Short Research Article

SPATIAL BEHAVIOR OF SOIL ERODIBILITY IN THE LA VILLA RIVER BASIN, PANAMA

ABSTRACT

Introduction: Soil erodibility is an important factor in understanding the erosion that takes place in a territory. This is a parameter that can behave erratically in small spaces, but that describes a trend in larger spaces.
Aim: Determine the K factor of soil erodibility in the La Villa-Panama river basin.
Place and Duration of Study: La Villa River Basin-Azuero Peninsula, Panama. 2010-2012.
Methodology: 98 points of the La Villa river watershed were sampled. Factor K was calculated using the adaptation to the sol-erodibility nomogram. The percentage of organic matter, structure class (in the field), permeability (combination permeameter) and the percentages of sand, silt and very fine sand (Bouyoucos method) were determined. To obtain the most complete information possible on the distribution of erodibility, a superficial interpolation of the point values corresponding to the soil samples taken was carried out. The software used was Arcview 3.3 and the Spatial Analyst extension. The interpolation method was IDW (Inverse Distance Weight). The erodibility values were categorized into seven intervals in such a way that it was possible to observe the differences on the map.
Results: The erodibility values were influenced by the content of organic matter and coarse particles (percentage of sand and silt + very fine sand) of the soil. In the province of Herrera, 86% of the land surface and 76% in the province of Los Santos presents susceptibility to erosion in the ranges of 0.032 to 0.043 Ton ha h ha^{-1} Mj^{-1} mm^{-1}.
Conclusion: The results indicate that 80% of the soils of the La Villa river basin present a moderately high erodibility factor, with the highest values being registered in the upper middle zone.

INTRODUCTION

Soil Erodibility or K Factor is an index of the Universal Soil Loss Equation that describes the susceptibility or vulnerability (Wishmeier, 1978; Kirkby and Morgan, 1984; Röder et al. 2006) of the soil to be eroded. Likewise, the K factor represents soil erosion per unit of pluvial erosion index, determined in plots with a slope of 9% and lengths of 22.1 m (CORINE-CEC, 1992; Morgan, 1997; Suárez, 2001). The knowledge of the behavior of the K factor in specific sites or geographic regions could be a guide or determinant of the measures (policies) leading to give it (Andrade et al. 2010).

Comparison between appropriate land use, the K factor and other factors that come into play in erosive fact can provide more detailed data on the extent of soil erosion risk.

The most widely known method for calculating the soil erodibility factor is the soil-erodibility nomogram (Wishmeier and Smith, 1978). This method was used in this research to make specific determinations; and the interpolations within the La Villa River Basin were obtained by means of the inverse distance method making use of Geographic Information Systems (GIS) tools.

MATERIALS AND METHODS

98 points were sampled throughout the geography of the La Villa river basin, trying as far as possible to do so according to a 4 km by 4 km reticular mesh at a density of approximately one sample every 16 km^2 (Figure 1).

