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# SPATIAL MODELING AND ASSESSMENT OF SOIL LOSS OF WATERSHED Oued Bou Moussa, HIGH CHAOUIA, Settat, MOROCCO

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***Abstract-****The watershed of Wadi Boumoussa (high Chaouia, La Meseta , Morocco ) is characterized by a sub-Mediterranean climate. Erratic rainfall, combined with a significant agricultural mechanization, causing damage". Severe erosion. Soils are increasingly degraded.The integration of thematic maps of various factors of universal soil loss equation in the Geographic Information System (GIS - Mapinfo) with their databases, allowed a fast and effective way to unravel the complexity and the interdependence of the factors in the analysis of risk of erosion, to better understand the impact of each factor and to assess its contribution to soil loss.*
*Integration into the GIS formulas of universal soil loss equation has produced a synthetic map of the distribution of degrees of tb (DGDC erosion, determines the rate of erosion by sheet runoff ( 25t / ha / year on average) and to establish the key factors that control water erosion are , in order of importance , slope, soil erodibility and vegetation cover . This work can be used to calculate the erosion potential in other similar basins in the plains and plateaus experiencing sheet erosion " sheet erosion".*

***Keywords:*** Bou Moussa, GIS, USLE*.*

## I. INTRODUCTION

The High Chaouia is an area predominantly lithological friable such as that the marls, the lime marls-lime and the clays, demographic pressure is manifested in an overexploitation agricultural support by the agricultural machinery, the soil undergoes degradation and a significant decline by water erosion. The evaluation studies of the risks of erosion and quantification of losses in soils in the Chaouia were limited á the Low Chaouia (H. ANYS et al. 1993) **(1) .**The watershed basin of the Oued Bou Moussa, presents a soil erosion accelerated very linked to the pattern of rainfall and to the slope. The assessment of the risks of soil erosion of the watershed using the universal equation of loss in soil (Universal Soil Loss Equation: USLE) (WISCHMEIER and SMITH, 1978) **[2]** has need the mapping and the analysis of many factors involved in the process eroding: the aggressiveness of precipitation, the slopes, the soil erodibility also occur throughout, the vegetation cover and tillage practices. The results integrated into the GIS we have allows you to assess the losses in soil and produce thematic maps of the watershed in this case the map of erosion risk.

## II. STUDY AREA

The watershed of the Oued Bou Moussa belongs to the plateau of the high Chaouia, characterized by one grade separation surfaces lime marls-lime highlighted by rocky outcrops. The irrigated areas are much localized, the natural vegetation in the entire watershed, is currently very damaged by human occupation. At the exit of the town of Settat, the Oued Bou Moussa drains a surface of 143 sq. km.

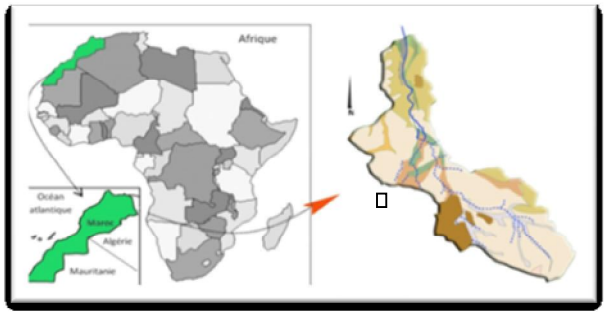


Figure 1: Situation of the study area.

## III. METHODOLOGY

To estimate the rate of loss in soil several methods are used including the more adapted to this case of sheet erosion, the universal equation of loss in soil; it is a multiplicative equation of five factors which control the water erosion: climate aggressiveness, erodibility of soils, slope and slope length, land use practices and anti-erosive, the rate of loss in soil is expressed as follows:

$$A = R. K. LS. C. P \qquad (1)$$

**A:** the annual rate of loss in soil in t/ha/year. **R:** the factor of the climatic erosive of rainfall in DOJ.MM /ha.

**K**: The erodibility of soils in t.ha.H/ha.MJ.mm. **L**: length of slope (in m). **S:** the tilt by %.

**C**: Represents the effect of the vegetation cover.**P: practices** anti-erosive.

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The application of the USLE in the watershedof the Oued Bou Moussa is based on the evaluation of the factors of the equation universal on all the extended of the watershed and their representation in the form of thematic maps. The integration of these maps in the GIS MAPINFO is done by scanning and data geocoding. The crossing of the cards by the module "Overlay" of the GIS and the application of the USLE by the module "Modeller" has allowed us to assess the rate of erosion on all points of the watershed and the production of the synthetic map of soil loss (A. SADIKI, 2004) **(3))** according to the methodological organization chart (Figure 2).

