

Diachronic analysis of the occupation of the steppe area of the department of Sidi Bel Abbes (Western Algeria)

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Abstract

Modes of occupation of the soil of the steppe area of the department of Sidi Bel Abbes (Western Algeria) know lots of mutations during the period 1987/2013; compromising the future of pastoral activity. This dissection based on supervised classification TSAVI values (Transformed Soil Adjusted Vegetation Index) using images of remote sensing of average spatial resolution of type Landsat-TM 5 and 8. The determination of the state of occupation of the ground and validation of remote sensing map shows that the status of the halophytic/psammophytic steppes and the Matorrals are detected in 38.38 % and 55,71 % of cases, respectively. On the other hand, the steppes chamaephytic mark -9,81 % regression only, agricultural land -24,51 %, and -46,24 % dense vegetation are correctly mapped. The sensing medium resolution is therefore, in the light of these figures, a management tool of the steppe field relevant and effective, which, in addition, allows enriching the field for a proper plan for the fight against desertification.

1. Introduction

The steppe area of the department of Sidi Bel Abbes (Western Algeria) is subjected to very high spatial transformations. These transformations are ecological, climatic, sociological and professional [1]. This has increased the degradation of plant cover of the steppe and promoted the event of desertification throughout the steppe space [2]. The study of changes in the steppe vegetation cover is undertaken by remote sensing. The availability of digital data from previous years allows to quantitatively and qualitatively assess land use patterns. The dynamics of the degradation is followed by the application of the index transformed vegetation adjusted to the ground (TSAVI) [3]. The data used to design maps of land use are satellite scenes "Landsat 5 and 8" TM (Thematic Mapper) from March 1987 and 2013. They thus help to establish a more complete diagnosis of the evolution the steppe area of the department of Sidi Bel Abbes for a period of 26 years.

2. Ecological characteristics of the study area

The steppe zone of the Department of Sidi Bel Abbes is between 34° 30' and 34° N and 1° and 0° East. It is located nearly 300 km from the coast of western Algeria (figure 1).