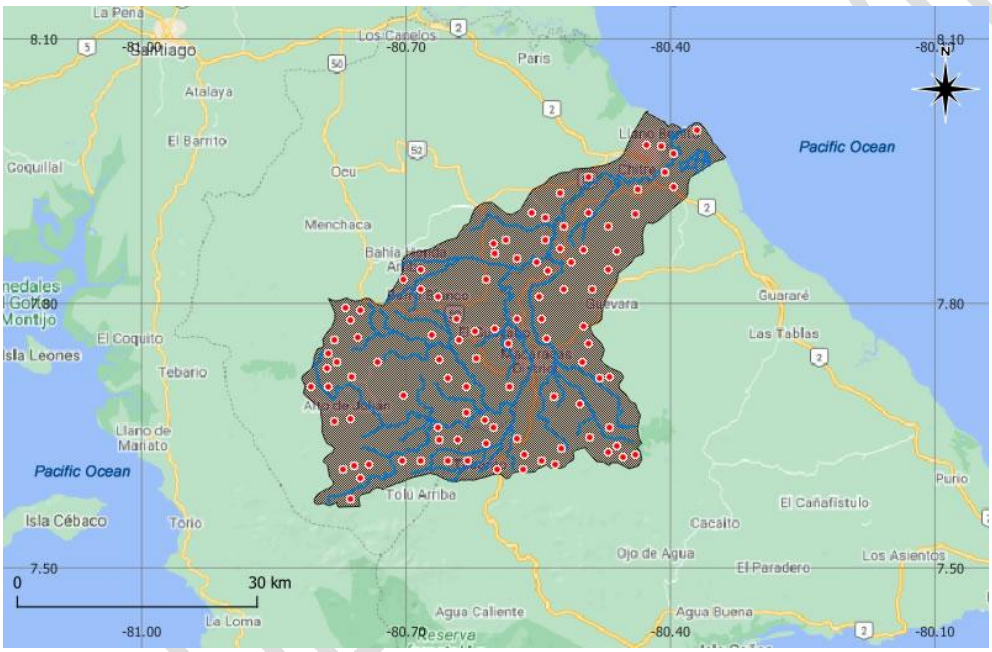

Figure 1. Points sampled throughout the geography of the La Villa river basin-Panama.

The K factor for each sampled point was calculated using the adaptation (Foster et al, 1981) to the soil - erodibility nomogram (Wishmeier, 1978) as shown in Figure 2. For this, it was necessary to determine the percentages of organic matter (Wakley Black method), structure classes (in the field), permeability (combination permeameter) and the percentages of sand and silt plus very fine sand (Bouyoucos method) (Villarreal and Name, 1996).

According to this nomogram, the erodibility factor is obtained using the value of the % silt + very fine sand in the sample and by drawing a horizontal line it is intercepted with the corresponding% sand curve and then another line is drawn vertically and intercepts the% Organic Matter curve. From this point of interception, by drawing another horizontal line to the right it intercepts with the curve of the type of soil structure and then vertically and downwards intercept the type of permeability (Figure 2). Finally, from this same point of interception, a horizontal line is drawn to determine the soil erodibility factor (on the vertical axis).

To obtain the most complete information possible on the distribution of erodibility, a superficial interpolation of the point values corresponding to the soil samples taken was carried out. The software used for this was Arview 3.3 and the Spatial Analyst extension. In this way, images were generated in raster format with a spatial resolution of 15 m. The interpolation method used was IDW (Inverse Distance Weight) (Watson and Phillip, 1985), according to which the "weight" of each station at a given point decreases compared to the others with distance.

