Lat, Rosu, Puiu, Ivancea, Sărăturile, Cerbului and Câşla Vădanei) or sea beaches. Also, facilitated the separation of very little and fine town structures from locality zones of vegetation (Sulina, Letea, C.A. Rosetti, Sfiştofca, Crişan, Mila 23, Sf. Gheorghe, Murighiol, Dunavăţu de sus and Dunavăţu de Jos).

3.3 The post-clasification comparison and change-detection

Using of the post-classification comparison methods is advantageously, because the image acquired at different times are separately classified. This method allow minimising the effects dues to different atmospherically conditions and using different sensors for multispectral images acquiring (Singh, 1989). Thus different studies showed that by association of mode filtering with classification procedures are possible the improve accuracy of change-detection (Jansen et al., 1993).

Mode filter applied in 3 by 3 neighbouring with a threshold value in generally three, allows to suppress the isolated pixels or poor classified or the pixels dues to noise (Jansen et al., 1993). It replaces central value pixels by a majority value. Majority threshold corresponds to threshold of which going, majority value replace central value pixels.

For classification was applied a hibryd classification process. In this technique by clustering are optimised defining the sample classes, which will be used in the supervised classification process.

For spectral signature file establishing first was appllied a clustering method (Isodata from Erdas). Afterwards, the file to supervised classification realised by maximum likelihood has been.

The classification of composite images from 1986, respectively 1993 was performed in accordance with seven classes: uncovered soil, stagnant water in lakes, running water, sea water, compactly common reed, mixture common reed-mace reed, town structures. The mode filtering technique was applied to the two classified images in a 3 by 3 neighbouring.

The accuracy classification from two date was estimated by using for each the standard, single-date, qualitative accuracy assessment procedures (i. e., an error matrix and Kappa analysis) (Congalton, 1991).

The reference data was extracted of pedologychal map, vegetation's map and topographical map of the Danube Deltas.

The images classification from 1986 have been one generally accuracy of 79% and 0.46 Khat value, while for 1993 images was optained 76% and respectively 0.41.

For change-detection the classified images was compare by differencing.

