The use of geomatical data in the desertification risk's cartography Case of south of the Aurès region- Algeria-

BENMESSAOUD Hassen KALLA Mahdi

Laboratoire « **R**isques **N**aturels et **A**ménagement du **T**erritoire »
Faculté des sciences -Université El Hadj Lakhdar –Batna- Algérie
Email : ha123_m123@yahoo.fr Tél.: 00213 75 98 15 55

Abstract:

The risk's cartography is a primordial step for the valuation and management of desertification phenomenon but it is a complicated spot, which necessitate a big amount of spatial and statistic's data. The use of GIS permits to manage and use these data efficiency.

The objective of our study is the realization of the sensitivity to the desertification map of south of the Aurès region by means of Geographical information system in accordance with the MEDALUS method (Mediterranean Desertification and Land Use), which use the qualitative indices to define the sensitive environment zones to the desertification.

The creation of the database consist of four information layer (soil quality, vegetation quality, climate quality and the socioeconomic state) when the articulation in the space and in the time is submit to the validation on ground.

Once the database has corrected it help to the elaboration of the sensitivity to the desertification map with calculation of the indices of the sensitivity to the desertification (ISD).

The result is a risk's map at a middle scale (1/200.000) which presents a big efficacy in word of synthesis of a desertification phenomenon. The maps make a tool of help to decision as far as the protection of natural resources is concerned in regions stroke by the aridity.

Key words: The sensitivity to the desertification Indices, risk's cartography, Geographical Information System, MEDALUS Concept, South of the Aurès.

Introduction:

Algeria is one of the countries most affected by desertification in the world; this phenomenon is the culmination of a process of environmental degradation in arid and semi-arid areas.

With 2 million square kilometers of desert and 382 000 sq. km-dominated semi-arid and sub-humid, Algeria is the second largest African country [1].

Desertification is a strong presence in Algeria, however, the steppe areas which remain the most sensitive with 20 million hectares [2]

The fight against this scourge must be based on reliable data on the phenomenon itself, the elements at risk (Soil, flora, people, etc.). And their sensitivity, which requires large amounts of data space and statistics [3, 4].

The use of geographic information systems used to manage and effectively use these data for mapping and analyzing the process of desertification and its impact [5, 6].

In sum to fight against desertification is necessary to use tools for decision support, GIS as such powerful tools in this regard. The region south of the Aurès known for some decades of rapid degradation of natural resources [7, 8, 9, 10].This sector supports several factors of desertification, such as wind sands growth, diminution of human population, the reduction of crop and animal production, etc. Achieving a sensitivity map is an indispensable step for the development of this area.

This work addresses a specific case, the evaluation of the risk of desertification in the region south of the Aures (Eastern Algeria) with the completion of a map of sensitivity to desertification Medium Scale using the geographical information system, according to the methodology MEDALUS (Mediterranean Desertification and Land Use).

Geographical context:

The Aurès constitute a geographical entity located in the East of the Saharan Atlas. This whole mountain is very steep heavily exposed to the phenomenon of desertification, particularly in its southern part. This is in direct contact with the Sahara.

Geographically, the study area is located to the south (Figure.01), between the meridians (6 ° 29' and 5 ° 36') East and the parallel (35 ° 15' and 34 ° 41') North.

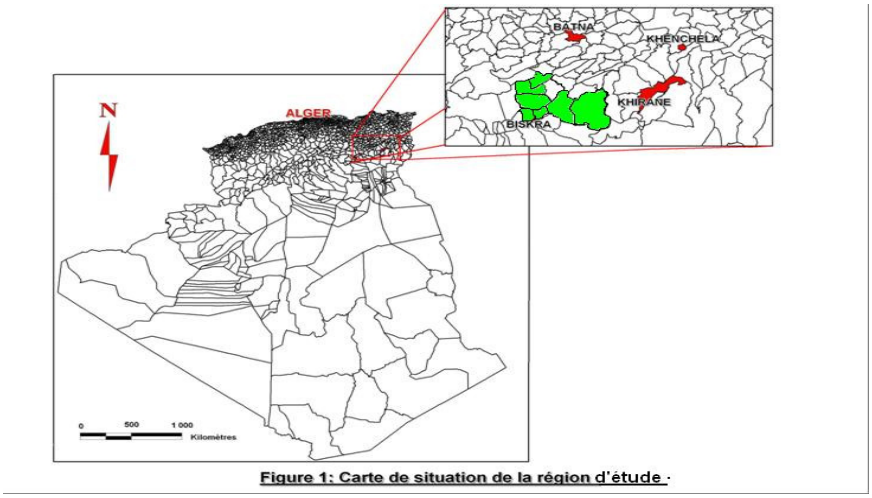

Fig.1: Location map of the study area.