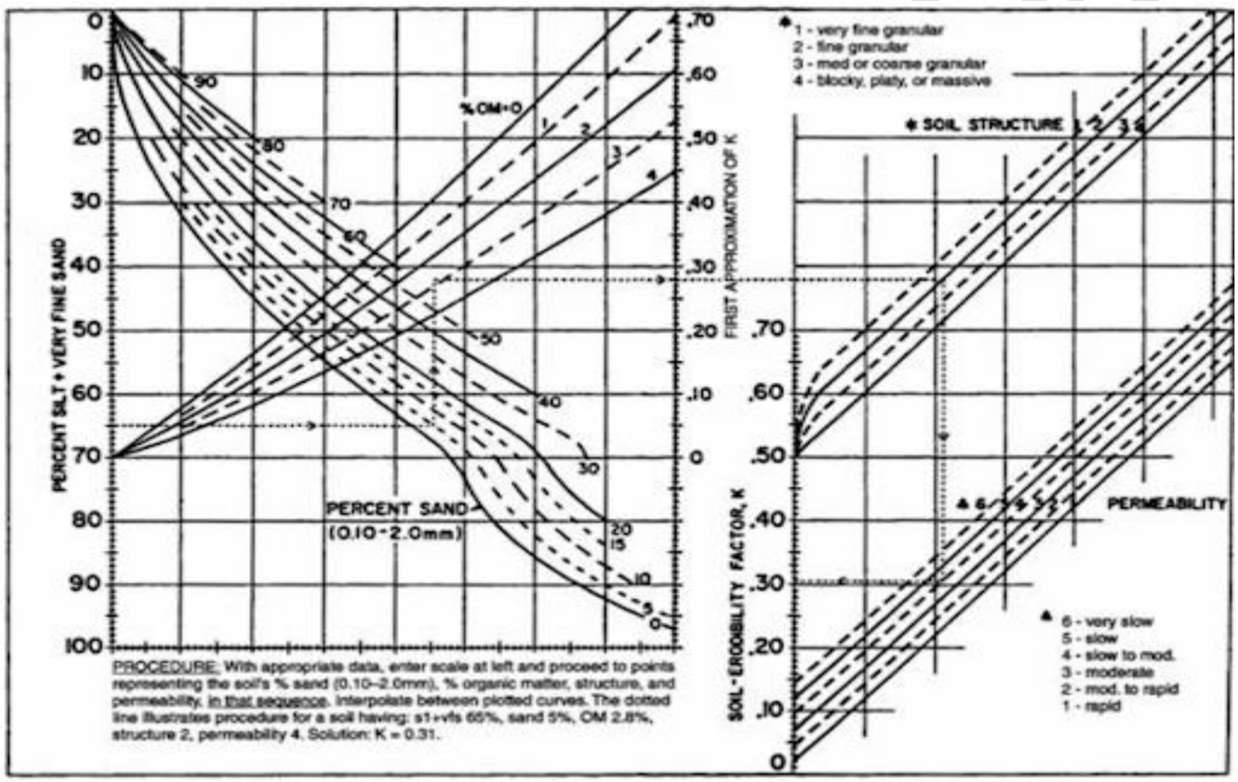

Figure 2. Soil nomogram - erodibility. (Wischmeier and Smith, 1978; Foster et al, 1981).

The erodibility values were categorized into seven intervals so that the intervals allowed to observe the differences on the map.

RESULTS AND DISCUSSION

Relative frequency of the erodibility factor

In total, 98 soil samples were taken from the La Villa river basin using a density of one sample per 16 km^2. The laboratory analyzes and the calculations carried out allowed determining that the mean of the erodibility factors in the basin was 0.037 Mg ha h ha^{-1} Mj^{-1} mm^{-1} and the standard deviation was 0.009 Mg ha h ha^{-1} Mj^{-1} mm^{-1}, with extremes of 0.012 as a minimum and 0.056 as a maximum. The most frequent values were included in the intervals between 0.026 and 0.043 as can be seen in Figure 3.

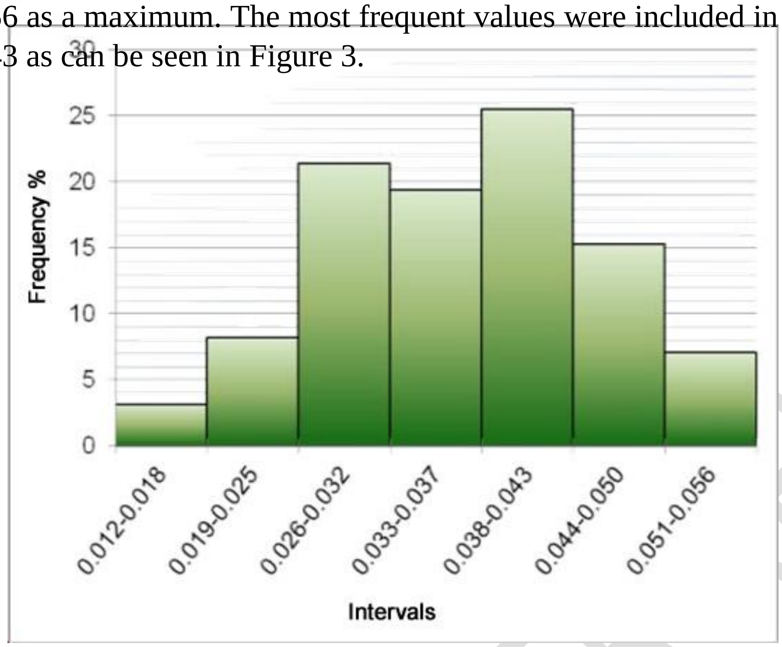

Figure 3. Frequency of existence of the K factor for the study area by interval.

Distribution of the erodibility factor in the La Villa river basin

The interpolations carried out by means of the inverse distance, produced the distribution that is presented in Figure 4. It illustrates the values of soil erodibility by means of an increase in the color tone. The erodibility values obtained are higher towards the southern region of the study area and the lowest values are more frequent towards the northeast zone and towards the flat regions of the basin. This trend is apparently influenced by the organic matter content and the content of coarse particles (% sand and silt + very fine sand) of the soil. Radziuk and Switonak (2021), in northeastern Poland soils, found values of the K factor between 0.0172 and 0.0352 Mg ha h ha^{-1} Mj^{-1} mm^{-1}, relating the high susceptibility to erosion with the low carbon content in this soil.

