SPATIO-TEMPORAL ANALYSIS OF FOREST AREAS

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ABSTRACT:

The main aim of the study was to determine the forest area change using Landsat ETM+ images in the observed time-span of 1990-2000. After initial processing of images, optimal band combination was chosen based on data comparison with the digital orthophoto of the area in the scale of 2000. Both supervised and unsupervised classification were being performed and compared to the same aerial data. Change detection of forest areas is then followed by accuracy assessment. Software used was IDRISI Kilimanjaro.

1. INTRODUCTION

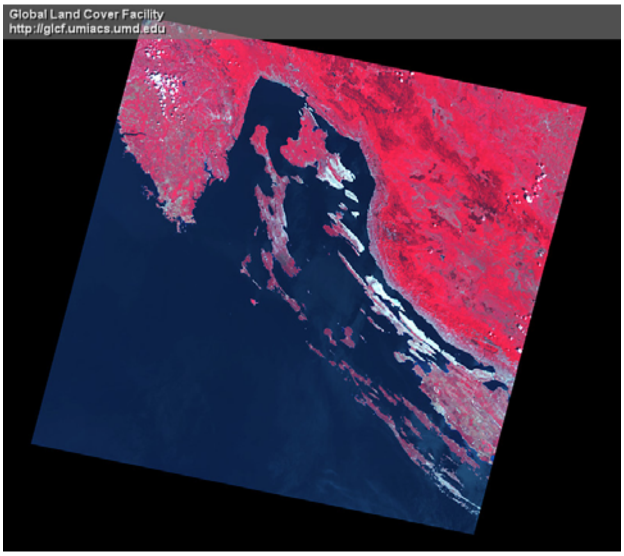
Forests are important natural and economic wealth and they have big influence on human population on both global and local level. Their dynamic change but also size itself makes them an interesting topic for remote sensing application. Growing population and specially urbanization of the popular tourist areas like observed here could possibly reduce forests span. Remote sensing is already widely used technique in these assignments since results can be with a relatively high accuracy, easy and fast to use from an expert but also with cost much lower than any traditional method. Aim of the study was to show the above stated and to produce data that potentially can be used in land protection, land planning purposes and also continued in future with up-to-date data. In this work, specie of lat. Quercus robur L. was used for a time-change analysis.

2. DATA USED

For receiving satellite images, I used free images of Landsat from Institute for Advanced Computer Studies, University of Maryland, USA site http://glcf.umiacs.umd.edu . This institute makes preprocessing, radiometric or geometric corrections within the images and I used data from June 6th 2000 and August 6th 1990.

Precisely, used 7-channel images are located on ftp://ftp.glcf.umiacs.umd.edu/glcf/Landsat/WRS2/p190/r029/p190r029_7x20000606.ETM-EarthSat-Orthorectified/ (190th path and 29th row in the WRS system, dated June 6th 2000). Image covers north of Adriatic sea and Croatia's west part. In the preparation phase, following has been noticed: 1990. images have poorer quality, small contrast and on 3rd and 4th channel an obvious error of banding. Images from the year 2000. have area of clouds covering large part of terrain in peninsula of Istra. For removing of banding, IDRISI's Principal Components Analysis module was used and there where 96% of data from first two components.

Data used as reference data were digital orthophoto maps in the scale of 1:2000 from the year of 2000 and positional accuracy of +-10cm.



Picture 1: Overview

3. STUDY AREA

With the area of 409km^2 Krk and Cres share the title of the largest islands in the Adriatic sea. Island Krk is on the far north, and it has a well defined coastline and various vegetation groups covering mainland. South of the island has almost no vegetation, covered with up to 500m high bare rock mountains.

This area has a moderate Mediterranean climate with some above-average rainfall influenced by the proximity of Alps.
Aim of the study was to make a time-change analysis of the forest areas on the island of Krk, represented mainly by deciduous Quercus robur L and in smaller areas coniferous pine forest.

Quercus robur L. is widely spread sort of oak on the island, and besides little parts of pine sorts in the south, we can say it is the only naturally grown tree. The density of the forest varies, and the spatial resolution of the TM sensor does not allow the detection of sparsely populated trees.

