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Using Satellite Imagery to Estimate the Rate of Vegetation Cover in the Lower Cheliff Plain Case of Wadi Yellel Watershed (Algeria)

HARTANI Ahmed[1*], BAGHDADI Djilali[1], ANTEUR Djamel[2], MEDERBAL Khalladi[2], and COUIEB Mohamed[1]

[1]University of Abdelhamid IBN BADIS, Faculty of Science and Sciences engineering, Department of Agricultural sciences Agronomiques, Mostaganem – Algeria
[2]Geomatics laboratory and sustainable development (LGEO2D) University Ibn Khaldoun, Tiaret, Algeria

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ABSTRACT

The ground cover is the factor that is most effective against erosion by protecting the soil surface against the erosive force of the drops of rain and runoff. Our work proposes to do an estimate of the rate of plant collection using satellite imagery in a semi-arid region of the underlying basic watershed of valley Yell, the latter is one of the main watershed which constitute the great basin bottom Bas Chellif. It is to estimate the rate general recovery of the vegetation on site and implementation in relation index values (NDVI) matching on the image.
The result has helped develop a map to three classes of recovery; the first is completely denuded of vegetation. It corresponds to the rocky outcrops, or areas of bed (common capital, bare soil around the town). The second with vegetation less 20%, which corresponds to natural vegetation on moderately significant altitudes at the flanks of the mountains. The third class is one that has a recovery rate of more than 20% represented on agricultural plots following the banks of the valley, or areas reforested by reaching a collection that exceeds 30%.
KEY WORD: Watererosion, watershed, Bas chellif, covered plant, vegetation index, SIG and remote sensing.

INTRODUCTION

The recent studies on vulnerability to climate change in the Mediterranean region indicate a tendency to an increase in aridity that accelerates the erosive (De Ploey et al., 1991; Joftic et al., 1992; Shaban et Khawlie, 1998). The semarid climate of the underlying character catchment area of the valley of Mina accentuates the phenomenon of water erosion of the soil that remains poorly known, despite the various studies carried out (Kouri, 1993; Gomer, 1994; Touaïbia, 2000). Its irregular and random character, and its spatio-temporal discontinuity makes complex. This phenomenon occurs when rainwater. Unable to infiltrate, runoff on the parcel, taking particles of Earth ; This refusal of the ground to absorb the surplus waters appears when the intensity of the rain is greater than the infiltrabilite of the surface of the ground. When the rain comes on a surface partially or totally saturated by the water (Yves *et al*., 2002). The erosive process depends on a variety of factors interacting with each other; these are according to (Wischmeier et al. 1978), the soil, its occupation, the topography and climate. When the theme of the erosion of soil and land degradation, it is important to consider the four basic physical factors which condition the erosive regime, namely the erosvility of the rains, the erodibilite of soils, topography, nature and the density of the cover plant because the latter is a factor that protects the soil against erosion by water surface.

Objective of this study is to develop a method, based on the procedure « satellite images to estimate the rate vegetation cover.

Presentation of the study area

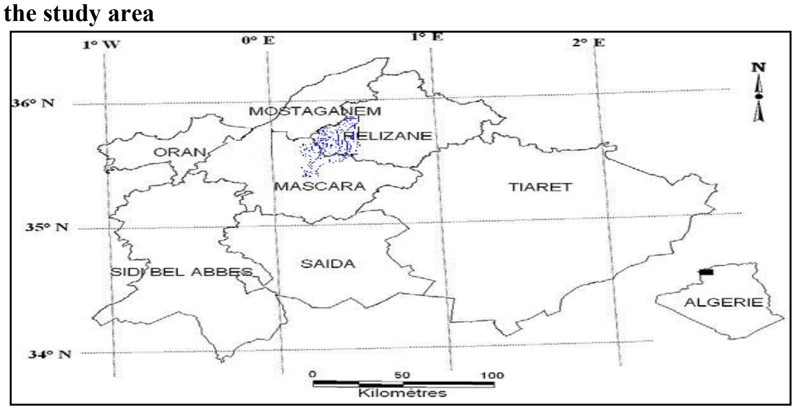


Figure.1 situation of the study area

***Corresponding Author:** HARTANI Ahmed, University of Abdelhamid IBN BADIS, Faculty of Science and Sciences engineering, Department ofAgricultural sciences Agronomiques, Mostaganem – Algeria.
E-Mail :hartani81@gmail.com

The watershed area of the valley **Mina** is located **about** 300 km to the West of Algiers, between à 0° 20’ and 1° 10’ longitude and between 34° 40’ et 35° 40’ North latitude (figure 3), reached an area 4900 km² (KOURI et VOGT, 1993). It is part of the larger watershed of the Algeria of the North, the valley Cheliff, which has a total area of 43 750 km². He stretches out on 128 km from South to North, since 20 Km of Chott chergui until the Bottom Bas Chéliff, and on about 55 kilometres from the west to the East, between the massif of the Ouersenis and Beni Chougranne.

