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USE OF GIS FOR THE ASSESSMENT OF SENSITIVITY TO DESERTIFICATION BY THE MEDALUS APPLICATION APPROACH (REGION WESTERN STEPPE ALGERIA)

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Abstract

The western steppe region Algeria's El Bayadh area has experienced in recent decades a considerable increase especially desertified areas in the sandy plains. This problem is hampering the development of the region and enhances the rural exodus. Several studies have been conducted to fight against the desertification.

The objective of this work is the spatial and quantitative assessment of sensitivity to desertification watershed Brezina. The information system tool geographically GIS- was used to develop a sensitivity map by MEDALUS model (Mediterranean Desertification And Land Use). Mapping the sensitivity index desertification is based on a weighted combination of four major indicators of desertification are the indicator of the quality of vegetation (QLI), the indicator of soil quality (IQS) the climate indicator (CQI) and the indicator of the quality of facilities (IQSA). Map developed as part of this work can be used for the implementation of the fight against desertification strategies in the region.

Key words: Steppe region, Desertification, GIS, MEDALUS, Brezina, El Bayadh

Introduction

The phenomenon of desertification, which affects the arid and semi-arid [1] results primarily from the interaction of environmental factors, climate variations and human activity. This phenomenon manifests itself through processes that lead to changes in the vegetation cover of the elements of the soil surface (litter, bare ground, frosting film and salinization), the depletion of the soil and its disappearance. The final stage of this dynamic process makers the biological productivity practically zero, therefore a breach of ecological balances and socio- economic [2], [3]. The Algerian South-west steppe area and particularly that South of the wilaya of El Bayadh is the best example of this degradation is progressing mainly under the effect of grazing and over exploitation of natural resources. The impact on the local population is often catastrophic. The objective of this work is a digital quantitative assessment of vulnerability to desertification in the region of El Bayadh. In this work, it is not to assess desertification in any but a lot more to define the level of vulnerability and its spatial articulation at the basin scale watershed Brezina. This requires of course a systemic approach integrating the objective parameters that can influence vulnerability and applied in a space discretized whose systematic units are geo-referenced. Numerical evaluation of the vulnerability index as parameters allowed ultimately to model the level of vulnerability on a temporal plane using this model MEDALUS to which it was necessary to make objective adjustments to respond to the local reality of our region.

Materials and methods

Presentation of the study area

The site chosen for this study is located in the steppe space extending syncline of El Bayadh forming the flank to the North, Khang Larouia on the South side, forming a