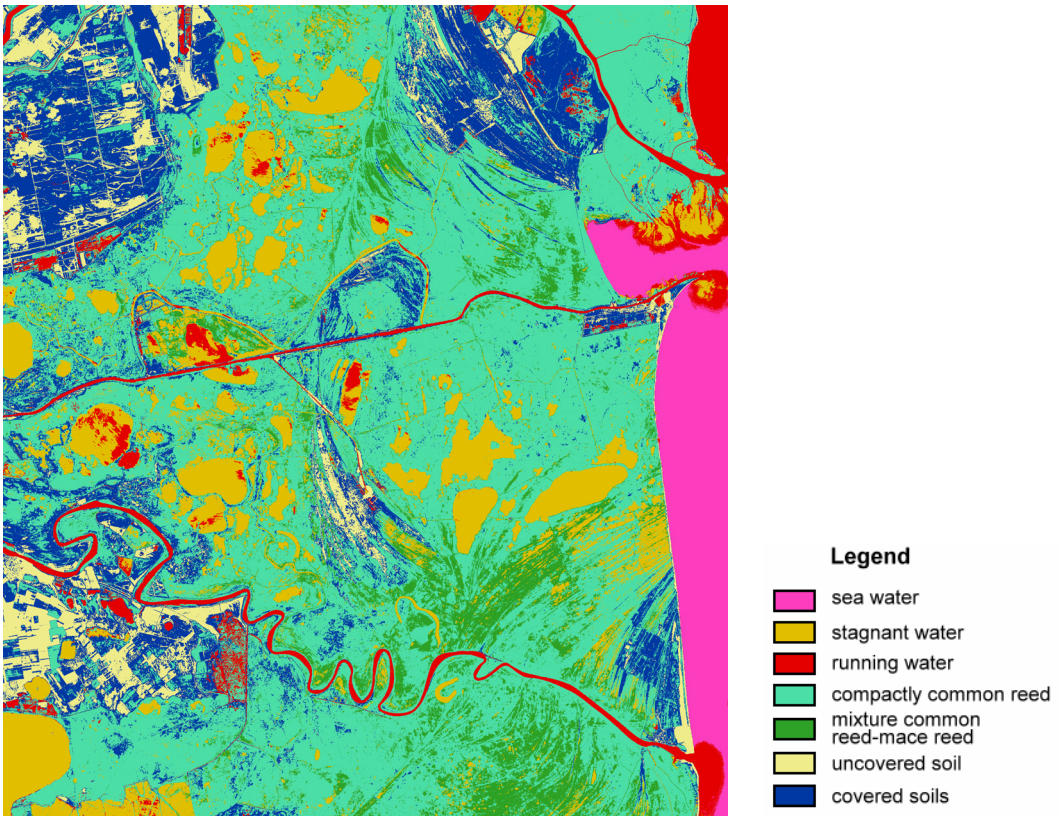


Figure 4. Classification for SPOT HRV May 27, 1986

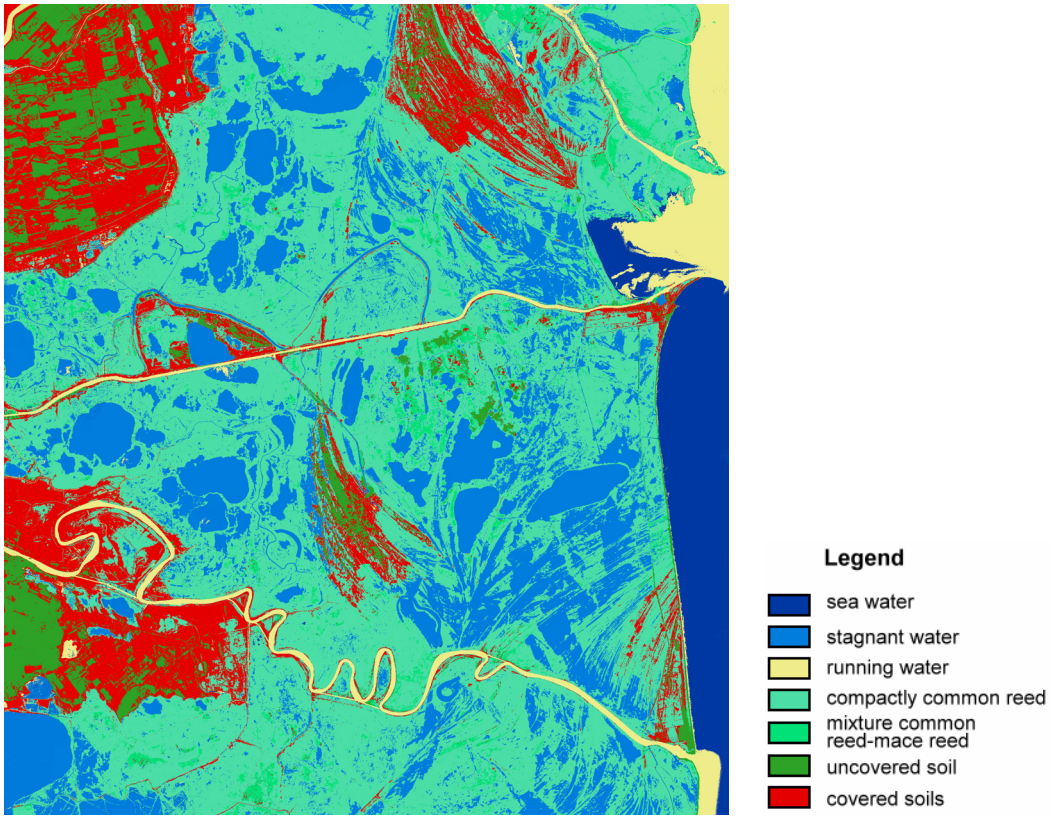
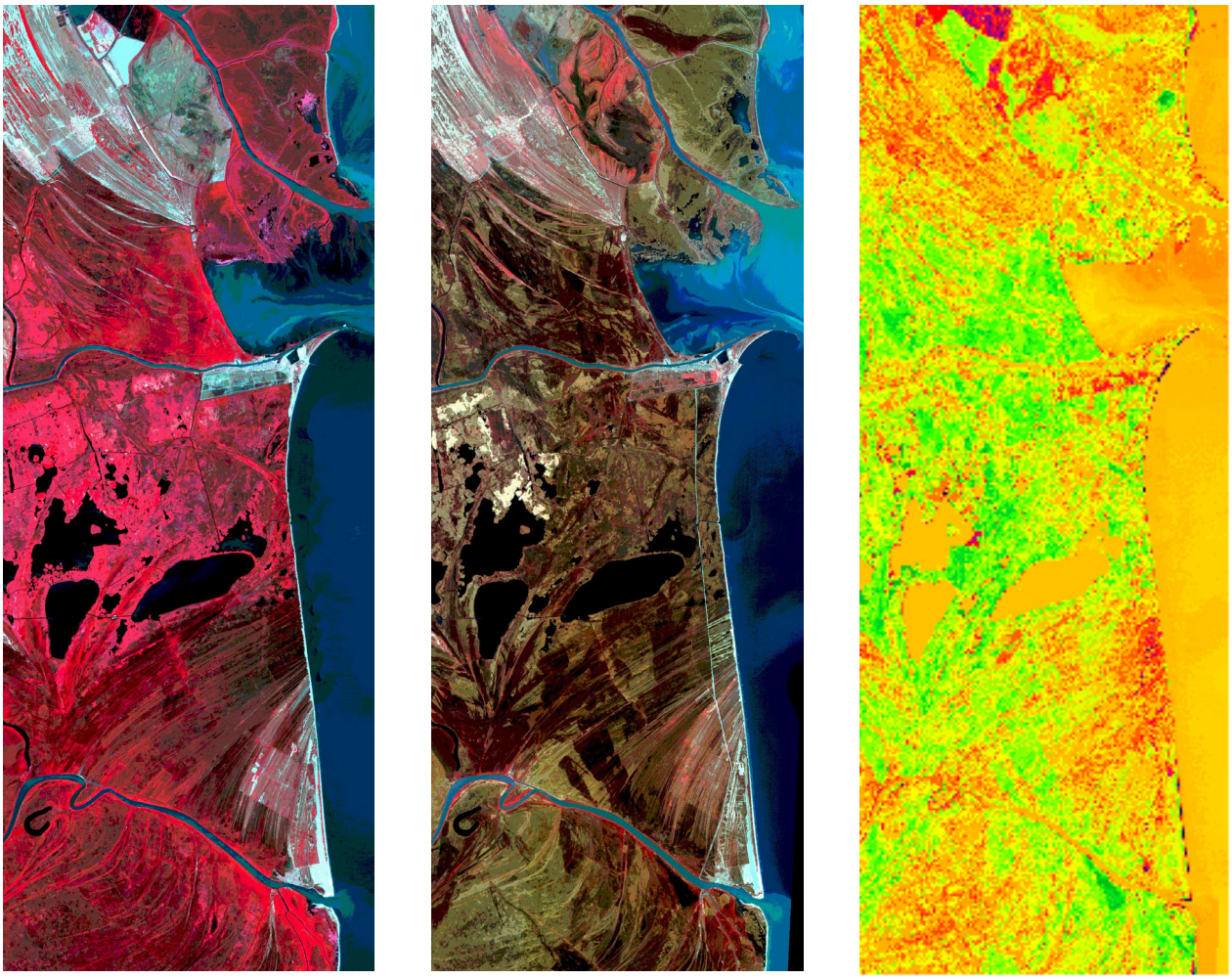