Valley Mina is one of the main tributaires of the valley Cheliff, it travels a distance of about 90 Km between the dam of Bakhada and Sidi M'hamed Ben Aouda, with a don’t NE-NW direction.

The study area is under the conditions of the Mediteraanean climate with 5 to 6 dry months, a strong autumnal rainfall. In terms of lithological, this study area consists mainly of marl that contribute significantly to the production of sediments in plain.

The ecological factor of anthropogenic type leads to over exploitation of naturel resources and strong pressure. From the geological point of view, the catchment area of the valley Mina is characterized by the preponderance of the Jurassic in the North and West. The rest of the region presents a Cretaceous landscape with limestone rocks and sandstones. Agricultural soils are generally made up of alluvium and colluvium where diverse culture practiced..

Analysis of the spatial distribution and diversity of vegetation on basin showed two clearly distinct parts (Kouri, 1993 ; Mahieddine, 1997): The northern area purely marneuse, strongly eroded and devoid of vegetation with the exception of a few pockets of reforestation and plantations of fruits trees in the valley; and the less-eroded area in the South and with about 50% of the area covered by vegetation density very variable and very strewn, ranging from (Aleppo Pine) forest located in the maquis very scattered. He has noted that of self-subsistence agriculture reigns with over exploitation of soils, a permanent clearing and intensive over grazing.

MATERIALSAND METHODS

This work proposes to develop a map of vegetation recovery from the satellite image. For this the following approach was adopted:

- Classification of the area in homogeneous spatial units,
- Visua estimation of the rate of collection of each homogeneous unit (on the ground).
- Statistical treatment of data to draw correlations between visually estimated recovery rates

and values of vegetation index derived from the satellite image.

Study Materials

Monitoring plant recovery requires that the signal of the images is calibrated to ensure the comparison of data between them (Dehbi, 2007). To this end, various corrections (radiometric, geometric and atmospheric) are plansall images utilises.

We have worked on:

- The landsat image 5 of March 2010, which covers the lower forested part.

The period of shooting of this picture is very suitable since March chlorophyllous activity is very strong which is easily detectible in the bands of the visible and the near-infrared. This will allow us to better discriminate and map areas to the different plant ensites.

- The resolution of 30 m from satellite Lansat 5 image (March 2012) covering the common chief town of Relizene.
- The geological map Bosquet Mostaganem scale 1/200 000 Th, to delimit the

large geological structures in the study area, and then integrate it as a decision criterion in the creation of homogeneous spatial units.

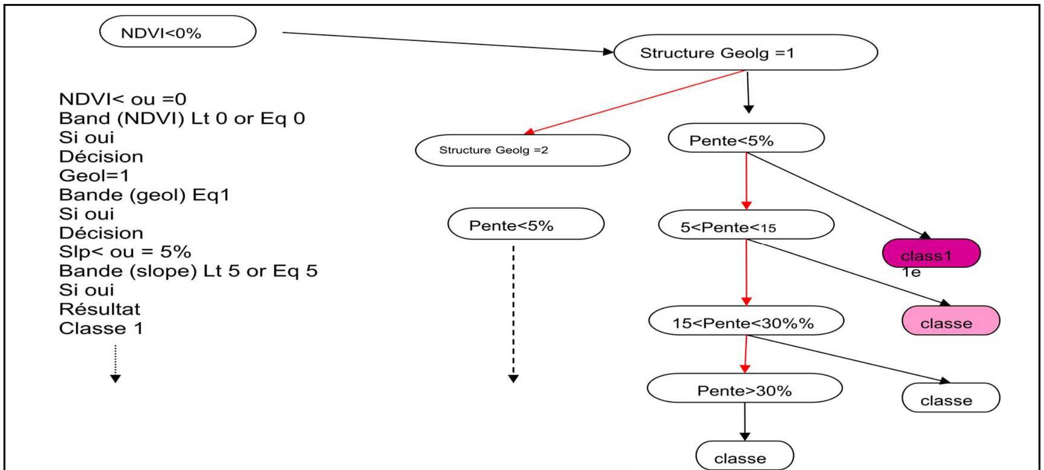


Fig. 1: Example of the classification algorithm by decision tree adopted for extraction homogeneous spatial