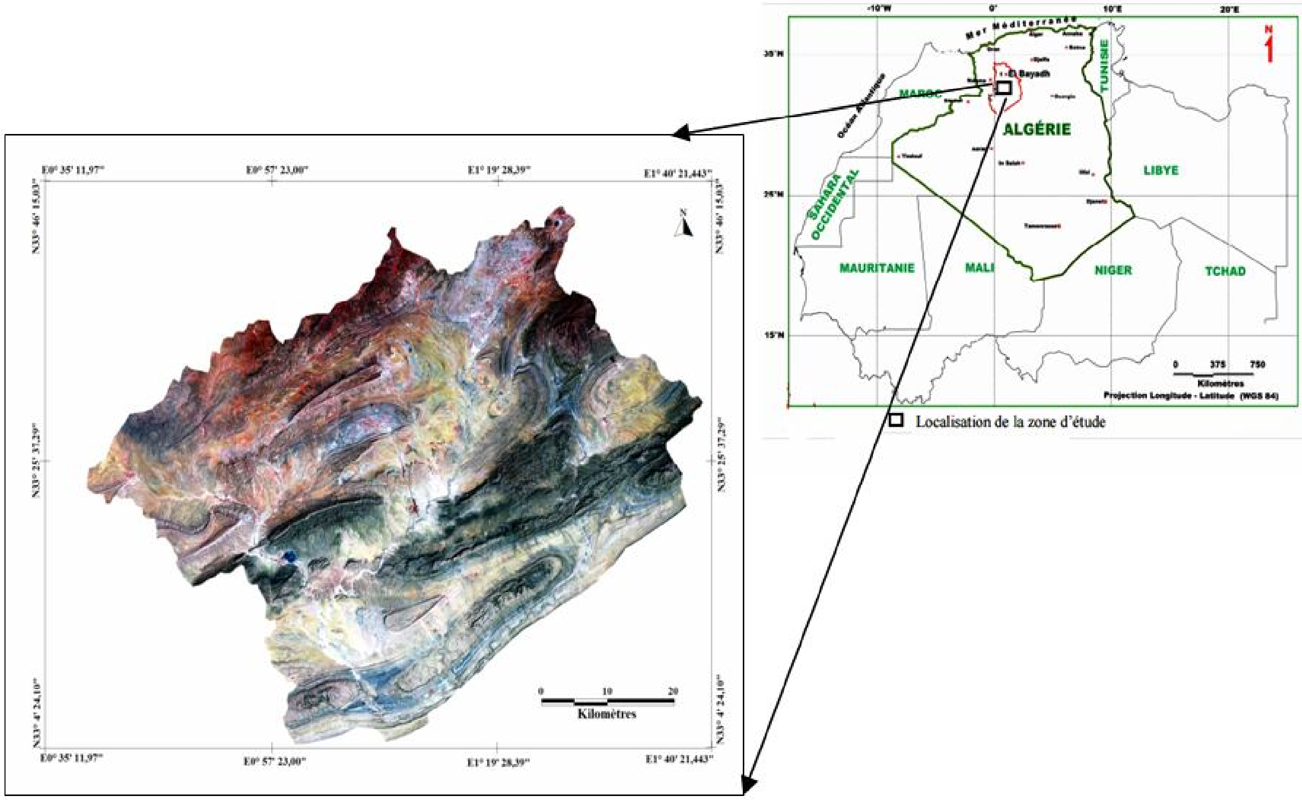

Fig. 1: Location of the study area

real physical barrier at the edge of the Sahara retenu pour cette étude est localisé dans l'espace steppique s'étendant du synclinal d'El Bayadh formant le flanc au nord, à Khang Larouia au flanc Sud, formant une véritable barrière physique à la limite du Sahara (Fig. N°1). It represents a unit water upstream of the dam of Brezina, located about 10 Km north of « Brezina oasis ».

It is distinguished by a vulnerability of the watershed, marked by a strong natural and anthropogenic degradation soil, a rugged terrain, avaried lithological mosaic. Intense pastoral activity, upstream of the dam site avery lean land, often a prelude to an announced desertification.

Methodological approach

The sensitivity of the study to desertification area has been assessed by the MEDALUS. MEDALUS is the name of a project supported by Europe to assess, model and understand the phenomena of desertification that increasingly affect the Mediterranean area. According this desertification sensitivity method is determined by the ISD index (Desertification sensitivity index) resulting from the combination of four Sun-indices: the index of the quality of the (IQC), soil quality (IQS), index of the quality of vegetation (IQV) and index (IQSA) land management system quality according to the following equation:

$$ISD = (IQC \, . \, IQS \, . \, IQV \, . \, IQSA)^{1/4} \qquad (1)$$

More information on the parameters involved in the phenomenon of desertification are prepared from data a available on the study area and integrated in a GIS. These parameters are used to calculate the indices IQC, IQS, IQV IQSA and ISD (Fig. 2). Among the data used in this application: Spacial data in vector format imported project "agricultural map", geological maps, two images satellite Lansat 8- digital field SRTM 30 and other model.

Quality of the IQC climate index

The approach of MEDALUS climate quality is evaluated using the parameters that affect the availability of water for plants: rainfall, temperature and aridity [4]. IQC is calculated by crossing the three layers of information represent exposure index (OR), precipitation total (PP) and the index of aridity according to the following equation:

$$IQC = (PP \, . \, OR \, . \, IA)^{1/3} \qquad (2)$$

It was noted that the annual precipitation in the study area is less than 280 mm, an essential value for the erosion of soil and growth of plants [5]. Lack of accurate data, the aridity index is defined based on the climate floor area (Table 1). Raster orientation is calculated from the DEM SRTM30.

