Multitemporal Analysis of Changes in Range and Condition of the Mountain Forest Stands
– case study Tatras, Poland

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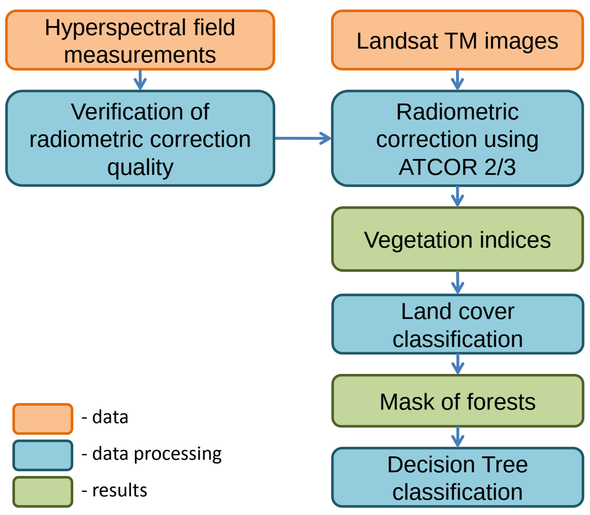
Introduction

The aim of the study was to assess the condition of Tatra National Park (TNP) forests and to show changes in their condition for three selected years, where the first and last year was characterized by the maximum available time span. The data used were Landsat TM images and spectral curves from field measurements. As method to assess the condition Decision Tree classification method was used.

Methods

Images were radiometrically corrected using ATCOR 2/3 software. Quality of the correction was assessed calculating RMSE for reflectance values from images and resampled spectral characteristics collected in terrain. On the corrected images a vegetation indices were calculated. Landsat images and Normalized Difference Infrared Index (NDII) were classified using Maximum Likelihood method to identify dominant land cover types. Based on the classification results masks of the forest areas were prepared. Next, Normalized Difference Vegetation Index (NDVI), Moisture Stress Index (MSI) and Decision Tree method were used to discriminate forest areas in different condition.

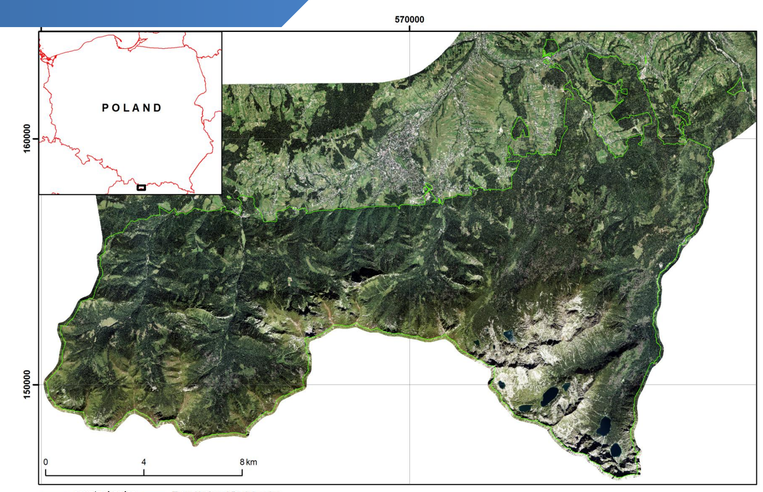


Data processing scheme

Study area

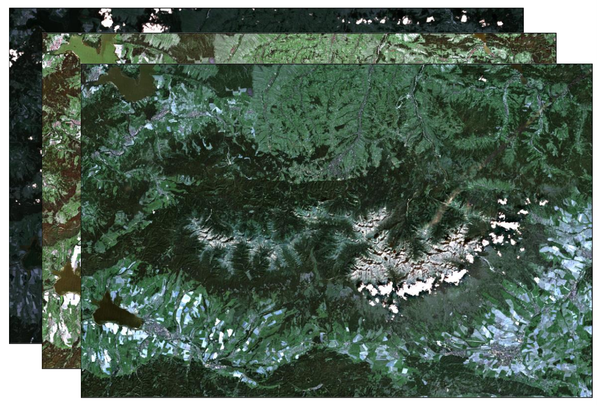
Study area is located in the Tatra National Park in southern part of Poland. The object of the study are forests in the border of the Park.

