Monitoring Land Use Change in South-west Romania Using Multi-temporal Landsat Remote Sensing Imagery

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Abstract— The changes in land cover in south-west Romania could affect the low frequency cycle of precipitation regime through changes in ground water stress and atmospheric circulation. Monitoring these changes using satellite images has been proved less expensive, as well as more reliable compared to conventional methods. The 50 ha of walnuts plantation, which were meant to strengthen the dunes in the area, have been deforested since 2013. This analysis to detect the deforestation was done using GIS, ENVI and ERDAS software and the method was made based on NDVI. The entire study was made with Landsat remote sensing imagery, choosing the month July. The change is quantified via spectral (image) or thematic (characterization) contrast. The percentage of vegetation losses after deforestation was 85.7%.

1. INTRODUCTION

Early detection of land use changes is important for environments with a frail ecological equilibrium like the ones affected by drought or having a sandy soil. Sudden changes are caused by modifications in landscape alteration, disturbing events, deforestation being the main phenomena in this case study. In general, these types of events radically alter the spectral properties of the land surface, and are readily discernible in Landsat imagery [7]. Human-made forcings result from, for example, the gases and aerosols produced by fossil fuel burning, and alterations of Earth's surface from various changes in land use, such as the conversion of forests into agricultural land [1]. GIS and Remote Sensing have the potential to support such models, by providing data and analytical tools for the study of environment. The literature is replete with examples of mapping and monitoring major disruptive changes using remotely sensed data [2–5, 8].

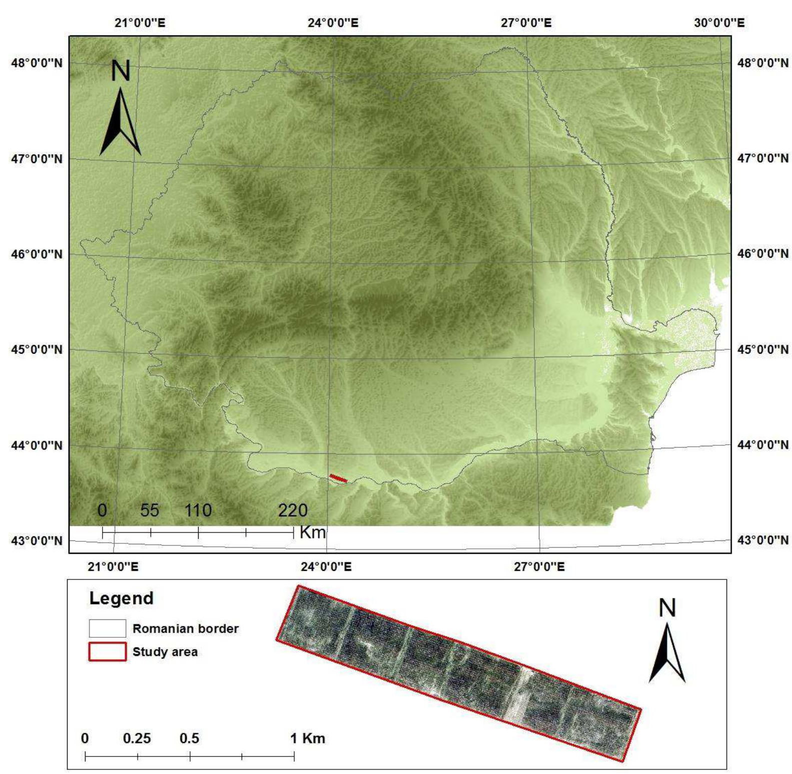


Figure 1: Walnut plantatin location.

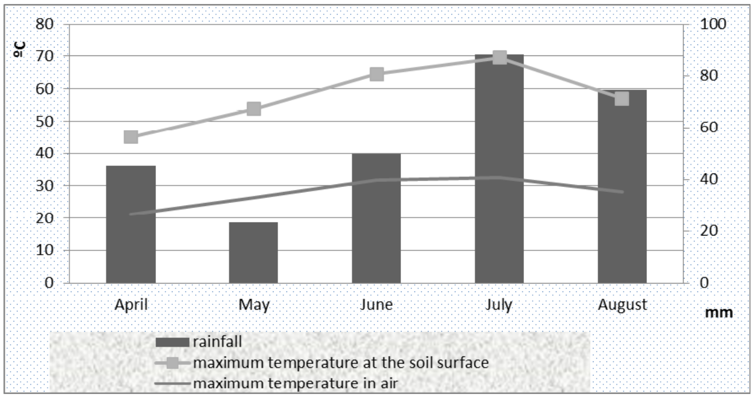


Figure 2: Climatic parameters for growing season — Bechet weather station (1987–2013).