The study area is a transition zone (Figure.02), the area between Atlas North pleated and flat desert expanses in the south.

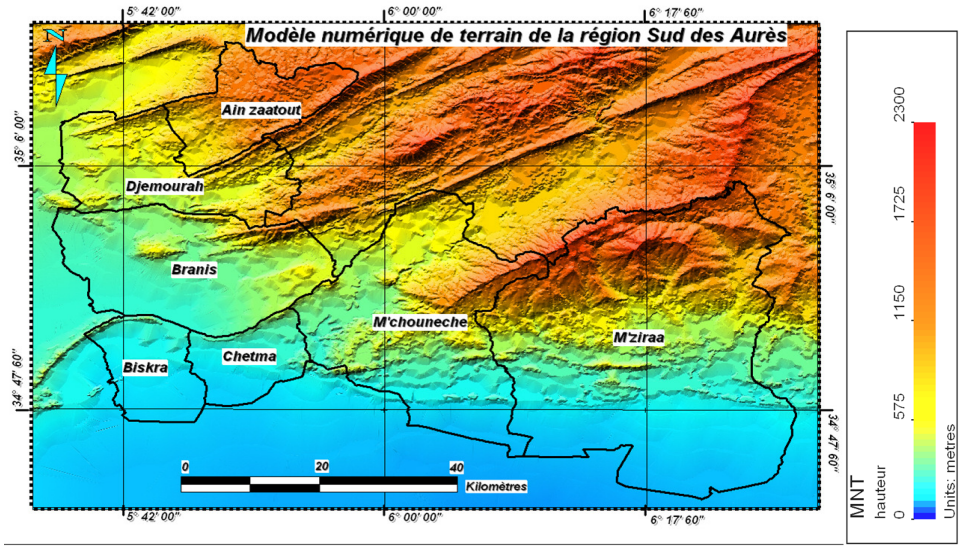

Fig. 2: Orography of the study area by TAM.

From the climatic point of view the study area belongs to the Mediterranean climate characterized by hot and dry summer and winter charges on relief and mild in the plains but remains generally tinted aridity (Figure.3 and 4).

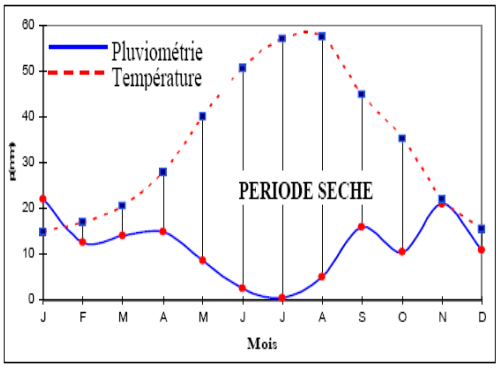

Fig.3: Charts Ombrothermique

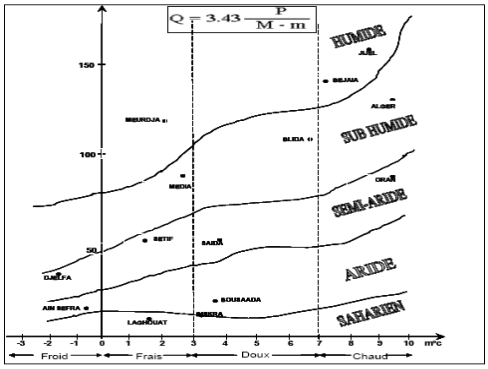

Fig. 4: Climagramme d'EMBERGER

Methodology of work :

The methodology is based on the concept MEDALUS, its aim is to assess the risk of desertification with the use of geographic information system.

The risk is calculated with qualitative indices that will enable assessment of the ability to resist desertification using four layers of information.

Each layer of information is a factor governing the resistance or sensitivity to the desertification of the environment studied .

We opted to create four layers of information in the GIS for the development of the map of sensitivity to desertification in the region south of the Aurès.