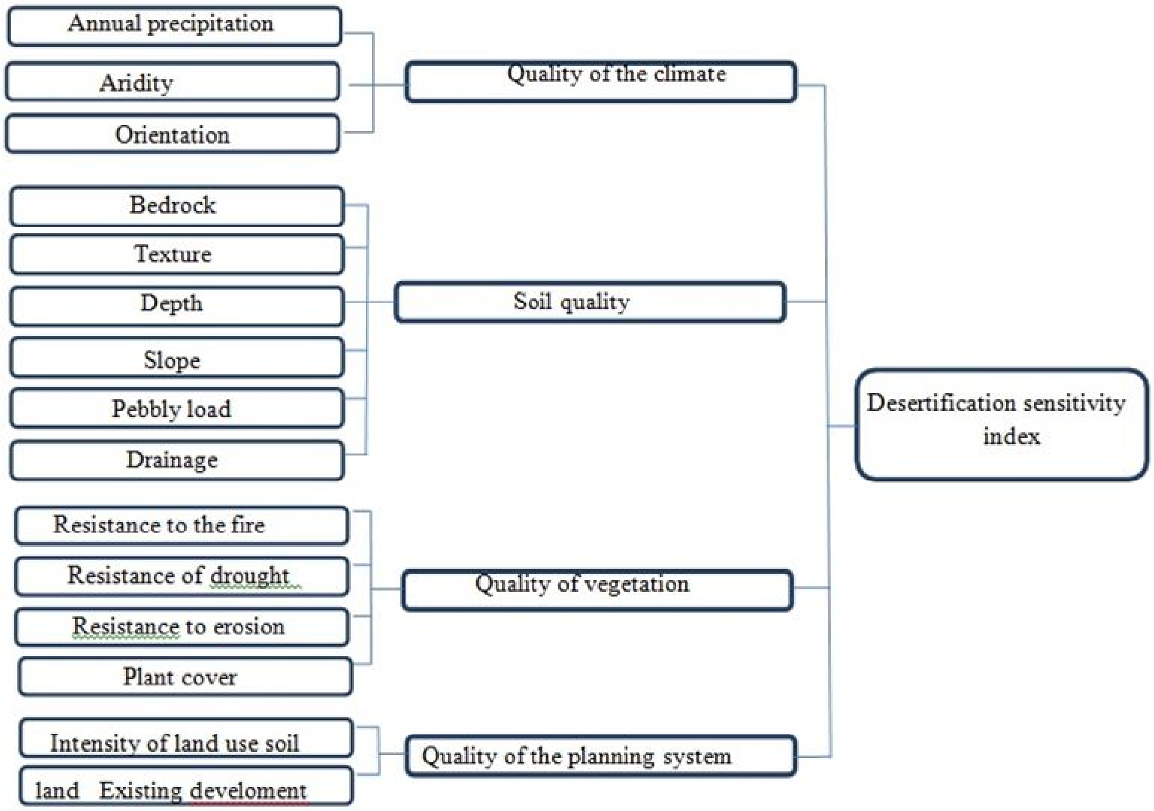

Fig. 2. The steps followed for the calculation of the index ISD.

Soil quality index (IQS)

Six parameters are used to assess the impact of the quality of the soil in the process of desertification using the formula:

$$I\,QS = (T.RM.FR.P.Pe.D)^{1/6} \quad (3)$$

These settings affect the texture of the soil (T), pebbly load (FR), the nature of the bedrock (RM), depth of cover soil (P), slope (Pe) and the rate of drainage (D).The indices assigned to these parameters are shown in table 1. Data for these setting are imported from the data base of the agricultural map.

Quality index of vegetation (IQV)

The quality of the vegetation index is the geometric mean of the weighted value of different parameters for fire hazard (RI), resistance to drought (RS), to the protection against erosion by vegetation (PE) and vegetation cover (CV using the following formula:

$$IQV = (RI.PE.RS.CV)^{1/4} \quad (4)$$

The land developed by classification supervised image satellite Lansat TM 8 is used to determine these parameters. Attributed to these indices are defined based on the nature and density of the vegetation cover in the region.

Quality of the planning system (IQSA) index

The parameters used to define the quality of the planning system of land use in the study area concern (IU) and political planning (PA) committed to combat the phenomenon of desertification. IQSA represents the geometric average of the weighted values assigned to these parameters according to the following formula:

$$IQSA = (IU.PA)^{1/2} \quad (5)$$

Table 1 illustrates the indexes assigned to the various classes defined from the map of occupation of the soil and map showing the location of the projects CES in the study area.

Result and discussion

Map of soil de quality

Good quality soils occupy an area of 275 Km^2 representing a rate of 7.9 % of the surface which is 3720 Km2. This class is occupied mainly by afforestation of Aleppo pine and it is less subject to entropic pressures those other classes which explain the high stability of the soil.