METHODOLOGY

Extraction homogeneous spatial units

After Delpoux (1972), all landscape divides into two basic units: the physical medium and its cover of vegetation. The first is related to the geological and geomorphomogical, features while the second is essentially related to the biological variant.

However, the knowledge of the natural environment requires a study of all its components. To delimit components homogeneous units of the studied area, which has allowed for first time the following layers.

- The geological map layer :
  - The scanning from the geological map of Grove Mostaganem in scale of 1/200 00 th.
  - Rasterization of this layer la rastérisation
    - The consideration of three geological structures characterize the substratum of the area (calcareous shells, alluvium) –limestone.
- The layer in the map of the slopes: obtained from the SRTM (Shuttle Radar Topography Mission) of watershed area of the valley Mina with four classes defined (<5%, 5-15%, 15-30%, >30%).
- The map layer of occupation of the soil carried NDVI in considering two key themes:
  - Vegetation
  - No vegetation (bare soil).

Based on the image of the colourful composition and the NDVI could, by the method of histogram and visual analysis, determine value of zero (0) as a threshold between the two selected lasses (vegetation and no vegetation).

Note: three images are raster (same spatial resolution) format and include the same features

The decision tree classification was the best method for the making of the homogeneous units and the decision of the classes (Ricco, 2005).

The integration of decisions conditions (NDVI $\geq$ 0, the four classes of slopes and three geological classes) in the algorithm of decision, must give maximum of 24 new classes by the multiplication of layers of information.

After visual analysis and application of image smoothing filters led up to six essential classes taken as homogeneous unit (table I), the application of the median filter enabled us to overlook the smaller classes that have no spatial meaning.

Table 1: Classes from the classification by decision tree

Classes	TVI	Geology	Slop
1	>1.14	G1	<5%
5	>1.14	G2	<5%
14	< 1.14	G1	5-15%
17	<1.14	G2	<5%
22	<1.14	G3	<5%
23	<1.14	G3	15-30%

With :

G1 : Agile sandy
G2 : Alluvium
G3 : Calcareous shell

Visual estimation of the rate vegetation recovery on the ground
This step was taken in the month of Maps (printemps 2012). It enabled us to see its complexity and choose the route to follow in our study. Thus, six stations have been defined (according to the number of defined homogeneous units) in order to visually estimate the rate of plant cover in each spatial unit. Indeed, the period of the investigation in the field is the same season of shooting of the satellite image.

Sampling
The sampling technique used here is one that has been used by Godard (Toutin, 1996) in southwestern Mauritanie, which is a region with sparse vegetation which is similar to our case. As the vegetation is sparse, the sampling by plots approach was adopted. The number of selected plots is based on the heterogeneity of the study site. This last was appreciated from value of
NDVI image. Among the 38 placettes sampled and visually estimated in the field. The size of the plots of inquiry should not be less than La (9 x 9 pixels) due to the level of precision of localization (Tidiane, 2006); According to equation (1) :

$$\boxed{A = L(1 + 2n)} \quad \text{……(1)}$$

Where
A:The smallest plot,
L:The pixel size (here 20m),
N:The precision error in number of pixels (here4).

So : A = 20[1 + (2 x 4)] = 180m = 9 pixels

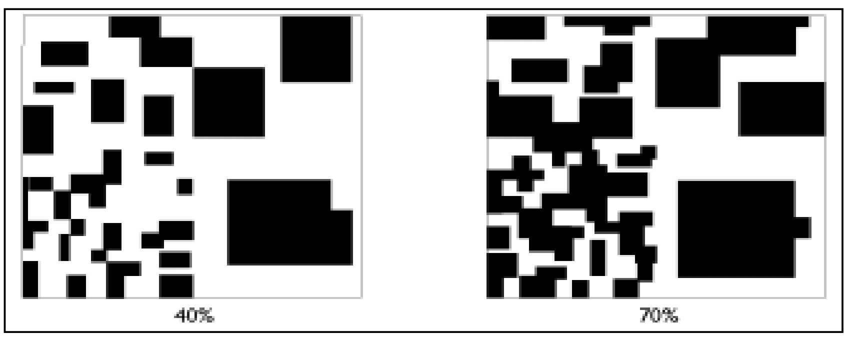


Fig. 2: visual Estimation of the percentage of coverage of a given area, indicated by the area coloured in black.