Vegetation and landscape of this region are very valuable and unique for that reason this Park is enlisted on UNESCO M&B program.



Data

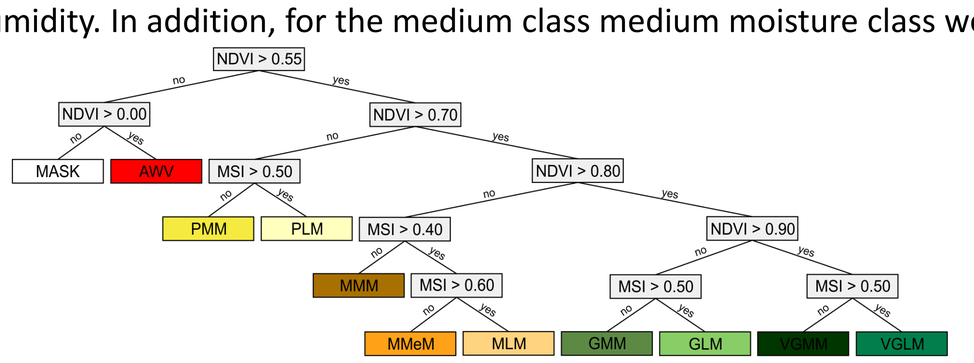
Selected Landsat TM data were acquired in following dates: 1987/09/01, 2005/09/02, 2011/09/03. A key of this choice was to obtain the images from the same sensor with maximum time interval and also from similar period of the year to reduce the influence of phenological changes. The hyperspectral data collected using ASD FieldSpec 3 FR spectrometer were used for verification of radiometric correction quality.