Average quality grade covers an area of 2244 Km^2 is a rate of 60.23%. A soil with low quality class extends over an area of 1204 Km^2 and a rate of 32.36% of the

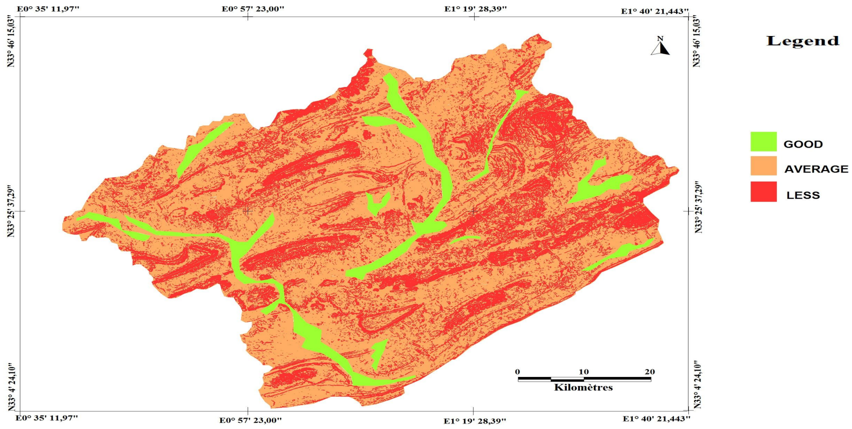

Fig. 3. Map of soil quality

Table 1: Soil quality

Class	Quality	Index	Surface (Km²)	Surface (%)
1	Good	<1.15	275	7.9%
2	Average	1.15 à 1.81	2244	60.32%
3	Less	>1.81	1204	32.36%

total area; it occupied for his major part south of the watershed Brezina.

The quality of the vegetation map

Good quality vegetation occupies an area of 213 Km² or a rate of 5.72% of the total area which is of 3720 km²

Table 2: Quality of vegetation

Class	Quality	Index	Surface (Km²)	Surface (%)
1	Good	<1.10	213	5.72%
2	Average	1.10 à 1.20	1852	49.79%
3	Less	>1,20	1655	44.48%

is predominantly occupied by Aleppo pine reforestation.

The class to average quality covers an area of 1852 Km² is 49.79% she is either the result of degradation of the land where it corresponds to different cultures. However, the poor quality class extends on 1655 Km² at a rate of 44.48% of the total area; she is for the most part south of the study area.

This study shows that the nature of the vegetation present in the study area does not protect against desertification.

The quality of the climate map

Good and favorable climate class occupies an area of 103.6 Km² is a rate of 2.78% of the total area that is 3720Km² this class is located at high elevations where rainfall is abundant.

Class of average quality covers an area of 1720 Km² or a rate of 46.23%. She is for the most part the middle of the watershed. Ingeneral, the distribution of rainfall in fact obeys an elevation gradient.

Low quality grade spans an area of 1732 for example rate of 46.55% of the total area; it is the fore most of the three categories of the region of Brezina is located in the arid climate plan.

Table 3: Quality of the climate

Class	Quality	Index	Surface (Km²)	Surface (%)
1	Good	<1.15	103.6	2.78%
2	Average	1.15 à 1.81	1720	46.23%
3	Less	>1.81	1732	46.55%

Map management system

On the quality of the planning system (Fig. 6). Map there are three classes good, medium and low. Areas whose quality is average are the most dominant with a 50.80% the total surface area of 1890 Km². Is as with good quality of the present planning system 10.77% of the territory in an area of 401 Km². However, the low quality class extends on 1413 Km² at an rate of 37.98% of the total area.

This situation of planning system linked in particular to various factors:

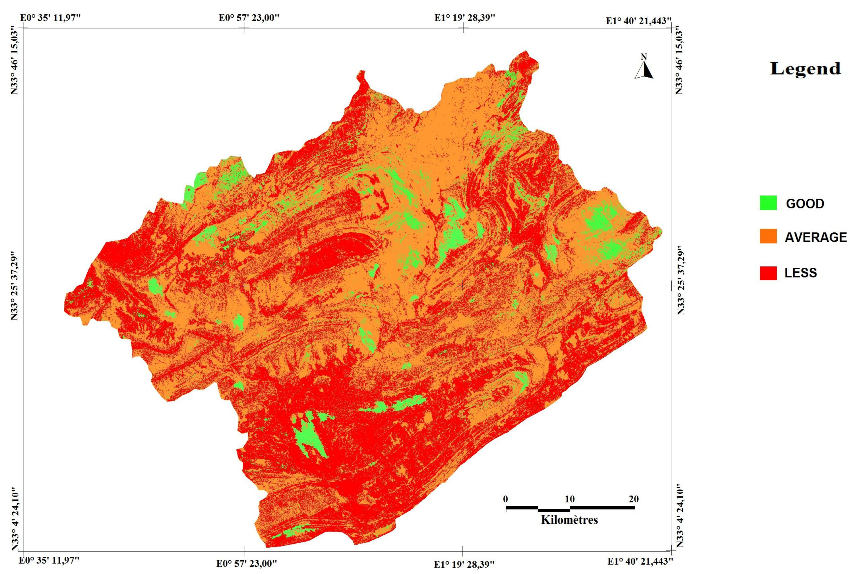

Fig.4: Map of quality of vegetation

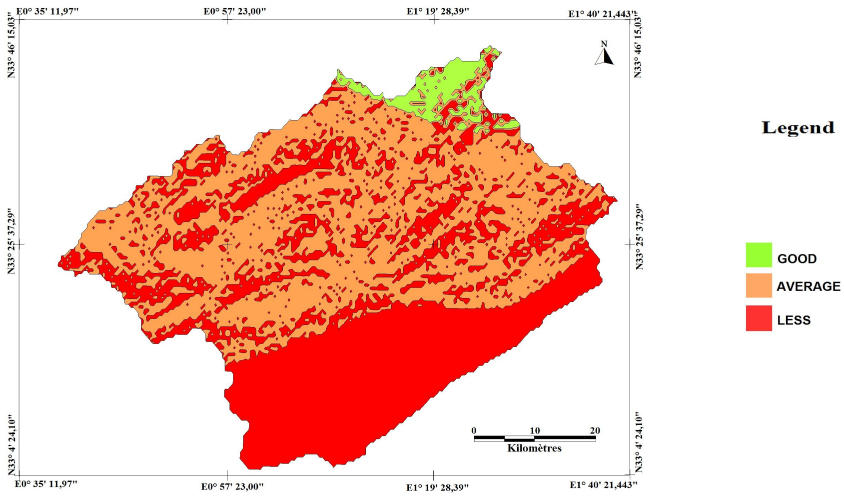

Fig. 5. Map quality of Climate

- Pasture in various states of degradation and the practice of aranching in the area resulting in the degradation of the environment.
- The absence of significant environment protection policies.

Table 4 : Quality of the planning system

Class	Quality	Index	Surface (Km²)	Surface (%)
1	Good	<1.15	103.6	2.78%
2	Average	1.15 à 1.81	1720	46.23%
3	Less	>1.81	1732	46.55%

Desertification sensitivity map

From the foregoing, it has been possible to identify the main types which characterize the zones of desertification sensitivity:

- Insensitive type;
- Fragile type;
- Type critical;

Insensitive to desertification land areas occupy an area of 412 Km² or 11.07% of the total area which is 3720 Km² these lands are less subject to desertification as the rest of the classes but are not immune to degradation because they are poorly managed, in some years, they will suffer the consequences and will turn in to deserted land.

Fragile land class covers an area of 1750 Km² or a rate of 47.04% this sensitivity affects mainly areas of course and it is dueto poor quality soil, the unfavorable climate and the extension of crops and pastures. However, critical class is located in the south of watershed, it covers an area 1570 Km², or a rate of 42.20% of the total surface most of this land is located in the southern region of the watershed and constitutes a priority for any action to combat desertification. If the phenomenon of degradation is dams to the source, the rest of the land will be naturally protected. This class is considered land as it globes all the bad qualities of the different parameters suitable. This unfavorable situation led ver a logic of desertification to almost irreversible nature of this region.

Table 7: Index desertification sensitivity

Class	Type	Indexes	Surface (Km²)	Surface (%)
1	Critical	>1.38	1570	42.20%
2	Fragile	1.38 à 1.23	1750	47.04%
3	Insensitivity	< 1.23	412	11.07%