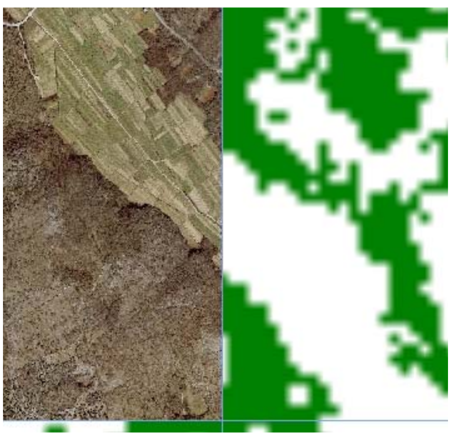
4. METHODOLOGY

It is known that some wavelengths have good reflectance in areas covered with vegetation, in Landsats sensors it is specially TM4 detecting chlorophyll in vegetation. First step in process was to find band combination or band ratio to have the best data for classification. I used SLAVI (Specific leaf area vegetation index) (by Lymburner et al 2000) ratio NIR/(Red+MIR) and compared the results with data extracted from NDVI ratio (NIR-Red)/ (NIR+Red) and color composite 4-5-3.

Change detection was based on subtracting two-date images after classifying them into only two classes - with and without forest. Results were 0,1,-1 (0-no change, 1-new forest area, "-1" lost or cut forest).

Similar analyses can be used also for example to follow particular species, if having more classes and better distinction.
The use of image differencing technique was not possible since the geometry of the images was not satisfactory and errors in change detection occured.

Both supervised and unsupervised classification were being performed, including IDRISI's ISOCLUST and MAXLIKE. The ISOCLUST is an iterative self-organizing unsupervised classifier based on a concept similar to the ISODATA routine (Ball, G.H., and Hall, D.J., 1965.) It was performed on the bands 1,3,4 and 5 of the data and in three iterations sorted in chosen number of clusters (here was 15). Pixels are then allocated in clusters by minimum distance method. Results were compared to the DOF images and then decreased the classes corresponding to forest areas were being extracted. In supervised classification, training sites were also chosen with the help by DOF images and the authors knowledge of the study area. Selection of good training (signature) sites is necessary for obtaining accurate classification results. For the classification itself, IDRISI's MAXLIKE- module for maximum likehood was used which is Bayesian classifier resulting in probability values. On the Picture 2 we can see results of the classification where forest area was successfully distincted from agricultural fields.



Picture 2: Comparison of DOF image with classification results

5. RESULTS

Accuracy assessment was being performed on the data from the year 2000 with accuracy of 76%(on 50 points comparing to digital orthophoto images). The accuracy of the classification itself is higher and for Maximum likehood method has the amount of 82% and 88% for the data from 1990 and 2000 respectively. We can also point out poorer quality of the year 1990 images which made limitations on the results accuracy and quality. Results received for the areas covered with forest have noticeable differences as can be seen in Table 1. Still, we can make a conclusion about increase of the forest areas, despite the obvious urbanization on the island. It is caused by people leaving they agricultural fields in last decades and these fields partly grow into small trees, bushes, and finally forest. Using these remote sensing data it was also visible the span of urbanization. More reliable results for the forest cover would be ones when included environmental parameters like soil moisture, details about vegetation phenology etc. which can be included in possible future studies with data from the following years.

Picture 3: Differences in forest cover 1990.to 2000.