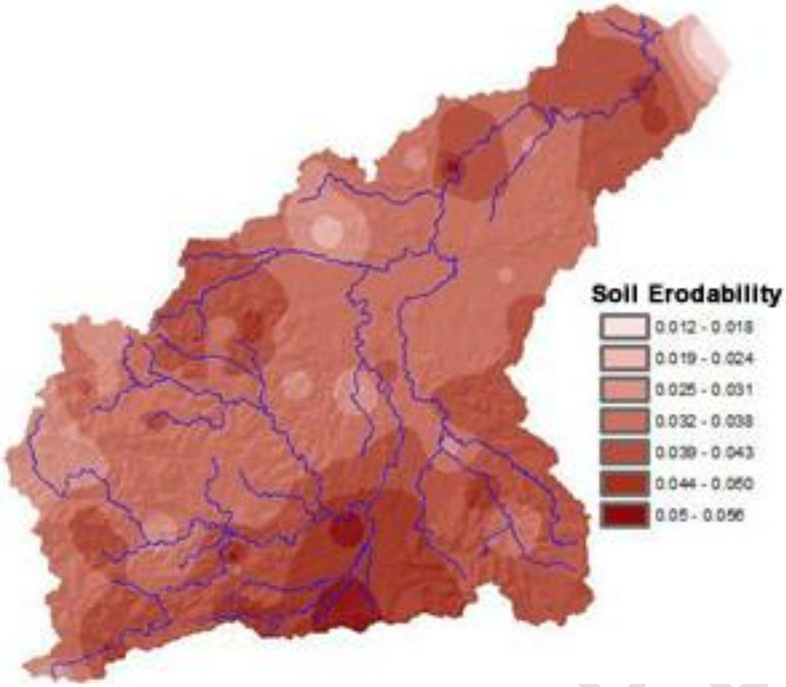

Figure 4: Distribution of erodibility in the La Villa river basin. Panama.

The results found are closely related to the low coverage and land use in the basin. In Figure 5 it is observed that only to the south of the basin, in the highest part, there is a remaining forest, almost 90% of the basin has agricultural use with low content of organic matter (< 2%). To the northeastern you can see, in red color, the two main cities in the lower part of the basin.

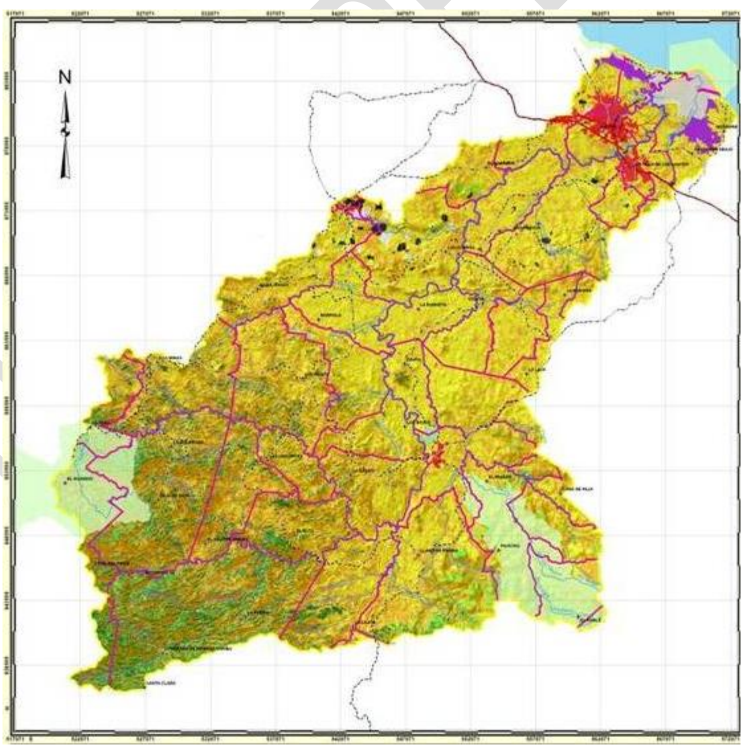

Figure 5. Land cover map in the La Villa river basin (ANAM, CATIE, PRONAT, 2008).

Figure 6 shows that in the province of Herrera, the largest land area, 86%, presents soils with susceptibility to erosion in the ranges of 0.032 to 0.043 Mg ha h ha^{-1} Mj^{-1} mm^{-1} and corresponds to the districts of Los Pozos and Las Minas followed by Pesé and Chitré. The highest values found are located in the Los Pozos district, in the upper-middle region of the La Villa River Basin.

