ECOLOGICAL ANALYSIS OF DESERTIFICATION PROCESSES IN SEMI ARID LAND IN ALGERIA USING LANDSAT AND ALSAT 2A DATA

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Abstract:

The degradation of arid and semi-arid ecosystems in Algeria has become a palpable fact that only hinders progress and rural development. In these exceptionally fragile environments, the decline of vegetation is done according to an alarming increase and wind erosion dominates. The ecosystem is subjected to a long hot dry season and low annual average rainfall. The urgency of the fight against desertification is imposed by the very nature of the process that tends to self-accelerate, resulting when human intervention is not forthcoming the irreversibility situations, preventing any possibility of restoration state of these zones. These phenomena have led to different degradation processes, such as the destruction of vegetation, soil erosion, and deterioration of the physical environment. In this study, the work is mainly based on the criteria for classification and identification of physical parameters for spatial analysis and multi-sources to determine the vulnerability of major steppe formations and their impact on desertification. We used LANDSAT and ALSAT 2A data with two different dates March 2010 and November 2014 in order to determine the changes in land cover, sand moving and land degradation for the diagnosis of the desertification Phenomenon. The application, through specific processes, including the supervised classification was used to characterize the main steppe formations. An analysis of the vulnerability of plant communities was conducted to assign weights and identify areas most susceptible to desertification. Vegetation indices are used to characterize the steppe formations to determine changes in land use.

1. INTRODUCTION

Desertification is the irreversible extension of desert to areas where they did not occur in the recent past (Le Houérou 1996). It is the result of two factors operating either singly or in combination in arid Mediterranean zones. These are (1) periods of prolonged drought and (2) man’s exploitation of arid lands (LeHouérou and Rapp 1976; Manière and Chamignon 1986; Le Houérou 1993, 1996, 2005). The resulting degraded conditions threaten two-thirds of the world’s arid countries (Nahal 2004). The High Plains steppe south Oran is part of arid and semi-arid Mediterranean. They have always been a key component in the stability of the economic and social balance rural world. Indeed, the course is a resource natural for grazing animals, provide habitat for wildlife, home to groundwater supplies, protect watersheds and in the fight against the desertification. They consist of grassland formations under part of the arid Mediterranean floor under the aspect of a mosaic of plant communities dominated three respectively two grasses: Alfa (Stipa tenacissima), the Esparto (Lygeum spartum) and a composed Wormwood (Artemisia herba-alba). However, the existence of populations rural, particularly in pastoral lifestyle is a permanent cause alteration of vegetation which is supposed to be protected by a formal policy grazing. The importance of biological resources twice ecologically and cost is well established, and from the severity of the deterioration of the ecological situation in this zone.
1.1 Objectives of the study

The ecosystem in the semi arid region Naama has a very advanced state of degradation of forest and steppe course. This degradation of natural formations is the result of adverse weather conditions, or irreversible deterioration process, making losing steppe ecosystem and ecological diversity. This irreversible process of deterioration accentuated by wind erosion enables installation of Phenomenon of desertification. In this study it is to make a diachronic analysis with remote sensing images with different dates to detected changes.

2. Recommended methodology

To accomplish this work, we have used remote sensing imagery satellites LANDSAT TM of the months of March 2010 and November 2014 combined with ground surveys. The result of this combination has allowed us to infer the impact of the semi arid ecological diversity of steppe formations. This longitudinal study based on the use of remote sensing data is to analyze the evolution of steppe ecosystems. The satellite data used allowed us to establish thematic maps. These are the land use map, and sand cover map (extracted from the map of land) that constitute the basic maps that will serve to establish map of change and desertification. The methodology is based on the double aspect multi date and multi sources. In working in multi date way, it's possible to apprehender a dynamic aspect of the steppe ecosystem. Then when working in multi sources, it’s possible associate tools offered by the various data (NDVI, MSAVI2.). Of course; came to transplant these two theoretical notions the notion of reality, which is indispensable in this kind of study. In our case, the used data are: some pictures satellites of LANDSAT 5 TM of month of March 2010 and November 2014. In order to succeed in determining the different formations and land cover, we used the RGB mode order to identify the plants formations which provide us the aspect of the ecological diversity of this ecosystem. The data LANDSAT TM were also treated at the time of classifications supervised by maximum of verisimilitude and at the time of development of index normalized of vegetation (NDVI) and Modified Soil-Adjusted Vegetation Index 2 (MSAVI2). The use of NDVI and MSAVI2 had the objective of visualization of the dynamics steppe formations. The picture of the changes is obtained from some arithmetic combination of index of vegetation of the two dates respectively LANDSAT 2010 and LANDSAT 2014.