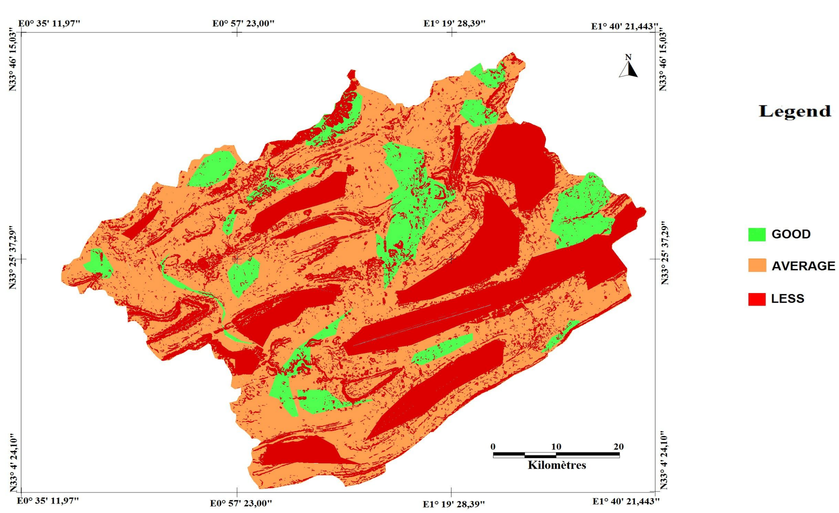

Fig. 6. Map quality of management system

Conclusion

At the end of this work, it may be noted that the development of the map of vulnerability to desertification in the study area allowed to make clear the main features of the results shows the importance of the phenomenon of desertification which threatens virtually all the watershed of the Brezina, indeed more than 11% is only classified just susceptible to desertification.

At the methodological level, MEDALUS concept is a consistent scientific approach that responds to an objective approach of the regional indicators of desertification. The nature

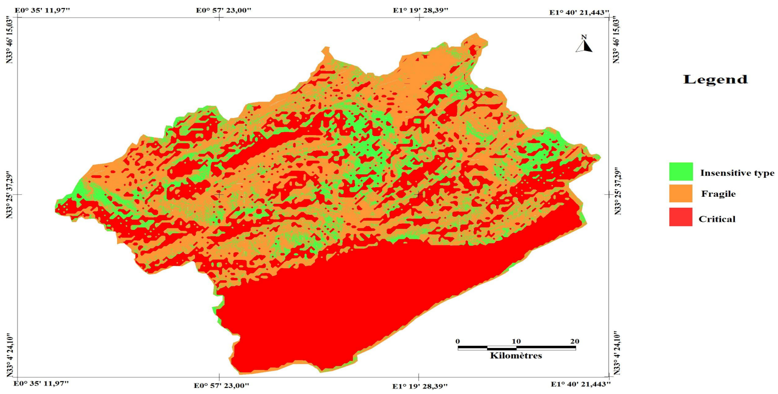

Fig. 7. Spatial distribution of sensitivity classes to desertification

Indexes of quality from the MEDALUS approach

Table 1: Index quality of Climate

Annual precipitation		Aridity		Orientation				
Class	Description	Indexe	Class	Floor Locator	Index	Class e	Description	Index
1	<150 mm	2	1	Arid soft lower	1	1	NW-SE	1
	>150 mm	1	2	Superior arid and arid lower	1,5	2	SE-NW	2
			3	Upper Saharan	2			

Table 2: Index soil quality

Bedrock			Texture			depth			slope			pebbly load			Drainage		
Class	Description	Index	Class	Description	Index	Class	Description	Index	Class	Description	Index	Class	Description	Index	Class	Description	Index
1	hard	1	1	balanced	1	1	>75	1	1	<6	1	1	surface	1	1	property	1
2	compact	1,5	2	fine	1,5	2	75-30	1,33	2	6-18	1,2	2	depth	1,5	2	Imperfect	1,2
3	stretch	2	3	coarse	2	3	15-30	1,6	3	18-35	1,5	3	Absent	2	3	Evil	2
						4	<15	2	4	>35	2						

Table 3: Index quality of vegetation

Risk of fire			Erossion Protection			Drouth resistance			vegetal cover		
Class	Description	Index	Class	Description	Index	Class	Description	Index	Class	Description	Index.
1	Low	1	1	low	1	1	low	1	1	low	1
2	Moderate	1.33	2	Moderate	1.33	2	Moderate	1.33	2	Moderate	1.33
3	High	1.66	3	High	1.66	3	High	1.66	3	High	1.66
4	Very high	2	4	Very high	2	4	Very high	2	4	Very high	2

Table 4: Index quality of management

The intensity of land use			Planning policiers		
Class	Description	Index	Class	Description	Index
1	Low	1			
2	Moderate	2	1	planning	1
3	High	3	2	Do not planning	2

of these elements essentially given an overview of their impact on the sensitivity to desertification. Some are more than others, but all have a role in this process.

Thus, the interests of the GIS are to collect the necessary data on a harmonized basis, allowing to assess the risk of this process; it allows to use indicators and to develop decision support tools by these parameters.

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