Figure 5. Classification for SPOT HRV April 27, 1993



a b c

Figure 6. Change detection using images difference
a - color composite image May 27, 1986 ; b - color composite image April 27, 1993 c - difference image

3.4 NDVI Image differrencing

Difference images were created by first calculating NDVI values for each date of imagery by following equation:

$$NDVI = (XS3 - XS2)/(XS3 + XS2) \quad (2)$$

A difference was created by subtracting one date of NDVI values from those of the previous date:

$$DIF[8693] = NDVI[93] - NDVI[86] \quad (3)$$

4. DISCUSSION AND CONCLUSIONS

The principal changes distinguished with the image obtained by differencing the classifications of the two composite images have been:

- the increased variation of shore lines characterised by (deposition) or forwards to sea or retreating zones (erosion zones). In study zone are revealed especially expansion zones with amplitudes of 1.5-5 pixels (beaches from east and south-east of Sulina town, agricultural polders Pardina and the one from south of Sulina town, mouth of Chilia branch, neighbouring of south-east zone of Roşu lake);
- changing of the lakes shape dues to floating reed islet formation moving (lakes: Fortuna, Gorgova, Lumina, Puiu);
- decreasing of compactly common reed areas where this was intensively exploited (for instance decreasing with 25-30% of some areas of south lakes Rosu, north-east of Razim lake and between Sulina branch and Lumina lake) and extensions of areas with common reed- mace reed mixture;
- news channels opening (parallel to shore line the channel Tataru and the channels for agriculture Sulina precinct plotting of land), six shortcuts of Sf. Gheorghe branch and news fishery areas from east Caraorman locality, Popina, north Mahmudia and others.

In the case of method vegetation index comparison especially point out variation of shore lines and news channels opening
This study clear distinguished that can be localised and in amplitude estimated the principals changing in deltas environment, using the HRV SPOT data. The result accuracy is directly conditioned by applied methods.
The post-classification comparison is advantageously because minimised the effects, which arise dues different acquiring images data. If the classification of used images enough accuracy, good results of change-detection are obtained. In this context mode type filtering technique prove to be adequately for accuracy improving. The threshold value of mode filters must be choosing to suppress one maximum pixel number due to noise or inadequate classification.

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