1- How to evaluate to risk of desertification :

The risk is calculated with the geometric mean of the parameters of each layer: Soil; Vegetation climatic and socio economy.

These factors are evaluated by quality indices which quantify their ability to resist.

- IQS, an indice of soil quality ;

IQS = (I. lithology x I. depth x I. Texture x I. Slope x I.F. Caillaux x I. Drainage) 1/6

- IQV, quality indice of vegetation ;

IQV = (I.R. fire x I.R. Erosion x I.R. drought x I. recovery) 1/4

- IQC, quality indice climate ;

Storeys bioclimatiques values

•IQE, socio-economic quality indice ;

IQSE = (I. Population x I. livestock) ½.

The sensitivity of land to desertification is measured by an indice of sensitivity ISD which is the geometric mean of indices of four factors .

ISD = (I.QS x I.QV x I.QC x I.QSE) 1/4

2- The reality on the ground and validation of data collected:

The audit field has enabled us to validate our database and identify the stations chosen at random (Figure.5). To do this, we used the GPS as a tool stations exact location (latitude, longitude, itinerary and terrain profile).

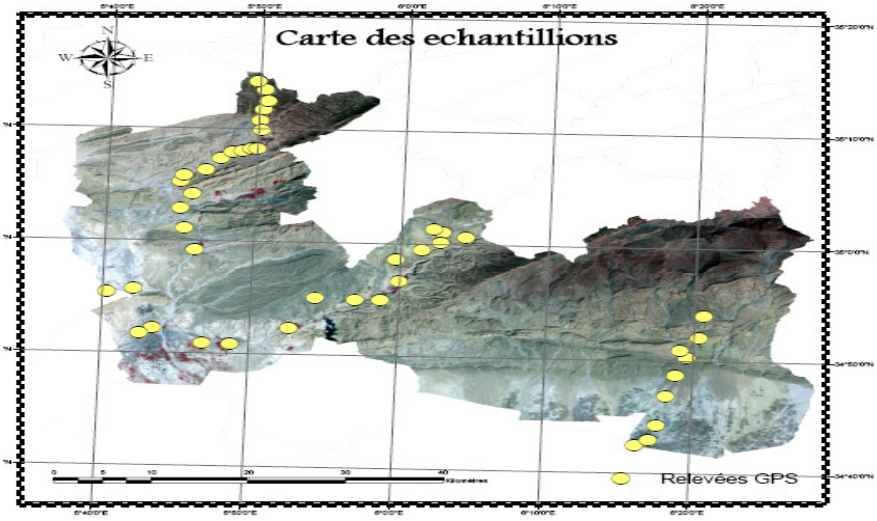

Fig.5 Map identified in GPS and sampling.

3-processing layers themes :

The data collected are classified into different categories so as to obtain four layers . The information collected on land is entered in the database. It fulfils the updating and validating data .

It then proceeded to the overlapping layers that highlight certain similarities that allow us to create a data base containing all the information layers.

4- Development of the map of sensitivity to desertification:

Once the final database should be completed create a new field ISD (indice of sensitivity to desertification), which is calculated with the following SQL query

FORMULA SQL: **ISD= (I.QS*I.QC*I.QV*I.QSE) ^1/4**

Then the geographical areas are classified into four categories Sensitivity (Tableau.1). The map of sensitivity is dressed according to the basic rules of cartography (title, legend, scale, orientation ,and grid).

ISD	Description	Indice
1	Unaffected	0 - 1,22
2	Insensitive	1,23 - 1,30
3	sensitive	1,31 - 1,41
4	Very Sensitive	1,41 - 2

Tableau.1: The indices of sensitivity to desertification.

Results and analysis of thematic maps:

Finally after recovery, analysis, management, validation and formatting of results, we will analyze the results obtained by the different quality cards and the card synthetic sensitivity to the desertification of the study area.

1-Analysis of Soil quality:

Regarding the ground we made SQL queries and simple queries, and each time a query is executed we are updating the table request obtained until a last day of the entire database, these results have shown three qualities of soil on a total area of 2500.1 km ² that are distributed as follows (Tableau.2, Figure 7).

IQS	Description	Area (sq km)	Area (%)
<1.33	Good	1341	53.63%
1.33 à 1.45	Moderate	595.47	23.81%
>1.45	Poor	564.096	22.56%

Tableau.2: Area of the different qualities of the soil.