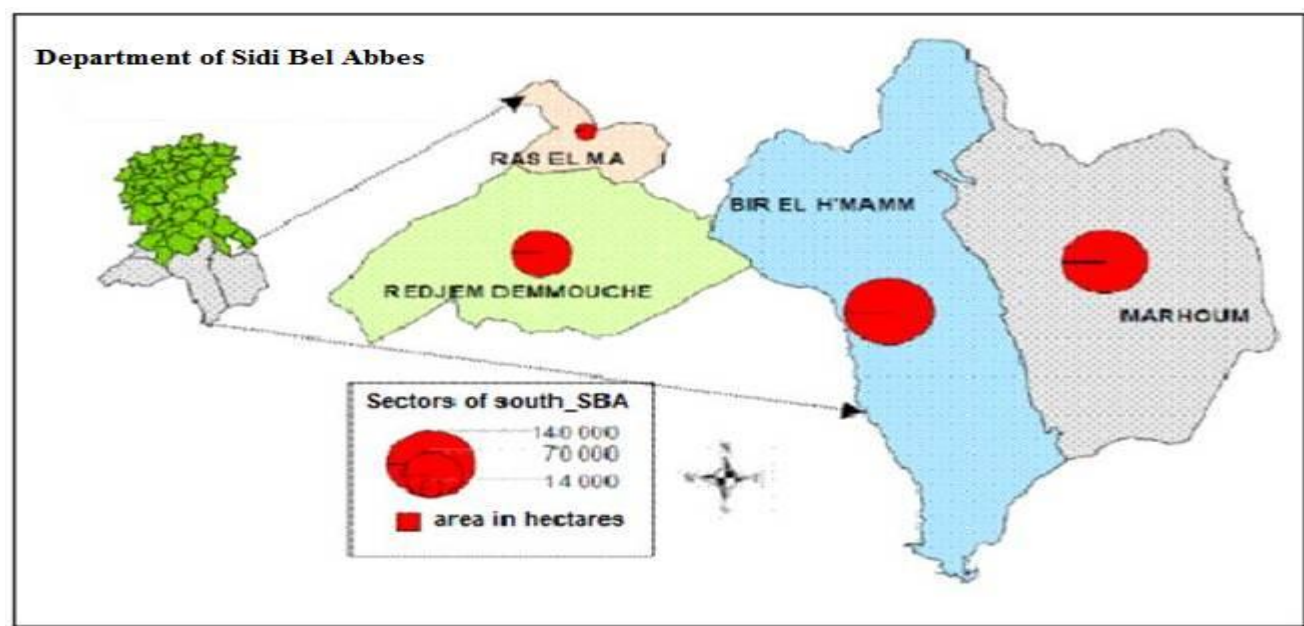


Figure 1. Location of the steppe area south of the department of Sidi Bel Abbes (Algeria).

It covers an area of 3531.18 km² or 38.58% of the area of the Department of Sidi Bel Abbes. It is located at an average altitude of 1200 m. They have four municipalities with Ras Elma (143.52 km²), Redjem demmouche (765.84 km²), Marhoum (1253.13 km²) and Bir El' Hmamm (1368.69 km²). Annual rainfalls of 125.1 mm to over 200 mm. Maximum temperatures (M) are between 34.5°C and 35°C [4]. The region is moving in the arid bioclimatic moderate cold winter [5]. The predominant brown limestone soils are characterized by a depth of 30-40 cm and a sandy clay texture clay surface and at depth. They rest on a limestone crust more or less indurated. Calcimagnesian xeric soils are also represented in the study area. The glaze of the south of the region is characterized by calcareous brown soil crusting xeric to less than 30 cm deep.

3. Materials and methods

The study is based on two satellite images Landsat TM5 and Landsat-March 1987 TM8 March 2013. They are geo-referenced and projected into the conical Lambert system (geographic coordinates system applied in Algeria). The pixel size on the photographs is 30 m.

3.1. Pretreatments of satellite scenes

Satellites scenes have undergone digital pretreatments using appropriate software (ENVI, version 4.7). This allows among others to perform geometric and atmospheric corrections to improve the colored composition of the three selected channels. This step makes it possible to reduce to a maximum of artifacts related to the conditions of shooting.

The image of Landsat TM5: TM1 (blue channel), TM3 (red channel) and TM4 (near infrared channel). The image of Landsat TM8: TM2 (blue channel), TM4 (red channel) and TM5 (near infrared channel). The radiometric corrections (atmospheric) is supported on the physical model based radiative transfer "MODTRAN". This second step corrects the wavelengths in the visible through near infrared and shortwave infrared up to 3 m [6]. It makes the two satellite images from different dates directly comparable [7].

Georeferencing of satellite images is a correction operation in a raw image, geometric distortions due to variations in orientation of the observation platform. This correction can bring the geometry of the raw image to a map geometry.

3.2. Treatment index transformed vegetation adjusted to the floor (TSAVI)

The index converted adjusted vegetation soil (TSAVI) is based on the predetermination of right soil from the spectral band of the sensor. It is expressed by the following formula [8]:

$$TSAVI = a (PIR - a \times R - b) / [R + a \times (PIR - b) + 0,08 (1 + a^2)]$$

with :

(PIR) : near infrared channel; **(R)** : infrared channel ; **(a)** : the slope of the soil ; **(b)** : the intercept of the straight soil, values range from (- 1 et + 1) respectively to absence and presence of vegetation.

The clustering is proposed to define the land use classes on thematic bases. The results are then compared with control zones using a confusion matrix [9]. The land cover classes are determined from different values of TSAVI calculated on two satellite scenes.