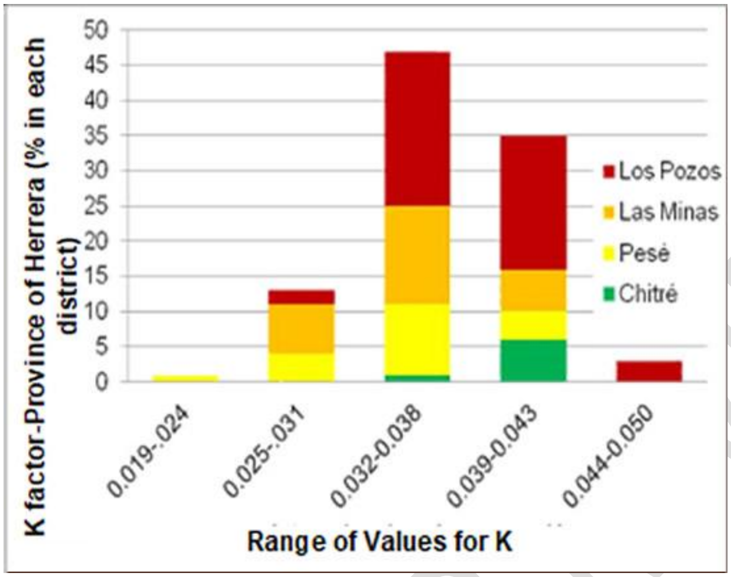

Figure 6. Percentage of surface area of the La Villa river basin within the province of Herrera according to District and erodibility factor.

Similarly, for the province of Los Santos, it was possible to determine that the largest surface area corresponds to soils with susceptibilities in the interval from 0.032 to 0.043 Mg ha h ha^{-1} Mj^{-1} mm^{-1}, according to the sample (Figure 7). In Brazil, working on ultisol soil, Cassol et al. (2018), found a K factor of 0.0338 Mg ha h ha^{-1} Mj^{-1} mm^{-1} characterizing it as a soil highly susceptible to water erosion.

The percentage of surface, in this case corresponds to 76%, based on the surface of the province of Los Santos coinciding with the La Villa River Basin; and the district that registers the highest susceptibility is Macaracas followed by Los Santos. The highest values found were in the Macaracas district.

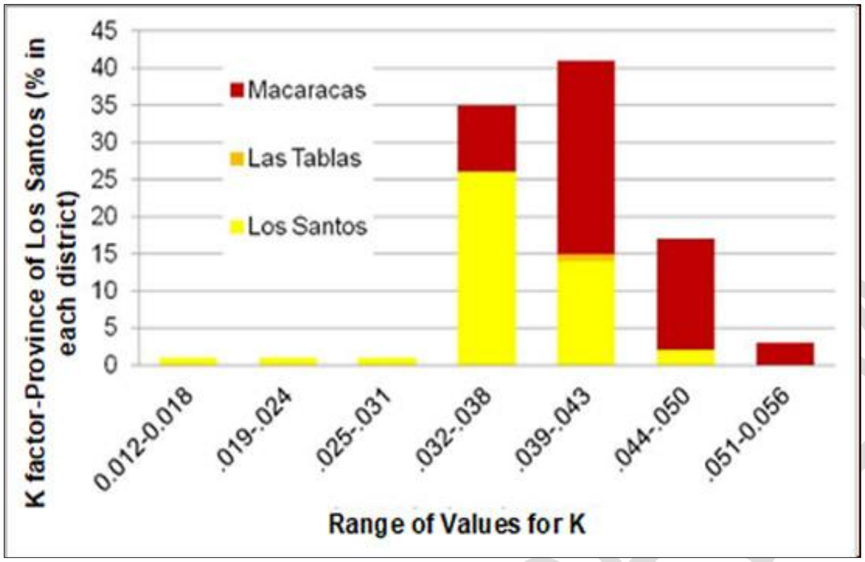

Figure 7. Percentage of surface area of the La Villa river basin within the province of Los Santos according to District and erodibility factor.

CONCLUSION

The results obtained indicate that 80% of the soils of the La Villa river basin have a moderately high erodibility factor and that the highest values are registered towards the upper-middle part of it.

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