Estimation of the rate of plant collection by the vegetation indexes method
The vegetation indices calculated from satellite image to get an idea on the vegetation that occupies the territory studied. A large number of indices is proposed in the literature whose properties and sensitivities to external factors differ considerably. The relationship between the vegetation recovery rate and vegetation indices can be identified using several methods. As such, many study found a linear relationship between the vegetation indexes and characteristics biophysical vegetation (Purevdorj *et al*., 1998).
The NDVI (equation 2) index is the most used in its simplicity of calculation of standardized character and external factors such as the optical properties of the soil, lighting geometry or atmospheric effects (Cayrol, 2000).towards its lower sensitivity (compared to the reflectance).

$$NDVI = \frac{PIR - R}{PIR + R} \quad \text{……(2)}$$

PIR: infrared channel, **R**: the channel of red

In order to estimate the overall recovery rate, calculations are performed with the average values of recovery rates on the vegetation index field.

The equation below (3) and(4) respectively, give the general from of linear and polynomial of the second order functions, these allow to link rate of plant recovery (R) with the normalized vegetation index (NDVI).

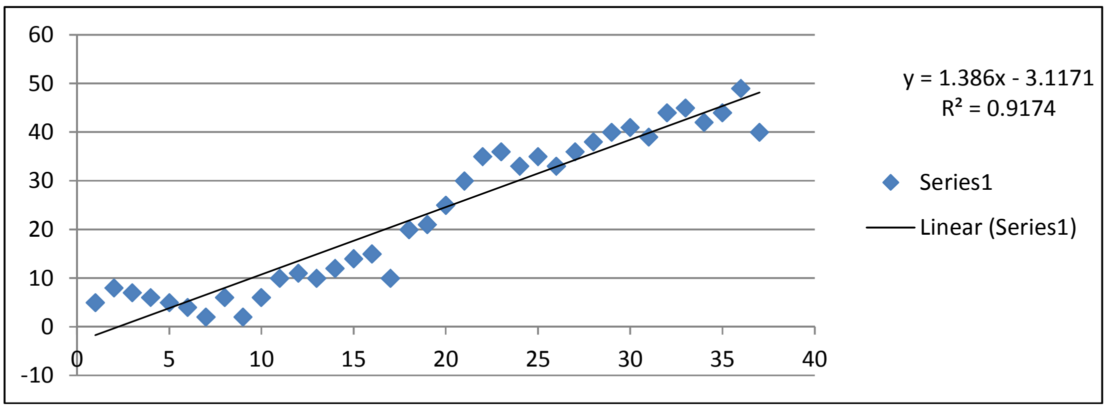
$$\boxed{R = a\,.NDVI + b} \quad .... (3)$$

$$\boxed{R = a.(NDVI)^2 + b(NDVI) + c} \quad .. (4)$$

Where a, b and c are regression coefficients (real numbers)

RESULTS AND DISCUSSION

To determine the function that represents a good relationship between NDVI is the recovery rate in the study area, based on the value of the correlation coefficient (the critical threshold for a good correlation $r^2 \geq 0.6$). There are therefore two relationships that give the best recovery in led function NDVI. According the graph (a), we notice that it is has a strong correlation between the NDVI and the recovery rate (r^2 =0.92), but the application of this relationship NDVI values for the calculation of the collection rate has given us a result that do not represent the reality on the ground, most often the values exceed standards (more than 100%).



Graph3: Simple linear relationship between the NDVI and the recovery rate.

This graph, represents the simple linear relationship between the la NDVI and the recovery rate, the correction is acceptable since the correlation coefficient is equal to (r^2 = 0.64), the application of this relationship on the NDVI values gave us very good results and who better represents the reality on the ground. For this our choice is fixed on the relationship of the simple function, the equation R=F (NDVI) established is this (equation 5):

$$\boxed{Taux(\%) = 348.26(ndvi) - 212.82}$$

Two values samples remaining (visually estimated in the plots) are replaced in equation (5) for validation, which we has given very good results (recovery rates calculates automatically corresponds to the reality in the field), it explains well the good correlation expressed by this relationship (see table n°2).