The evaluation of the performance of the classification structure is based on the calculation of the percentage and number of pixels correctly classified within each test polygon of the control zones. The confusion matrix of the estimation on the two finally selected pictures will illustrate this performance.

4. Results

4.1. Index of TSAVI

The results of the processing of satellite images are shown in figures 2 and 3. The analysis identified seven main types of land use in the study area: (Class 1: wetland and urban area, Class 2: ground uncovered, Class 3: halophytic and psammophytic steppes, class 4: chamaephytic steppes, class 5: grain farming, class 6: matorral and maquis and class 7: dense vegetation).

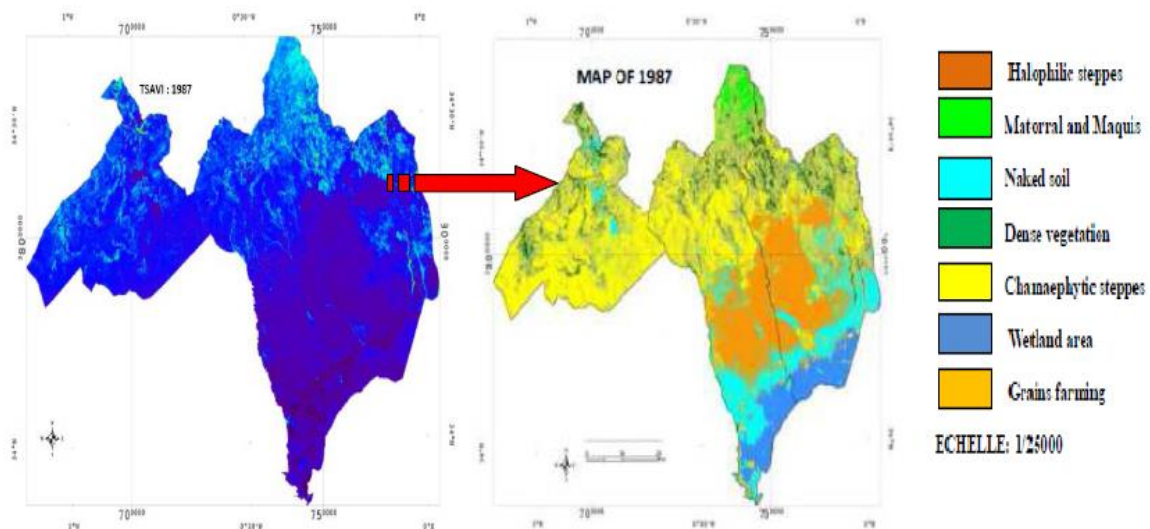


Figure 2. Images of index of TSAVI of the study area (from year 1987).