2.1. Presentation of the area of study

The Naama region belonging to the semi-arid bioclimatic, has a fairly large area of land described the phenomenon of desertification. Having a texture usually dominant sandy soils used for pastoralist, which once denied the permanent cover, will be subject to severe wind erosion. Overgrazing is a second cause of degradation and loss of land. The forested areas consisting primarily of older forests of Aleppo pine are in a state of degradation.

2.2. Choice of the pictures

For this survey, we chose some data of satellite LANDSAT March 2010 and November 2014. A window of 1213 columns and 1644 lines were chosen, covering a zone of steppe in Naama which presents a degradation of steppe ecosystem.

Fig.1: Color composite of LANDSAT 2010
2.3. Method adopted for the classification

In the case of the supervised classification, the operator defined priori the classes that he wants to constitute, in referring the reality. This method rests on the statistical distribution some answers radiometric of every class which serves therefore to establish the beaches radiometric for witch a given pixel corresponds to a given class. On the other hand, in the classification no supervised, the pixels are going to be classified by following computer some criteria's of homogeneity of the radiometric values. One chose the fashion supervised in order to achieve this classification, the method of maximum of considered verisimilitude like a powerful technique of classification was chosen also.

The result of this classification is given in the figure 4. Considering the above facts, the objectives of this paper are: to use remote sensing techniques to identify the land use of the Naama region in accordance with their actual use; to detect and monitor the changes in land use/cover from 2010 to 2014; to compare the classification results and to determine the change in the ecosystem steppe. to examine the effect of land use change on landscape structure in terms; and to determine the major driving factors of land use/cover change.
2.3.1 Land cover classification scheme:

The next step was to create a nomenclature of land cover. The land cover classification was carried out during the visual study of image and literature review. Eight separable land use/cover types have been identified in this study as forest and vegetation, water, sand, sandy sailing; soil course and cereals.

2.4 Change detection

The main objective of this study is to identify the changes of land protected areas of Naama due to the negative impact of the megacity on natural ecosystems and to predict their dynamics. Because of the knowledge of historical trends of land cover change, not only how much has changed but also where and when changes have occurred can help land managers identify the key resource and ecosystem stressors, as well as prioritize management efforts. So In order to study the evolution of the site concerned by our study it was decided to opt for the use of vegetation indices.

The vegetation index most used is based on the ratios. This index characterizes not only the vegetation but also eliminates the influence of the solar elevation, and structures and objects observed that reduces the effect of the conditions of shooting on multi temporal images. This ratio index expresses the ratio of the spectral response obtained in the near infrared band (between 0.79 microns and 0.89 microns), which is in the band for high reflectance of vegetation and the red band (between 0.61 microns and 0.68 microns), which is in the absorption band of chlorophyll. Among these vegetation indices, the most widely used is the NDVI:

![Vegetation density 2014](image1) ![Vegetation density 2010](image2)

**Fig. 6. NDVI Result**

The supervised classification showed the different classes of ecosystem steppe of the region of Naâma during both 2010 and 2014 period, respectively, and the results of area covered by different class is in the table below.