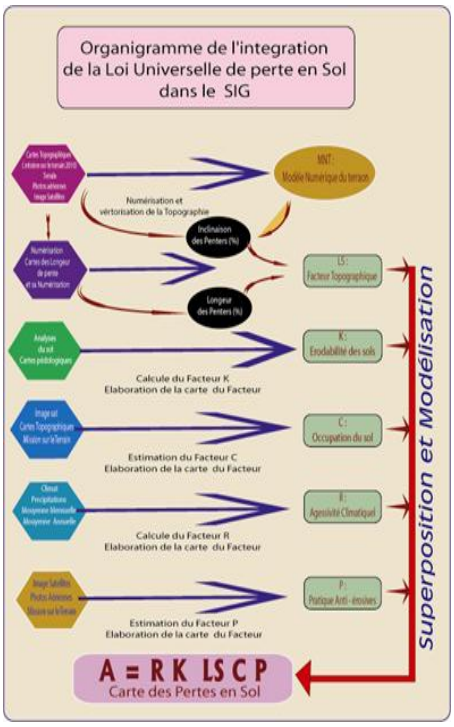


Figure 2: Flowchart for the integration of the equation of loss in soil in the GIS.

### III.1. Aggressiveness of precipitation (R)

HEUSH, B. (1970) **[4]** has developed for stations of Morocco an empirical formula which allows to calculate the factor of climatic erosivity of acid :

$$R = 143 \log (\overline{P} \cdot P_{24}{}^{2} \cdot 10^{-6}) + 89{,}7 \qquad (2)$$

P = precipitation annual average (mm);
P24 = maximum precipitation in 24 hours, return period 20 years (mm).

$$R = 143 \log\left(\overline{P}.P_{24}{}^{2}.10^{-6}\right) + 89.7 \qquad \mathbf{R = 38}$$

**Table I: average rainfall monthly, annual in (mm) ,from 1993 to 2013**

| Station of Settat | Jan | Feb | Mar | Apr | May | Jun | July | Aug | Seven | Octo | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average precipitation | 57 | 43.2 | 39.7 | 34 | 20 | 8 | 7 | 5 | 36 | 44 | 73.6 | 80.4 |

For the watershedof Oued Bou Moussa, average annual rainfall calculated on the basis of the last 20 years are of 274.2 mm maximum precipitation in 24 hours with a return period of 20 years are in the order of 40 mm of or : **R =38**

### III.2. Erodibility of soils (K)

The factor K has been determined, for each soil type, from the nomographe prepared by WISCHMEIER and Smith (1978) **(5).** The use of this last has need of data of particle size, rate of organic matter, structure and permeability. These data analyzes have been drawn from the pedological study performed by ABDILLAH (1985) **[6]** for the rural communes of ME Garto and tlat Loulad of the Settat province.

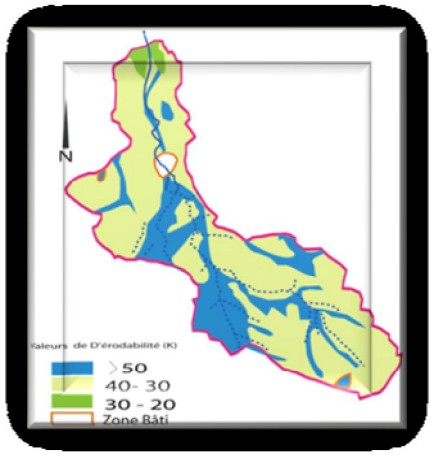


Figure 3:distribution map of the factor k in the watershedOued bou Moussa

### III.3. Topographic Factor (LS)

The topographic factor LS has been calculated using the digital terrain model (D. T. M.) created from three topographic maps (sheet of Settat, Ali Moumen and Ras al Ain) at scale map 1/50 000 with an equidistance of 10 m,which has allowed you to establish the major classes of slope produce a map of slope length (L) from file slope for any given point of the watershed(Soil Conservation Studies) (ZING, 1940) **(7)**. The LS factor is calculated as follows:

**LS = (L/ 22.15)m (65.41 sin2S + 4.56 sin S )+ 0.065 ) (4)**

L = slope length (meter); S = degree of slope%;
M = 0.2 if S < 1 %; m = 0.3 if 1 %< S< 3.5 %; m = 0.4 if 3.5 % <L= 20000m. S=3 m=0.3

The calculated value of the topographic factor is therefore: LS =**3.71**

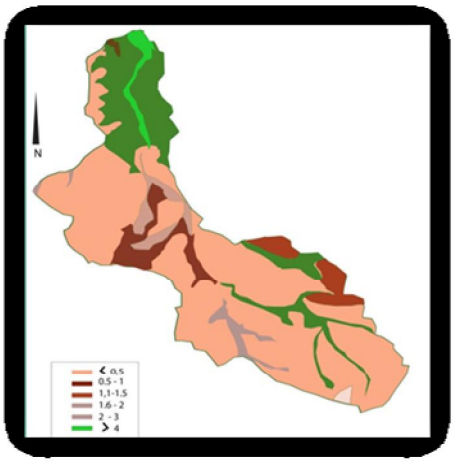


Figure 4: distribution of values of the Length and Slope (LS) factor

### III.4. Anti-erosive Practices (P)

It is a question of cultivation techniques implemented in order to reduce the damage caused by erosion, the most effective practices of soil conservation are: culture in curves of level, in strips, mounding, cover crops and the ridging. The P-values are less than or equal to 1. The value 1 is assigned to the land on which none of the practices cited is used. The values of P will vary according to the practice adopted and also according to the slope. Throughout the watershed of the Oued Bou Moussa, the crops are mostly grain and the plowing is rarely parallel to the curves of level. There is no facilities anti-erosive and farmers do not use of cultivation practices anti-erosive. The value **P = 1** has been assigned to the entire surface area of the basin.