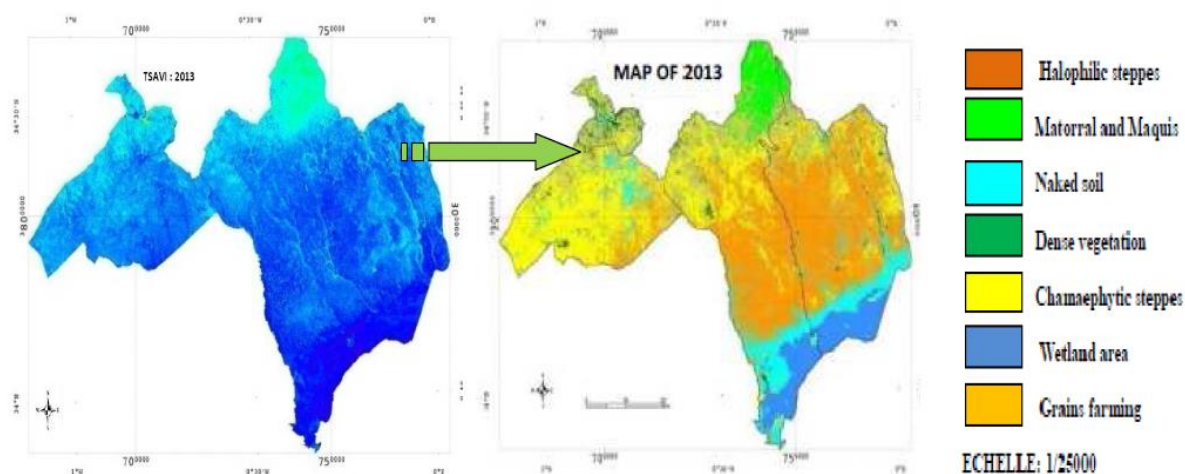


Figure 3. Images of index of TSAVI of the study area (from year 2013).

4.2. Change in vegetation cover by municipality

Figure 4 shows the status of land use in the municipalities of Ras Elma and Marhoum for the years 1987 and 2013. The changes between the two years are shown on the same figure (figure 4).

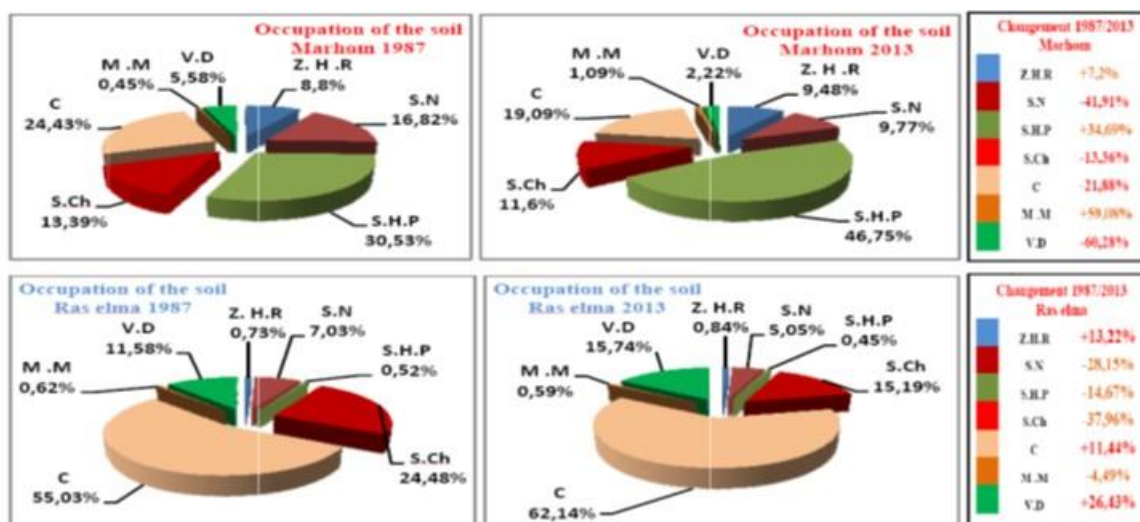


Figure 4. Percentage of land cover and change (municipalities: Ras Elma and Marhoum period 1987/2013).

NB : (Z.N.R : wetland and urban area). (S.N : ground uncovered). (S.H.P : halophytic and psammophytic steppes). (S.Ch : chamaephytic steppes). (C : grain farming), (M.M : matorral and maquis). (V.D : dense vegetation: forests / growing vegetables /cultivation of fruit trees/ replant trees).

The municipality of Marhoum recorded notable increases halophytic and psammophytic steppes, matorral and maquis couple with 34.69% and 59.08% respectively. The other classes fell to -41.91%

for the ground uncovered and -60.28% for dense vegetation. The Municipality of Ras Elma was characterized by an increase of 26.43% in irrigated crops and orchards. Cereal crops increased by 11.44%. Steppe rangelands and ground uncovered have declined by against because of land clearing, farming and put into crops.

The state of land use and changes between 1987 and 2013 in the municipalities of Bir El'Hmmam and Redjem Demouche are given in figure 5.