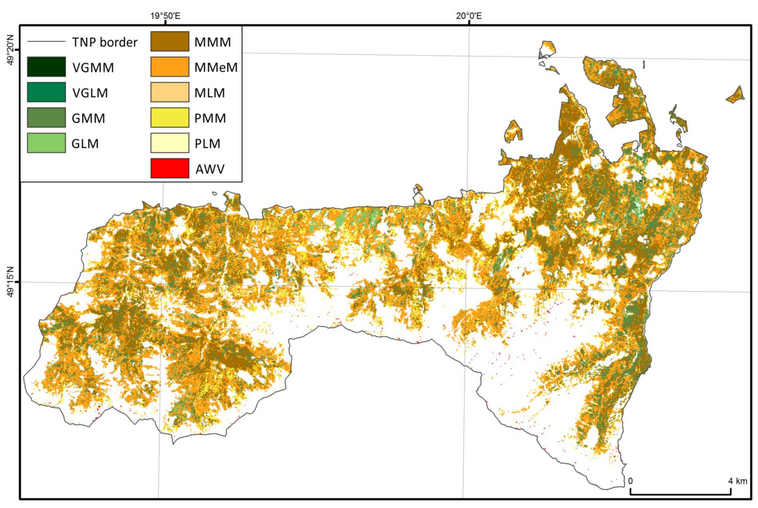
Landsat TM images

Results

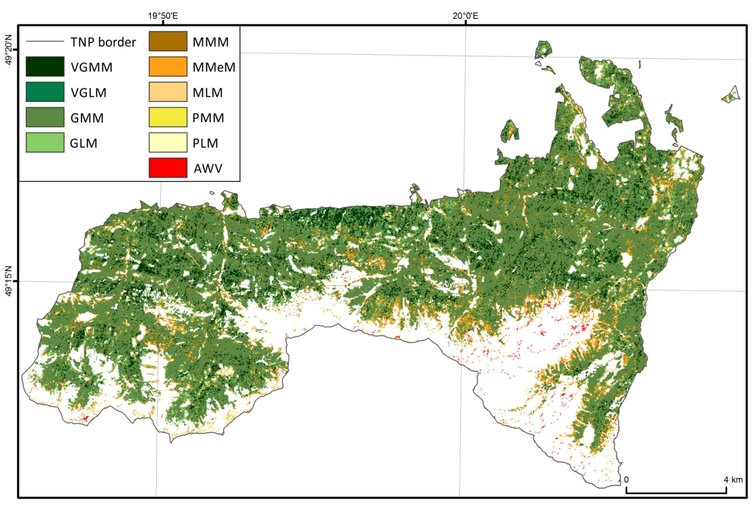
The results are the maps of 9 classes of forests condition, divided into four classes due to the general state: poor, medium, good and very good. These classes were differentiated due to more and less humidity. In addition, for the medium class medium moisture class were distinguished.



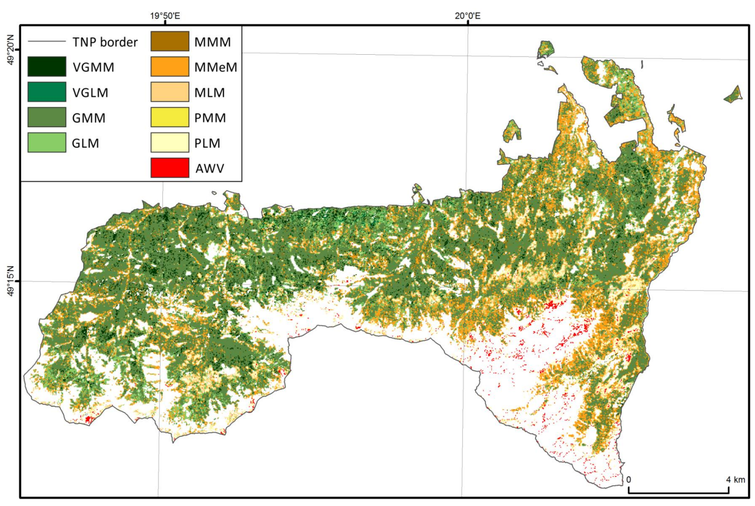
Decision Tree scheme



Classes of forest condition in 1987



Classes of forest condition in 2005



Classes of forest condition in 2011

VGMM - more moist vegetation in very good condition; VGLM - less moist vegetation in very good condition; GMM - more moist vegetation in good condition; GLM - less moist vegetation in good condition; MMM - more moist vegetation in medium condition; MMeM - medium moist vegetation in medium condition; MLM - less moist vegetation in medium good condition; PMM - more moist vegetation in poor condition; PLM - less moist vegetation in poor condition; AWV - areas without vegetation

Areas of condition classes related to forest area

Class	Year 1987		Year 2005		Year 2011	
	class area (km2)	forest area (%)	class area (km2)	forest area (%)	class area (km2)	forest area (%)
VGMM	0	0	16	10	6	4
VGLM	0	0	1	0	1	1
GMM	21	16	105	**69**	78	**51**
GLM	4	3	10	7	17	11
MMM	29	**22**	3	2	3	2
MMeM	57	**42**	13	9	31	**20**
MLM	1	1	2	1	8	5
PMM	13	10	0	0	0	0
PLM	8	6	2	2	8	5
AWV	0	0	1	0	2	1
Sum	133	100	153	100	154	100

Summary and conclusions

- Each of analyzed date was characterized by different condition.
- The worst overall condition was observed for the 1987, probably it was caused by air pollution.
- In year 2005 condition of the TNP forest was the best from all analyzed years.
- In case of year 2011 overall condition was quite good but there was noticed areas with poor condition caused by bark beetle.
- Proposed method allows for assessment of forest condition including wetness of stands. It is possible to detect damaged areas or in poor condition.
- It can be complement for traditional methods of monitoring and management in forestry.
- Monitoring of protected areas can be used with Sentinel 2 satellite images, more often.

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