Method	1990.	2000.
ISOCLUST	116.82km^2	139.30km^2
MAXLIKE	155.10km^2	177.98km^2

Table 1: Differences in forest cover on island Krk

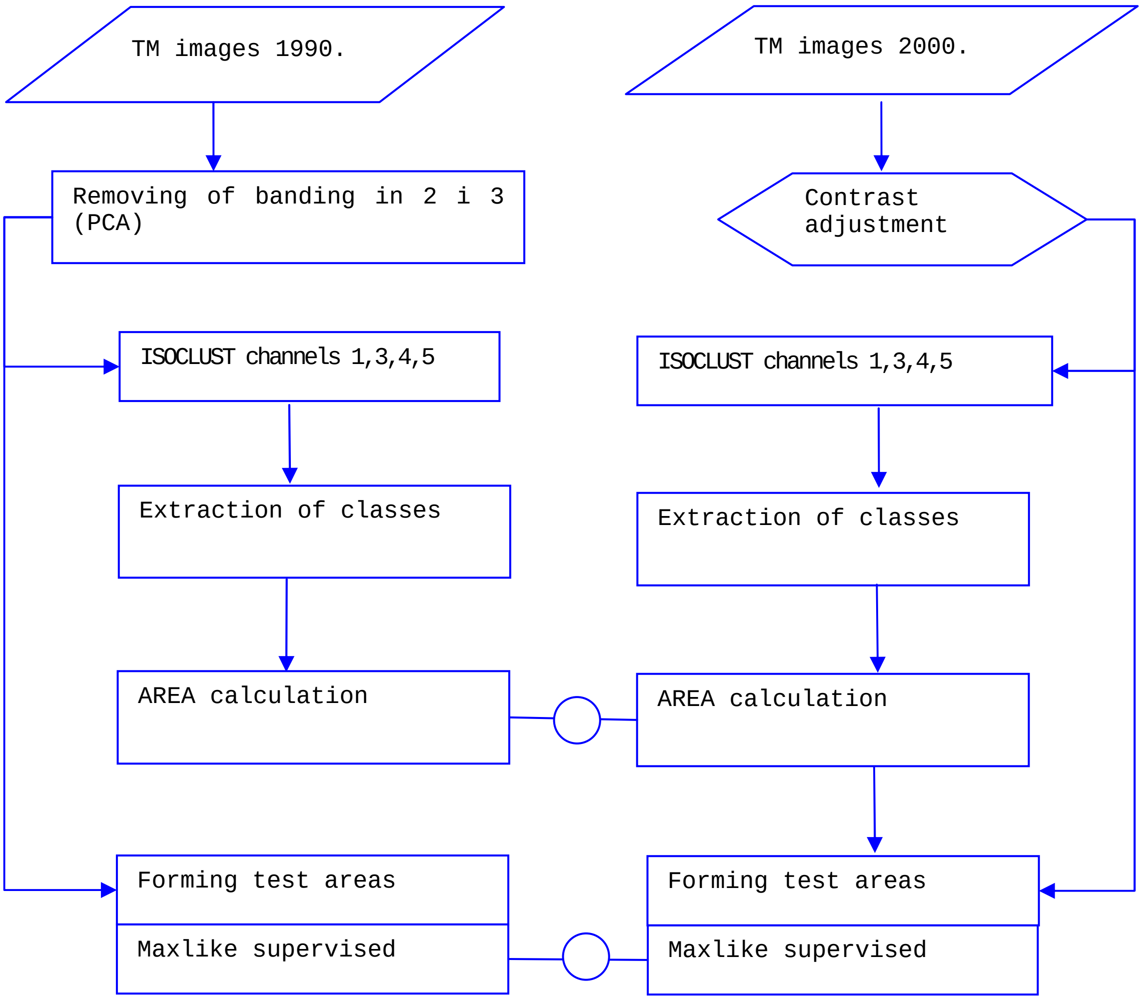


Figure 1 : Flow chart with IDRISI functions

6. CONCLUSION

The application of any change detection technique may be unsuccessful if user does not have enough knowledge about its characteristics in relation to the conditions over the area of study. Generally, the use of more than one technique is preferred by many researchers, because they can compare the results derived, and finally select the best ones for their project (Sangavongse 1995.)

The technique of change detection based on two-date classification and two-class operation has been found to be fast and simple to use with satisfactory results. In order to reduce errors in change detection it would be also required to have phenological codata about the images. The most important factors that should be taken into account when performing change detecting, as recommended by Jensen (1996), have involved the familiarity with the study area, the quality of the data set, and the characteristics of change detection algorithms.

It may be concluded that the use of Landsat TM for mapping forest change area provided satisfactory results which can potentially be improved. Land use/land cover should be conducted on a regular interval, to have reliable and usable results with conclusions about size and direction of change specially on large areas. The use of remote sensing is widely applicable and cost and time effective to their users.

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