Tableau n°2: validation of the results (correlation recovery rate- NDVI)

	TVI	Rate (field) %	Rate (calculated) %
Samples 1	1.08	10	10.38
Samples 2	1.16	29	25.13
Samples 3	1.19	30	30.66
Samples4	1.25	47	41.73

There are three classes of plant cover (Fig.3) on the map, the first is completely of vegetation. It corresponds to sandy areas, the rocky outcrops, or in area (common chief town, base soil around the town). The second with a vegetation of less than 10%, which corresponds to natural vegetation to moderately important elevations at the flanks of the mountains?The third class is one that a recovery area of more than 10% represented on agricultural plots following the banks of valleys, or reforested areas reaching a collection that exceeds 30%.

CONCLUSION

This work is set for objective the realization of plant recovery one card in the watershed wadi Mina watershed, which is characterized by a low rate of vegetation cover, this rates first due to the semiarid climate known by its low rainfall. The vegetation indexes method gave us some interesting results and that seems appropriate for an estimate of vegetation cover close to the reality on the ground, it is characterized by its simplicity and safiabilite; It requires integrating real data from the field without the need for a heavy equipment or expensive. The result map shows information on the degraded state of the vegetation cover, which in indeed one of the limiting factors that reacts very effectively against water erosion of soils.

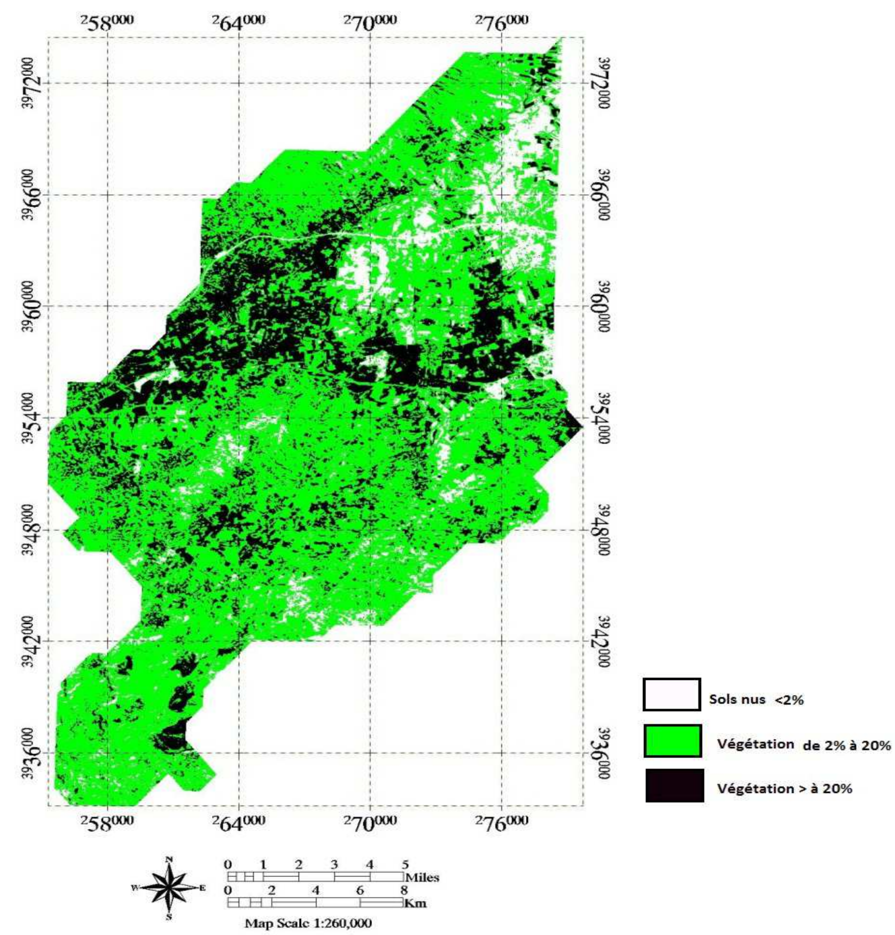


Figure.5 The rate of vegetation cover

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