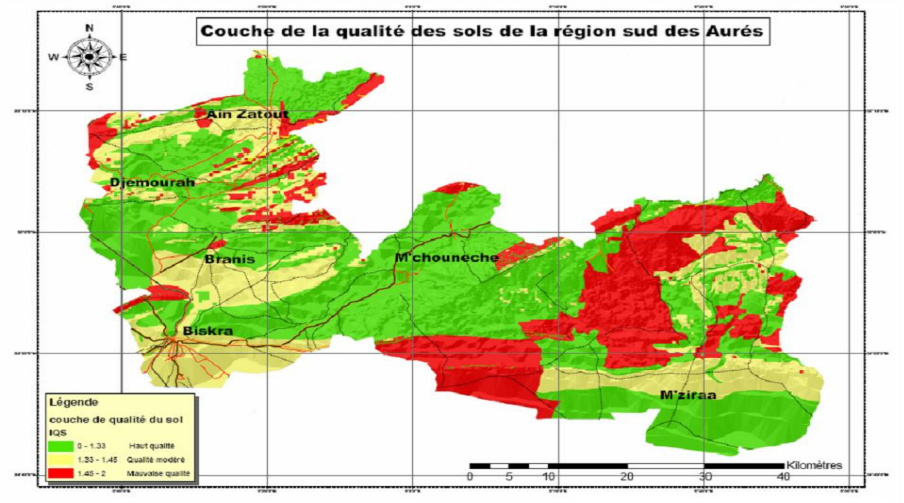

Fig.6: Map of soil quality.

The soil qualities occupy a square kilometer area de1341 km ² or 53.63% of the total area, with a quality indice below 1.33. This class is mostly occupied by forest vegetation, is less subject to human pressure than the other two, which explains the stability of the soil.

The class quality moderate covers an area of 595.47 km ² is 23.81% and an indice of between 1.33 and 1.45. It is spread over the central part of the study area.

The class of poor quality land covers an area of 564,096 km ² therefore 22.56% of the total area, with a quality indice above 1.45. It occupies its southern part.

2 - Analysis of the layer quality climate:

For this map, it makes the SQL simple as for the previous map, which shows three floors of the climate. They are as follows (Tableau.3, Figure 8).

IQC	Description	Area (sq km)	Area (%)
<1.34	Very favorable	747.926	29.91%
1.34 à 1.81	favorable	744.908	29.79%
>1.81	Unfavorable	1007.732	40.30%

Tableau.3: Area of different qualities clima

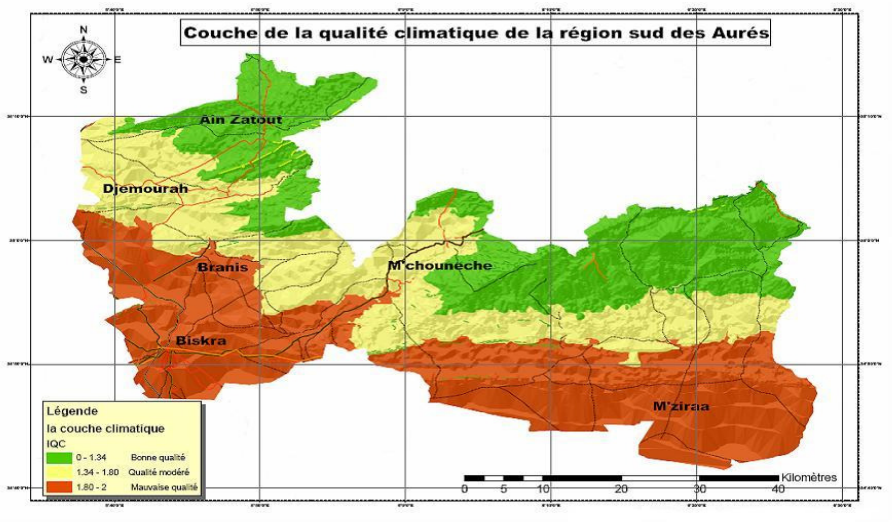

Fig. 7: Map of the quality climate.

The level climates very favorable occupy an area of 747,926 Km2 or 29.91% of the total area of 2500.1 km ², with a quality index below 1.34. This class is located in altitude with relatively heavy rainfall.