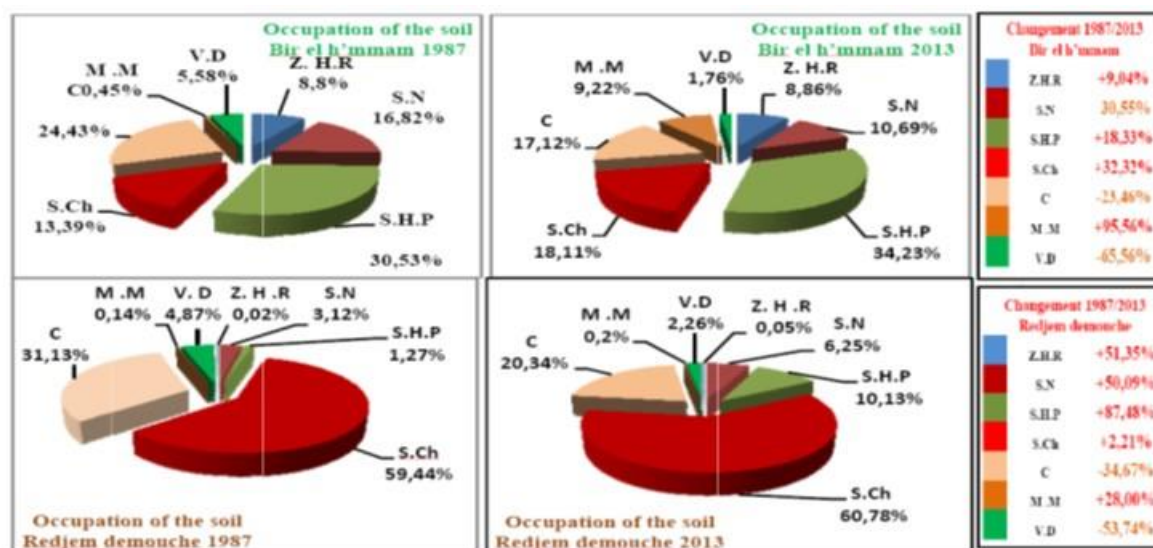


Figure 5. Percentage of land cover and change (municipalities: Bir El'Hmmam and Redjem demouche period 1987/2013).

NB: (Z.N.R: wetland and urban area). (S.N: ground uncovered). (S.H.P: halophytic and psammophytic steppes). (S.Ch: chamaephytic steppes). (C: grain farming), (M.M: matorral and maquis). (V.D: dense vegetation: forests / growing vegetables /cultivation of fruit trees/ replant trees).

The forest areas in the municipality of Bir El'Hmmam experiencing a remarkable extension of 95.66% by the reforestation work. The degradation of alfa grass and siltation of land favored the installation of halophytic steppes and psammophytic. She recorded by against a regression in agriculture with a percentage of -23.46%. The municipality of Redjem Demouche is significantly affected by the phenomenon of silting. Diachronic analysis of land use reveals a change in the natural area with increased halophytic and psammophytic steppes (38.38%), an extension of the matorral and maquis (55.71%), a reduction cereal crops (-24.51%) and the ground uncovered (-27.10%). The area occupied by the dense vegetation and chamaephytic steppes have undergone a significant change respectively in the order of (-46.24%) and (-9.81%).

4.3. Land use map

Halophytics, psammophytics and steppe sagebrush (*Artemisia herba-alba*.Asso) remain the two main forms of land use in the study area (figure 6). They occupy, in 2013, respectively 32.07% and 24.94% of the total area. The dense vegetation covering 4.83% in 1987. This class consists of forest areas dominated by the Aleppo pine (*Pinus halepensis*) and holm oak forests (*Quercus ilex*).

