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Mapping and assessment of water erosion in the Ouèd Bou Lajraf basin (Ouèd Inaouène BV) using the PAP/CAR model and GIS tools

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KEYWORDS

Water erosion
PAP/RAC method
GIS
Bou Lajraf watershed
Badlands

INTRODUCTION

Water erosion poses many problems in terms of the conservation of natural resources on the one hand and in terms of watershed management on the other. They lead to the interruption, damage or destruction of infrastructure and property, causing significant socio-economic damage.

The Bou Lajraf watershed, which occupies the upstream part of the Inaouene watershed, is characterized by a varied and irregular climate, a mountainous area with different geomorphological characteristics. It presents a surface of superposition between the essential geomorphological factors that facilitate the triggering of water erosion processes.

The morphology of the slopes in the Bou Lajraf watershed is influenced by a complex dynamic, it depends on several parameters: the fragmentability and degradability of the rocks, the shape and slope of the slopes, the behavior of climatic factors, land use and the rate of vegetation cover, soil cultivation practices and human activities. Thus it appears clear that the analysis and interpretation of the dynamics of the slopes call upon well-determined factors according to their degree of integration.

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METHODOLOGY

From a scientific point of view, the objective is to understand the couplings between the different processes that aim to improve our vision on the behavior of water erosion in this sector according to the changing geomorphological and geographical characteristics. How do they work? How do they evolve? What are the mechanisms and factors that control their genesis? What are the mechanisms and factors that control their spatial distributions?

We distinguish chronologically two stages of studies, the first is the reading and criticism of the data, the second represents the phase of analysis and evaluation. Both call upon investigations in the field and the collection of documents.

The assessment focuses on the different hazard components (water erosion), and in particular concerns the rupture hazard (degradation and detachment of surface layers). The assessment phase brings together several approaches, but the specificity of our slope dynamics problem requires focusing research on the morphological approach.

The morphological approach is a method that allows the analysis of the dominant features of the morphology of the site and the identification of these main components at several levels: slope, thalweg, general slope, morphological accidents. The morphological approach, like the other approaches, requires specific working tools:

- Analysis of data from the topographic background.
- Interpretation of field photos.
- Field work.

A good representation of the morphology is an important element of the study, for this, we used a qualitative study approach, adapted to the physical and human conditions of the watershed, it is the PAP/RAC approach.

According to the general description of the methodology, the fundamental methodological approach consists of three clearly defined phases:

The predictive phase

A phase of evaluation and integration of all erosive parameters, such as slope, lithology, land use and vegetation cover rate, with the aim of drawing preliminary hypotheses concerning the risk of water erosion.

The descriptive phase (creation of the map of water erosion forms)

The descriptive phase is the second step of this approach, it consists of describing and qualitatively evaluating current and active processes, carried out by direct observation and the use of satellite images, using the predictive map of erosive states as a reference cartographic and thematic model in order to highlight the specific and representative constraints of water erosion.

RESULTS

The integration phase

The final consolidated water erosion map is the result of the association and integration of predictive and descriptive data that uses the erosion states map as a reference cartographic canvas and provides a grid

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of homogeneous units that can be affected by a wide variety of erosion processes. The description and mapping of active erosion and more specific erosion risks (better identifiable through their main causal factors) are complementary to the data provided by the predictive mapping, which implies that the final erosion diagnosis must be expressed by a single and integrated symbol. (PAP/RAC, 1998)

The geographical analysis of the physical characteristics shows the predominance of signs favoring and accelerating the distribution of forms of water erosion, high slopes, lithology sensitive to the effects of precipitation, coverage rate only protects the soil over very small areas.

Climatic aggressiveness is manifested by individualization during the year, a more or less long dry period, this drought plays an important role in the degradation of the environment. By weakening the soil for several months, it leads to rural exodus, which also influences the balance of ecosystems.

With the succession of dry years that characterizes the agriculture of the Bou Lajraf watershed, it was found that the slopes of steep slopes are marked by the concentration of several forms of water erosion, these are surfaces that do not benefit from any maintenance on the part of the farmers, and consequently the reduction of water infiltration into the soil.

From a spatial point of view, the high and very high erosive state classes that mark the landscape are placed at the head, since it extends over 75% of the area of the Bou Lajraf watershed, it shows different degrees of evolution, three phases have been identified.

The primary phase which concerns 40% of the watershed area, identified by sheet erosion and the rise of elements of different sizes (heterogeneous granulometry).

The middle phase is an intermediate class where stripping leaves its mark on the landscape by lightening the colour of the soil in particular places such as the tops of slopes, breaks in slopes and on a good part of the convex slopes. It concerns erosion in rills and ravines, representing respectively 9% and 34% of the total surface area of the watershed.

Gullying primarily affects materials that are not very resistant and is generally located on steep and sufficiently long slopes. It locally concerns surfaces where man, through his activities rooted in history, has created the conditions favorable to its development.

The presence of sheet and rill forms of water erosion is explained by the exploitation of high slopes and lithology marked by low resistance to dry farming. These conditions favor these two forms of water erosion, which however pass to the form of gully erosion.

The developed phase represents a very advanced concentration of ravines, they coincide with the most attacked parts of the fields or the soil has completely disappeared (Badlands), occupying an area of 14% of the total surface area of the watershed.

The Bou Lajraf watershed represents a territory in transformation: morphogenesis is important, more particularly with the succession of dry years (linear ravines). It has undergone more significant transformations, vast sectors have been deforested for cultivation, because of the weakness of flat surfaces.

The analysis of the results of water erosion in this watershed gives very serious notions on the state of the slopes against this type of risk because of their fragility, more particularly the marly lithology and the low rate of vegetation cover. It should not be forgotten that the degradation of water erosion also affects forest slopes, which are not completely stable environments but are sometimes badland surfaces.

The schistose marls and marly limestones are sensitive to water erosion (linear incision) and give a chaotic appearance to the slopes. The marls are not very permeable and are capable of absorbing water through the desiccation cracks caused by the summer drought. These cracks play an important role in the instability of the slopes.

In the absence of vegetation, water flows without encountering any obstacles. It gains speed and carries with it a large part of the soil, thus causing water erosion of the slopes.

Crop systems play a role that is sometimes negative, sometimes positive, depending on the conditions and hydrodynamic processes of the slopes and the conditions of genesis of the risk of water erosion. Whether old or modern, we find large areas that have become sterile, affected by widespread stripping.

The vegetation cover on the slopes improves their stability in relation to the type of species and the rate of coverage. The progressive destruction of the vegetation at the expense of the development of crops

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constitutes a significant factor of instability. After this destruction, a very different replacement vegetation is established; both from a physiognomic and floristic point of view. This seasonal vegetation causes the appearance of forms of water erosion and the acceleration of ravine erosion.

CONCLUSION

The research concludes that the Bou Lajraf watershed contains surfaces of high and very high erosion degrees. This area is not a stable environment. The current vegetation cover does not provide strong protection against the onset of erosion processes. This state of affairs seems to be accentuated by the steep slopes which promote and accentuate runoff while minimizing the role of roughness.

The effects of such dynamics are spectacular: after each rainy period, profound disturbances affect the space, the changes incurred by the surface create new topographical conditions, the losses in terms of soil are very significant and the damage to equipment is costly to the local economy, thus aggravating the precariousness of the living conditions of the peasant community.

Finally, we note that the absence of forms of water erosion in a given slope is not automatically a stability for the future, the development of a form in a slope can one day be accelerated or reactivated by natural or anthropogenic conditions.

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