### III.5. Occupation of ground and calculation of factor C

The value of the factor (C) is a function of the density of vegetation cover from the ground by the vegetation and on the height of plant strata. The northern part of the watershed of the Oued Bou Moussa, constitutes the only area where we met with the forest cover, the service of waters and forests and of the fight against desertification has managed to rehabilitate the urban forest of Settat in y reforesting portions of eucalyptus and pine trees of Aleppo; the forest there is moderately dense on an area of 813 ha.

For the determination of the factor C is based on the tables of Wischmeier & Smith which give pre-set values for the forests.

Table 2:Value of the factor C as a function of the vegetation cover

| **Factor value of C** | **Convert Plant** |
|---|---|
| 0.058 | Dense Reforestation |
| 0.13 | Forest dense moderately |
| 0.70 | Grain farming |
| 1 | Bare Land |

The dense forest corresponds to the perimeter of wooded urban forest of Settat, which represents 4.6 %, the orchards and plantations represent only 4.21 per cent when to the built-up area corresponding to the town of Settat represents 1.42 % of the surface of the watershedarea of the Oued Bou Moussa, the zone of grain farming are dominant and represent 88 % of the total surface area of the watershed, which leaves adopt the value of **0.70**.

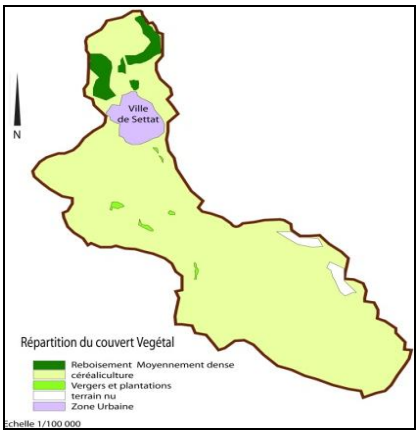


Figure 6: distribution map of the factor C

The five present factors (R, K, LS, C and P) are integrated in the GIS MAPINFO and the modeling function USLE, defined as the product of each factor, was used to obtain the final map of soil erosion. The values of erosion are quantified in tonne per hectare per year,

A = R. K. LS. C. P = 38x0.25xπx x3.71Provisions x0.70x1= 24t/ha/year.

## IV. DISCUSSION

The climate aggressiveness and the slope length have not shown a good correlation with the losses, several reasons may explain this poor correlation:

- The gap between the extreme values of R is low;
- The probable interaction between the different factors which control the erosion, namely the soil erodibility also occur throughout and vegetation cover. The empirical model of Wischmeier & Smith has several limitations to its applicability in conditions different from those where it has been developed. In addition to the fact that it applies only to sheet erosion and that the quantities of estimated losses do not include the losses by the other types of erosion (linear, solifluction lobes,etc.) .The model considers that all surfaces are subject to erosion if none of the factors is zero. It does not highlight the deposits as well as watershedfluvial.

The integration of the model in a GIS has many advantages, this integration allows you to:

- Manage in a rational way a multitude of data related to the degradation of soils;
- Clarify the interdependence of dominant factors;
- The update of the variations of the factors covered in the equation of soil loss;
- The production of the synthetic map of risk erosion of different areas of the watershed.

## V. CONCLUSION

This study demonstrates the importance of the application of the universal equation of soil loss integrated in a geographical information system in the watershedof the

Oued Bou Moussa. The results show that the watershed loses on average 24 t/ha/year. This value corresponds to higherosion not tolerated by the soils under aggressive climate with rainfall but to stormy character. This situation does not allow an evolution pedogenetique to compensate for the loss in soil. The other factors of the erosion couples in this situation accelerates the erosion, the steep slopes ( 30 % of the surface of the watershedarea of the Oued Bou Moussa presented slopes greater than 10 % ), soils highly erodible (83 per cent of soil shows a K factor >2.50 ) and a worrying deterioration of vegetation cover.

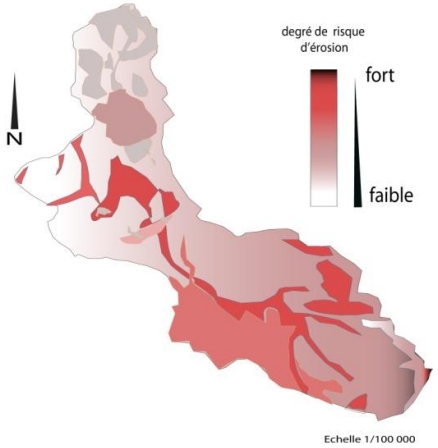


Figure 7: Map of risk erosion of the watershedarea of the Oued Bou Moussa.

The application of the law of Wischmeier and Smith is a tool to help in the inescapable decision dedicated to developers and decision makers to consider the actions of the development in the region by scheduling interventions anti-erosive and protect the soils of the watershed in question.

## ACKNOWLEDGMENT

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