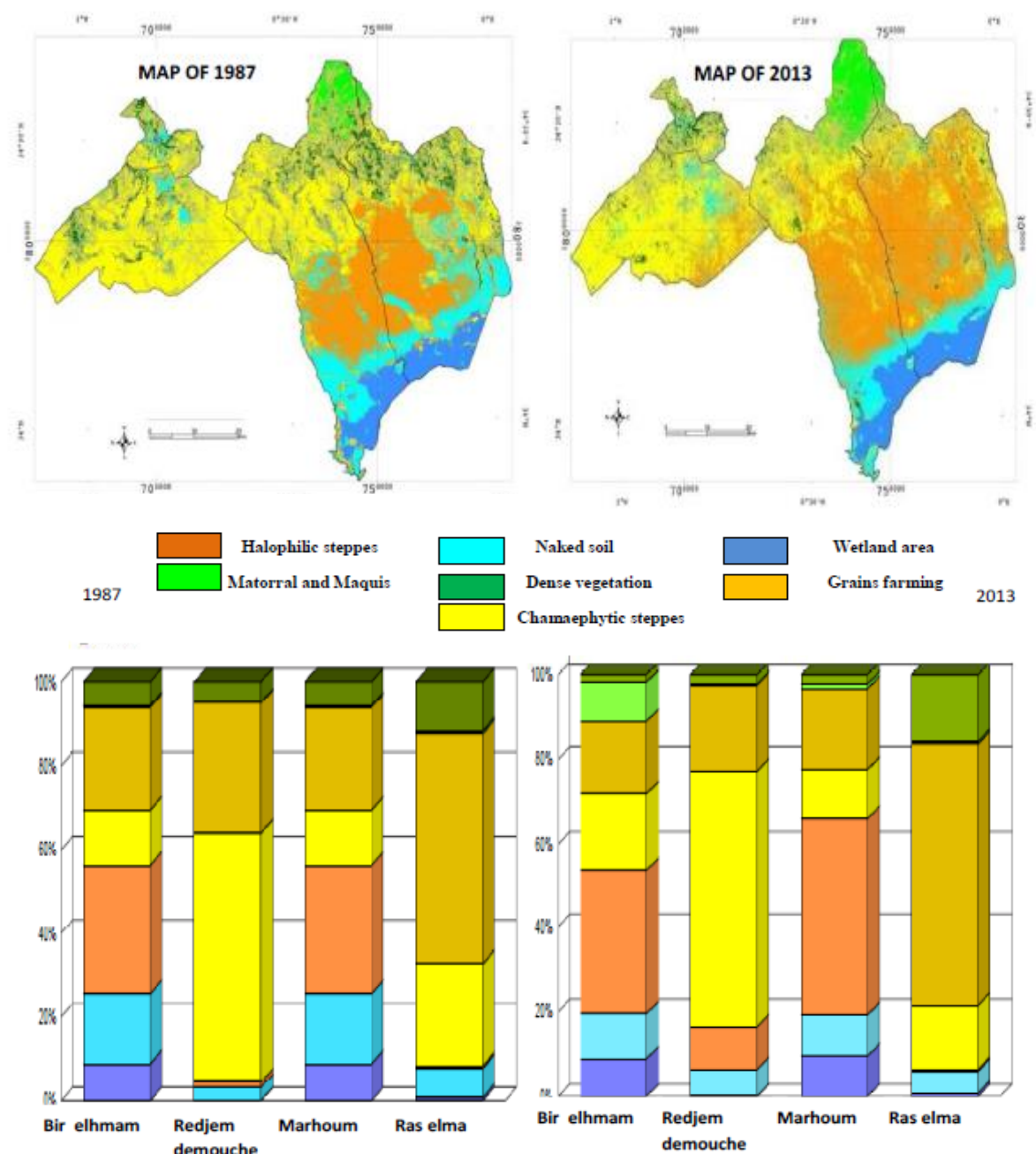


Figure 6. Use maps of soil of the study area (Southern of department of Sidi Bel Abbes – Algeria -).