The class covers a favourable quality de744.908 km ² area is 29.79% and an index of between 1.34 and 1.81. It is the biggest of the three categories as the region south of the Aurés is located in arid zone where rainfall does not exceed 200mm.

The class atmosphere extends to the rest of the area, with a quality index above 1.81 it spread over the southern part. In general, rainfall distribution obeys in a altitudinal gradient.

3 - Analysis of the quality layer of vegetation:

SQL used in this simple map, leading to the identification of different grades of vegetation. They are distributed as follows (Tableau.4 and Figure. 8):

IQV	Description	Area (sq km)	Area (%)
<1.13	Good	*24.167*	*0.97%*
1.13 à 1.38	Moderate	*520.353*	*20.82%*
>1.38	Poor	*1956.046*	*78.21%*

Tableau.4: Area of the different qualities of vegetation.

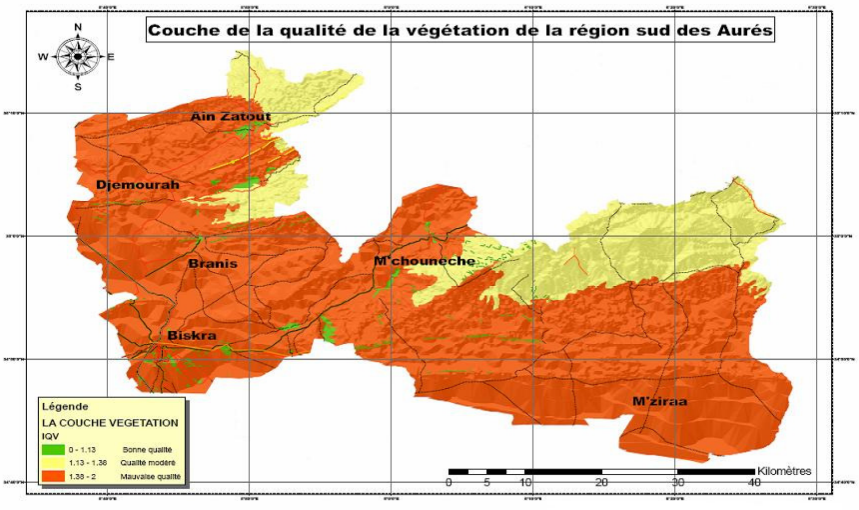

Fig.8: Map quality vegetation

The good vegetation occupies an area of 24,167 km2 or 0.97% of the total area, with a quality index below 1.13. This class is covered by forest vegetation (scrub oak green) over 50% The class quality moderate covers an area of 520.353Km2 is 20.82% and an index of between 1.13 and 1.38. It occupies the northern part corresponding to the degradation of forests and expansion of crops and pastures.

The class of poor quality extends to the rest of the area with a percentage of 78.21%, and a quality index above 1.38. It occupies the southern part.

4 - Analysis of the socio-economic quality:

The map obtained after treatment with SQL and Simple selection makes it possible to distinguish three qualities socioeconomic (Tableau.5, Figure.9).