<table>
<thead>
<tr>
<th>Types of the land cover</th>
<th>Land use 2010(he)</th>
<th>Land use 2014(he)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Course</td>
<td>34226.3</td>
<td>35,243.8</td>
</tr>
<tr>
<td>Course Alfa</td>
<td>89,294.9</td>
<td>107,414.3</td>
</tr>
<tr>
<td>Cereals</td>
<td>9,270</td>
<td>9,234</td>
</tr>
<tr>
<td>Sand</td>
<td>11,159.4</td>
<td>9,764.4</td>
</tr>
<tr>
<td>Sandy sailing</td>
<td>25,912.9</td>
<td>15,006.7</td>
</tr>
<tr>
<td>Forest</td>
<td>14,268.7</td>
<td>8,517.8</td>
</tr>
<tr>
<td>Water</td>
<td>113,4900</td>
<td>56,7000</td>
</tr>
<tr>
<td>Bare soil</td>
<td>4,490.1</td>
<td>3,379.1</td>
</tr>
</tbody>
</table>

2.5 Wind erosion

Wind erosion is the main physical factor depletion of agricultural land, and siltation...
is a major inconvenience in urban areas and oases dry ecosystems, causing poverty and migration of human populations who abandon their lands became sterile for new lands or cities. Anthropogenic factors (deforestation, overgrazing ...) are compounded by their superposition with recurrent drought phases or "accidents" rainfall (floods ...). There are also factors of vulnerability to wind erosion inherent in dry ecosystems, the first being the thin soils and drought sensitive. To promotes their fragility and reduction easily exportable powder. The soils are so depleted by a first wind winnowing process and fine sand particles (clay, silt, fine sand). Scanning by winds supports particles, winnowing sorts and their accumulation causes the organization of a new generation of dunes. Overexploitation by human activities (agriculture and grazing) leads to sterility of these soils low in organic matter.

Land sat TM image 2010 shows a large area of sand and sandyailing respectively 11,159.4 and 25,912.9 hectares, and following the phenomenon of wind erosion there is a net decrease of the area occupied by the sandy sand and sailing in 2014, (9,764.4, and 15,006.7 hectares).

This explains movement particles to the North West wind, these particles are formed by the action of ergs and accumulations of sand.

2.6 Post classification Treatments:

The most common of the slope based methods, NDVI, was proposed by Rouse et al. (1974) and is expressed as the difference between the near infra-red (NIR) and red (red) bands normalized by the sum of those bands:

Equation: \[
NDVI = \frac{NIR - red}{NIR + red}
\]

Huete (1988) introduced a constant soil adjustment factor, L, into the NDVI equation in order to minimize the influence of soil background. Huete’s (1988) Soil Adjusted Vegetation Index (SAVI), is represented by the following equation:

Equation:

\[
SAVI = \frac{NIR - red}{NIR + red + L} \times (1+L)
\]

The soil adjustment factor is represented here by L, and can vary between a value of 1.0 for low vegetation densities, 0.5 for intermediate densities, and 0.25 for high densities.

For certain area analyzed comparing the NDVI values and SAVI showed that SAVI values more significant for the canopy that NDVI values. As part of the multi-temporal analysis based classifications SAVI and NDVI data, we applied a cross-classification matrix which has proved very useful to identify changes between different dates.

![Fig.8. sand repartition](image)

![Fig.9. SAVI Result](image)
3. Results and discussion

The remote detection of vegetative change within arid areas is significantly more difficult, with the selection of appropriate methods being heavily scene dependant. Image differencing, and more specifically vegetation index differencing, is one of the most common vegetation change detection methods, mostly due to its simplicity (Singh, 1988; Lu et al, 2003).

The results of NDVI should be well to explain some of the variation in terms of steppe vegetation cover in the landscape between 2010 and 2014. It is easy to see that the steppe vegetation such as golf courses and a well-alfa have increased in area the table shows that during 2010 there has been an area of 34226 hectares of rangeland while it amounted to 35,243 hectares in 2014. The course has also been an increase alfa in terms of area of 89,294 hectares has 107,414 hectares in 2014. As against the forest vegetation shows an area of decreased because in 2010, the forest area that busy woody vegetation was 14268 hectares, while we see what decreases to 8517 hectares in 2014. The land occupied by agriculture includes cereal remains almost unchangeable there is 9270 hectares.

Conclusion

the results of this study shows the potential of TM data (2010) and (2014) and their integration in multi-temporal analyzes to obtain viable information about tracking changes in the natural environment in the area of El Naama over approximately 15 years. the use of vegetation index SAVI provided very useful information there regarding the percentage change of the different vegetation classes of the steppe ecosystem. under the action of wind déplacemnt sand detected by the TM image shows the action of wind erosion in the region and the process of desertification.

References