4.4. Change analysis

The diachronic analysis of land use between the two dates in 1987 and 2013 reveals a change in the nature area with a salt-tolerant and increased psammophytic steppes (38.38%), an extension of matorrals and maquis (55.71 %), reduced grain farming areas (-24.51%) in favor of such crops as arboriculture and market gardening. Bare soil by recorded against a decrease (-27.10%) in favor of halophytic and psammophytic steppes and grain farming areas. The area occupied by dense vegetation and chamaephytic steppes respectively suffered a significant change in the order of (-46.24%) and (-9.81%).

4. Discussion

The space steppe has undergone changes following irregular rainfall, overgrazing and land clearing for agricultural purposes. Livestock has increased during the last 23 years. The increasing availability of

cleared areas and abandoned by farmers is causing the regression of vegetation. These areas have become unproductive and converted rangelands. Forestry training at the rate of 2% of the total area of the study site, are frequented by livestock. Forest grazing remains an almost continuous activity throughout the year, the herd finds appreciable fodder units, estimated at 150 UF / ha for Aleppo pine forests and 250 UF / ha in the lower formations of holm oak [10-11]. The pastoral admitted steppe zone should not exceed 0.5 sheep equivalent per hectare. So according to recent agricultural statistics on the area, the pastoral care in the course of the municipality Marhoum is 0.53 sheep equivalents per hectare. It is respectively 0.63 and 1.53 sheep per hectare equivalent to municipalities of Redjem demmouche and Ras Elma [12]. The agricultural areas are reused as rangelands. The yields of these agricultural lands are still very low and closely dependent on the distribution of annual rainfall [5]. The land cleared for agriculture are abandoned when drought lasts for several successive years. The cultivation of fodder has increased significantly. It is explained by the high demand of sheep for forage supplement [13]. The strong use of land in crops has resulted in the decrease in the rate of organic matter in the surface horizon offering a favorable particle structure to water and wind erosion. Almost all cereal production is processed into feed due to the reduction in the number of plant species eaten by herbivores such as sagebrush, alfa and Esparto. Southern department of Sidi Bel Abbes (Western Algeria) is essentially agropastoral where space for vegetable crops seems to be affected by fluctuations in rainfall rates below average and therefore recorded low yields. Degradation chamaephytic steppe sagebrush (*Artemisia herba-alba* Asso.) and rising halophytic / psammophytic steppes on silted lands are favored by sedentary livestock causing overgrazing. This situation has become irreversible with a persistent imbalance between supply and demand of steppe rangelands [14-15-16]. Some spaces sagebrush are colonized by other plant species as *Salsola vermiculata*, *Noaea mucronata*, *Peganum harmala*, *Stipa parviflora*, *Atractylis serratuloides* and *Cercium syriacum*. In the extreme south of the department of Sidi Bel Abbes (Western Algeria) the soil is mostly covered by the particles of sand and silt. The winds from the south warm and dry, very common in autumn and summer accentuate the intensity of wind erosion that usually affects the soil of southern steppe of southern Oran [17]. The rise of salts following a high evaporation leads to dissociation of the soil particles, making them very susceptible to wind erosion and therefore unsuitable for any cereal crops [18].

5. Conclusion

The study of changes in the steppe south of the department of Sidi Bel Abbes (western Algeria), from the satellite scenes from 1987 and 2013, revealed various changes of vegetation. It appears from this study that different types of land use were reported cases of progression and regression during this period. Steppe and agricultural areas have suffered constant pressure imposed by the weather, overgrazing and land clearing. The dominance of livestock in the region and the almost permanent presence of livestock are mainly due to the settlement of the nomadic population. The appearance of desertification is encouraged by signs of clearing very fragile soil and climatic conditions binding for all cereal crops.