IQE	Description	Area (sq km)	Area (%)
1 à 1.25	Good	*178.551*	*7.14%*

1.25 à1.50	Moderate	*2211.44*	*88.44%*
> 1.50	Poor	*110.575*	*4.42 %*

Tableau.5: Area of the different qualities of socioeconomic status

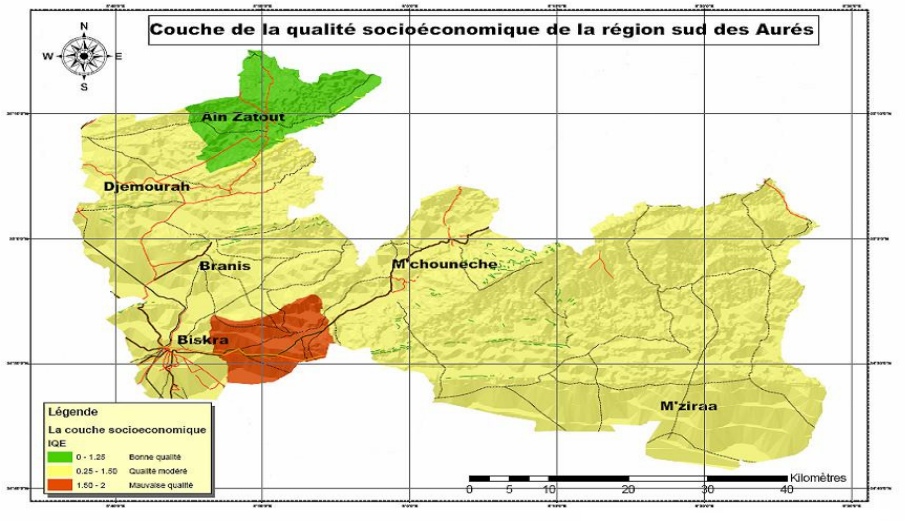

Fig.9: Map of socio-economic quality

The class of good quality occupies an area de178.551 Km2 or 7.14%, with a quality index between 1 and 1.25. It is localized mainly in the town of Ain Zatout whose population has increased from 3847 inhabitants in 1987 to 4,000 inhabitants in 1998 an average annual growth rate of 0.36%, this rate is very low compared to the national average (2.34%) the problems of insecurity. The quality moderate occupies the largest area that is of 2211.44 km ², or 88.44% of the total area, with an index between 1.25 and 1.50. This class occupies almost all municipalities in the study area. At the level of agricultural production is represented mainly by vegetables, cereal with fruit and phoeniciculture.

The class to poor quality covers an area de110.575 km ² or 4.42% of the total area, with a quality index above 1.5. They are usually pasture land where the population is dense.

5 - Analysis and interpretation of the map of sensitivity to desertification:

The final map produced from the combination of maps previously enables us to understand and classify our arid and semi arid regions according to their sensitivity to desertification.

The analysis of this map of the area south of the Aurès, the database and the various existing documents enables us to highlight the main areas that characterize the sensitivity to desertification: 1 - highly sensitive Type 2 - Type sensitive 3 - Type insensitive; 4 - Type unaffected, as shown on Table 6 and Figures .10).

Type	ISD	Area (sq km)	Area (%)
Very Sensitive	*1.40 - 2*	*1696.166*	*67.83%*
sensitive	*1.30 – 1.40*	*516.073*	*20.64%*

Insensitive	*1.22 -1.30*	*218.406*	*8.73%*
Unaffected	*0 – 1.22*	*69.921*	*2.80%*

Tableau.6: Area of different types of sensitivity to desertification.

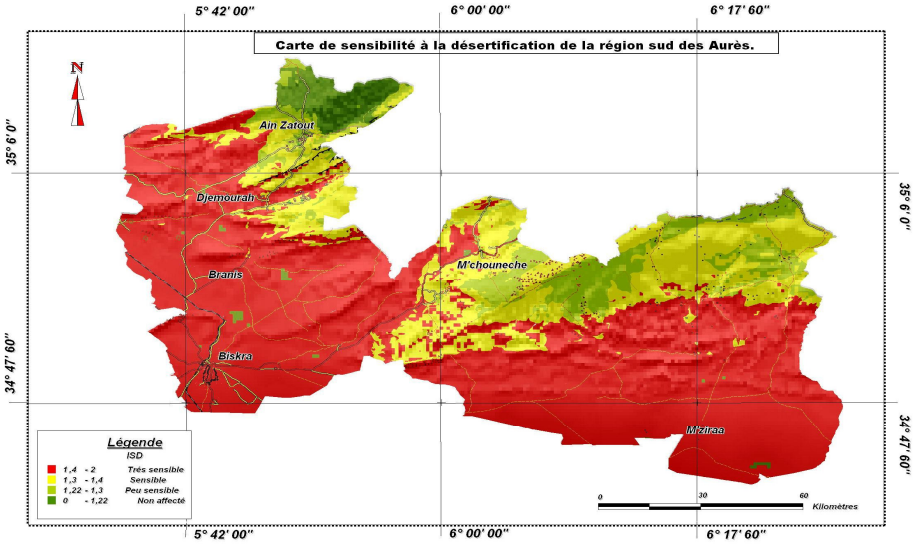

Fig.16: Map of sensitivity to the desertification of southern Aures region

The areas affected were the weakest area: 69,921 km ² or 2.80% of the total area, with an index of sensitivity between 0 and 1.22. This class of sensitivity is located north of the study area at the town of Ain zatout or forest areas have a more significant recovery against the phoenicicultures a small surface. The forests consist of Maquis clear. This area not exposed to desertification because of vegetation that exceeds 50% and semi arid climate with relatively high rainfall compared to the south.