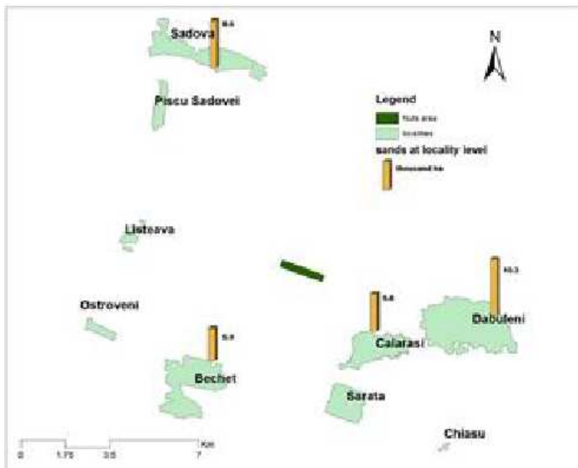


Figure 3: Sands at locality level according with Research Development Center for Agricultural Plants on Sands Dăbuleni, 2009.

2. STUDY AREA

The study area from Romanian Plain with a frail equilibrium also has a sandy soil and was covered by a walnut plantation which has now been affected by deforestation (Figure 1). Regarding the meteorological aspect, during the summer time, the area is not affected only by atmospheric drought but even pedological, with maximum temperatures up to 40°C in the air and 50–70°C at ground level. Rainfall records have a negative trend. July monthly rainfall average is 90 mm (Figure 2) which usually falls in only 5 to 7 days. Prevailing wind direction is the same as the sand dunes exposure, from West to East, with a frequency of 27.6%.

The walnut tree has been chosen for the fixation of the sand dunes (sands soils at the locality level is shown in Figure 3) due to its profound radicular system. The plantation started since 1977, but it has been gradually deforestated since the fall of 2012 onwards. A favourable plantation and development would be almost impossible due to non-operating irigation system and the pronounced pedological drought.

3. SURFACE DATA

The study area is covered by 5 satellite images from years 1987, 1993, 2006, 2009 and 2014. We used a multi-temporal imagery of Landsat Thematic Mapper (TM) and Landsat 8 (OLI) images for Path 184 and Row 29. The study area has the geographical coordinates: 43°49″17′ lat. N and 24°01″08′ long. E. The polygon corresponding with the studied area, walnuts plantation from the S-W Romania, was created using Google Earth, because the precise location was determined using GPS. In order to ensure comparability of data, it was chosen the month July, because in the full vegetation season the crowning is very developed. We chose July because then it is produced a large NDVI response. Preprocessing procedures can be expressed as: (1) radiometric calibration, each imagine was calibrated using Radiometric Calibration tools from ENVI software, (2) clipping the imagines used to get a subset where the test site is located, (3) RMSE (horizontal root mean square error) calculation by Erdas software, (4) NDVI calculation using Raster Calculator by ArcMap 10.1, (5) mathematical operation (report, difference) using NDVI product corresponding to each year of study.

4. CHANGE DETECTION

For this case study we've used remote sensing techniques integrated in a surface analysis in order to identify the walnut plantation areas affected by deforestation. This disturbing event was caused by human interference. Starting with the fall of 2012 the deforestation took place gradually until the fall of 2013. All six allotments have been cut gradually, but started from only branch cutting and ended with cutting the trunks. Due to its temporal profile with different types of seasonal coverages, we have calculated the NDVI using a common extraction data, the value thresholds method, based on the idea that the disturbing phenomena occured in the same time with the decrease of NDVI

