MODELLING AND MAPPING OF EROSION RISK IN RACHAYA (LEBANON)

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ABSTRACT

Soil erosion is a phenomenon that undermines the natural environment and the agricultural activities in the Bekaa Valley (Lebanon) and on the surrounding foothills. In the absence of some data, that the situation in Lebanon during recent decades has caused, it may be relevant to change or adapt some of the classical equations about soil loss. This research is done on an area located near the village of Rachaya, extending over 130 km^2.

The study area lies between latitudes 33°30'30'' and 33°38'30'' North and longitudes 35°49'30'' and 35°59'30'' East (**plate 1**). It comprises two types of geomorphic-dynamic units: the plain and the slopes of the western chain culminating at 1750 m. The median elevation is between 1350 and 1400 m, according to the hypsometric curve (**plate 2**), and the mean slope has an order of 9 degrees. The Mediterranean environment, the aggressiveness of the climate, the relief and geology (**plate 3**), the slopes locally rather strong, the deforestation and the extent of crops form a context favorable to erosion.

The methodology (**plate 4**) is based on a modeling adapting the Wischmeier and Smith Universal Soil Loss Equation, USLE, (A = R * K * C * P* LS) (Wischmeier & Smith (1960, 1978) whereby the factors entered into the model are: rainfall erosivity (R), soil erodibility (K), soil cover (C), cultural practices (P), slope value and slope length (LS) (plate 4). This model uses the contributions of geographical information systems and satellite images (Ikonos, Landsat).

- The R factor (**plate 5**) is calculated based on the formula elaborated by Renard & Freimund, (1994).
- The K factor (**plate 6**) depends on soil texture, structure and organic material. The calculation of this factor relies on the formula of Wischmeier et Smith (1978). Soil samples were taken from the site to show the soil granulometric characteristics of the study area (**table 1**).
- The C factor (**plate 7**) is determined based on tables established by Wischmeier & Smith (1978). It depends on the vegetation height, the recovery rate and the bibliographic knowledge of the Mediterranean region (Sadiki *et al*., 2009, El Garouani *et al*., 2008) (**table 2**).
- With respect to the P factor, two codes were identified, one for the agriculture terraces and the other for areas of anti-erosion practices.
- For the purpose of this study, the adopted model for the LS factor (**plate 8**) combines only the length and the inclination of the slope.

The results (**plate 9**) show the role of the steeper slopes and of the less protective vegetation cover. About 90% of the study area are affected by very high values of soil losses (higher than 200 t/ha/year, up to 1300 t/ha/year) or high values (between 50 and 200 t/ha/year). On the ledges, losses are limited (values between 5 and 50 t/ha/year). Only about 3% of the total area can be considered without erosion risk and negligible soil losses.

Soil cover is generally the most discriminant factor. It strengthens soil resistance by breaking the kinetic energy of raindrops and by intercepting some of the precipitations. It is true that the Rachaya area has been affected by a strong degradation of the vegetation cover, so that the C factor varies between 0.7 and 1 for 77% of the study area (**plate 7**). Anti-erosion practices are not widespread and subsist only on a few hectares of agricultural terraces. These conditions reveal the insufficiency of protection against the aggressiveness and that is why the R factor may exceed 1600 (**plate 5**). Several parameters are decisive to explain the soil erodibility: the infiltration capacity, the retention texture and the tearing susceptibility. Most of the

soil in Rachaya is fragile and prone to erosion. The force of the relief, especially where there are steep slopes and topographical irregularities, greatly helps erosion; Rachaya high values of LS in some places contributed largely to the erosive risk (**plate 8**). The validation of our results was made on the one hand on fieldwork and the other hand using the spectral response of the eroded areas, based on the brightness index value processed from the Ikonos satellite image with high spatial resolution of 1 m. This index, which is generated from the red and near infrared channels, characterizes the albedo and allows the diagnosis of soil degradation from color changes reflecting changes in the soil surface. The soil spectral signature depends on the organic matter content, on the moisture content and on the mineralogical composition. These variables have a major impact on the color and brightness of soil. The erosion mechanism, which strips the surface layer, makes the soil clearer because of the destruction of organic matter. At the opposite, the soil moisture, the presence of organic matter or an increase of the vegetation cover give a dark color to the soil.

Finally, the relative accuracy of our results, estimated through comparison of spatial modelling results and brightness index map, is about 80%.

Due to the importance of the erosion phenomenon which has been quantified, it seems necessary to increase the stabilization of the slopes and to implement protective farming techniques.

KEYWORDS

Soil erosion, USLE, spatial modelling, Lebanon.

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