The sectors have a neutral area of 218.406 km ², or 8.73% of the total area, with an index of sensitivity between 1.22 and 1.30. They are located mainly on the mountain north of the study area including the thicket of M'ziraa and M'chouneche where forests are used as livestock grazing by goats. The maquis are in a state of very advanced age and deteriorated.

The class is sensitive located in the northern communes of M'ziraa, M'chouneche and Djemourah. It covers an area of 516,073 square kilometers, or 20.64% of the total area, the index varies between 1.30 and 1.40. This sensitivity affects mainly scrub and rangelands; this sensitivity is due to the poor quality of soil, climate and expansion of crops and pastures.

The class very sensitive stretches over an area of 1696.166km ², or 67.83% of the total area with an index ranging between 1.40 and 2. It is very sensitive and occupies the largest area of the study area. It is located mainly in the south and moderately North West. This sensitivity affects all municipalities in the study area: M'ziraa, M'chouneche, Chetma, Biskra, bran, and low Djemourah Ain zatout.

This class is regarded as desert in the world because all the bad qualities of all the parameters that contribute to this environment switches in a logic of desertification are almost irreversible.

Conclusion:

After this work, one can conclude that the development of the map of sensitivity to the desertification of the study area has revealed clearly the main features of the distribution areas sensitive to this phenomenon

The analysis of results shows the importance of desertification which threatens virtually the entire area that appears across the various classes of sensitivity to desertification, in fact over 88% of the area of this zone have been classified sensitive very sensitive, while less than 12% are ordered not allocated to low sensitivity.

The idea is MEDALUS a scientific approach that responds to an objective approach to regional indicators of desertification. The nature of these essentially provides a global view, and their impact on susceptibility to desertification. Some act more than others but all have a role in this process. The value of GIS is to collect the necessary data on a harmonized basis which allows to assess the risk of this process, it allows the use of indicators, develop tools for decision support integrating them.

References:

1. Direction générale des forêts (2001). Document de projet d'appui au Plan d'action national Algérie. PNUD/UNSO DGF/Algérie, 2001 ; 88 p.

2. Oussedik A. ,Iftène T., Zegrar A. (2003). Réalisation par télédétection de la carte d'Algérie de sensibilité à la désertification, sécheresse n°02, vol.14, pp 195-201

3. Francisco L.B. (1993). Le programme MEDALUS de la communauté européenne, sécheresse n°03, vol.4, pp189.

4. Dubois J. M. et al ,1997. La réalité de terrain en télédétection : Pratiques et méthodes. Actes des journées scientifiques de Sainte-Foy- Agence Universitaire de la Francophonie- AUPELF-UREF, 356p.

5. Bensaid A. ,2006. SIG et télédétection pour l'étude de l'ensablement dans une zone aride : le cas de la wilaya de Naâma (Algérie). Thèse de doctorat en géographie, Université Es.Senia, Oran -Algérie-.325p.

6. Benmessaoud H. ; Kalla M. ; Dridi H., ARAR A.K. 2007 : Utilisation des SIG pour la réalisation d'une carte de sensibilité à la désertification de la région Sud des Aurès,- Algérie. Actes du colloque GEOTUNIS 2007-Tunis du 15 au 17 Novembre 2007.

7. Schoenenberger.A (1971).Étude du couvert forestier de l'Aurès oriental et inventaire des espèces pastorales du massif des Beni Imloul,Projet Algérie 15, A.D.F,Constantine ,Algérie.

8. Abdessemed K., 1981. Le cèdre de l'Atlas (*Cedrus atlantica* Manetti) dans le massif de l'Aurès et du Belezma **-** Étude phytosociologique, problème de conservation et d'aménagement. Thèse Doctorat, Université d'Aix**-**Marseille.

9. Ballais J.L. (1981). Recherches géomorphologiques dans les Aurès (Algérie). Thèse de doctorat. Paris, Université Paris I.

10. Ansar A. ,2002. L'Aurès Oriental : Un milieu en dégradation .Journal Algérienne des région arides. Revue semestrielle N°01, Juin 2002.Ed : C.R.S.T.R.A Biskra (Algérie).