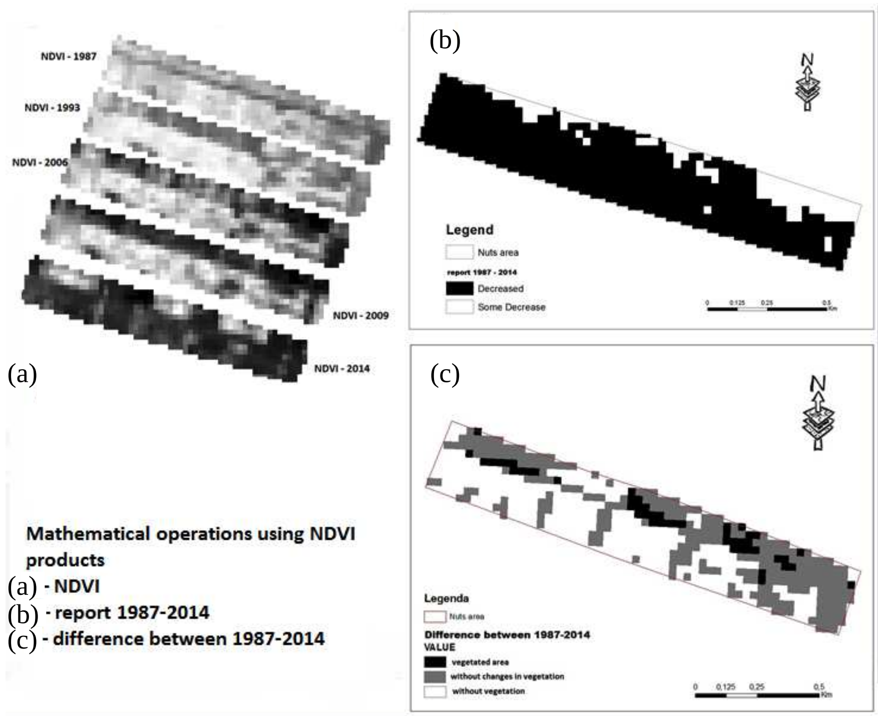
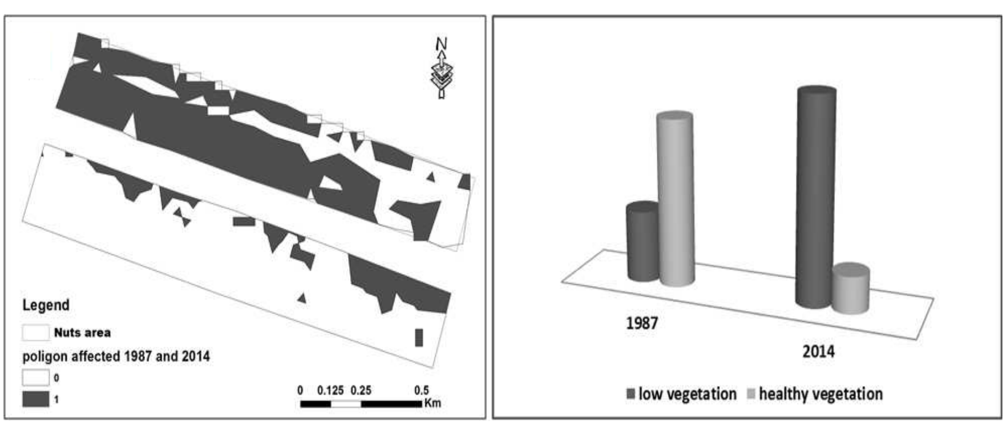


Figure 4: Walnut plantation — change detection (tool models).



(a) (b)

Figure 5: (a) Raster to vector conversion. (b) NDVI — quantitative analysis.

values, under the threshold. Thus we have graphically represented reality (Figure 4). Horizontally it means square error calculated for the satellite images used is situated between 0.3–0.35. The analysis required crossing from raster to vector representation, thus 0 values are polygons with a scattered vegetation and 1 values are dense vegetation polygons (Figure 5(a)). The negative and positive pixel values from 1987 and 2014 are acacia curtains that separate walnut plantation allotments and walnut trunks which weren't effectively ground cut so they grew new branches in the vegetation period of July. Surface analysis indicated a growth in deforestated areas, so if in July 1987, scattered vegetation areas had a low value of 15,05%, in July 2014 affected areas reached 42.7% (Figure 5(b)).

5. CONCLUSIONS

South-West Romania is facing major transformations regarding its land use. Human interference has higher and higher levels given that climate variability is corelated with a faulty management in maitaining and improving mitigation methods. GIS and remote sensing instruments like multi-temporal analysis of preprocessed Landsat satellite imagery followed by applying NDVI mathematic equations provided the data and analytical instruments which led to the disturbing phenomena detection. Quantitative analysis highlighted the high percentage of vegetation loss, of 85.7%, the rest of 14.3% being insignificant reported to the protection factors of that area's degree of necessity. Applying this change detection method, in this area with a frail equilibrium, led to findings which can be materialized in reorganising land use methods.

ACKNOWLEDGMENT

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