6. References

- [1] Bouabdellah H 1991 Degradation of the vegetation cover of the Steppic area South Oranaise: the case of aricha. Thesis Magister, Geography, University of Oran (in French).
- [2] Hadeid M 1998 Effects of settlement of nomads in sparse area in strengthening desertification of the South Oran steppe. In Proceedings of the Seminar "Drylands : retrospectives, Issues and Strategies," Adrar on 25, 26 and April 27, Edition CRSTRA, Algiers (in French).
- [3] Baret F, Guyot G and Major D 1989 TSAVI vegetation index which minimizes soil brightness effects on LAI or APAR estimation, in 12th Canadian symposium on remote sensing and IGARSS'90, Vancouver, Canada, 10-14 July.
- [4] ONM 2010 Reports of climatic data of the wilaya of Sidi Bel Abbes. Leaves of 1979-2010 monthly statements. National Meteorological Office, Sidi Bel Abbes (in French).

- [5] Hellal T, Hellal B, Baghdadi A, Ayad N and Bensmira Z 2014 Impact of rainfall on the cultivation of cereals in Southern steppe prefecture of Sidi Bel'Abbes (Western Algeria). *European Scientific Journal*,. Vol 10 N° **17**. (in French).
- [6] Haddouche I, Gacemi M and Bouhanifia K 2011 Spatial analysis of forest regeneration after fire in the forest "Fergoug" in Mascara, Algeria. *Wood magazine and Tropical Forests* **307**: **23-31**.
- [7] Benhanifia K, Bekrada A and Smith S 2002 Multitemporal remote sensing and geographic information systems: a useful tool for detecting and mapping forest changes. *Surveying and Land Information Science*, **62** (3): **171-178**.
- [8] Gilabert MA, González-Piqueras J, García-Haro FJ and Meliá J 2002 A generalized soil-adjusted vegetation index. *Remote Sensing of Environment*, N° **82**: **303-310**.
- [9] Lacombe JP 2001-2002 Introduction to software ENVI 3.4. INP, ENSAT
- [10] Mederbal K 1995 Understanding of the vegetation transformation mechanisms: phytoecological approach by aerospace remote sensing and dendroecology *Pinus halepensis* Mill. in western Algeria. State Doctorate, University of Aix-Marseille III (in French).
- [11] Labani A 1999 Analysis of the dynamics of land use and eco-development perspectives: Case of the municipality of Ain-El-Hadjar (Saida, Algeria). Sidi Bel Abbes: Magister, University Djillali Liabes. (in French).
- [12] DSA 2010. Technical Assessment and Agricultural Statistics of the wilaya of Sidi Bel Abbes. Report of the Directorate of Agricultural Services, Algiers (in French).
- [13] Armand R 2009 Research of surface states and their dynamics for different soil practices. Development of runoff indicator. Doctorate Thesis of Strasbourg University (in French).
- [14] Barbero M, Loisel R and Quézel P 1990 Changes and disturbances of forest ecosystems caused by human activities in the western part of the Mediterranean basin. *Vegetatio* **87**: **151-173**.
- [15] Ayad N, Hellal B and Maatoug M 2007 Dynamics of populations of *Artemisia herba-alba* Asso in the southern steppe Oran (western Algeria) *Rev. Secheresse*, **18** (3), **193-98** (in French).
- [16] Ayache A, Hellal B, Ayad N, Benhanifia K and Gacemi MA 2013 Diachronic analysis of the steppe land cover of the department of Sidi Bel-Abbes using the remote sensing (Western Algeria). *International journal of geomatics and geosciences*, Vol **6** Issue **2**.
- [17] Benabadji N and Bouazza M 2000 Some climatic changes in the southwest of Oran (western Algeria). *Revolution Energy Renovation*, **3**, **117-125** (in French).
- [18] Saidi D, Le Bissonnais Y, Duval O, Daoud Y and Halitim A 2004 Effect of exchangeable sodium and salt concentration on the physical properties of soils of the plain Cheliff (Algeria). *Soils Research and Management*, **11** (2), **81- 92** (in French).