Title : Soil erosion susceptibility map for the Basque Country

1. Introduction

Soil erosion is considered as the most widespread form of soil degradation. Risk assessment and quantification of the soil erosion are two main activities to provide better political plans for natural resources, forestry and environment. Assessment of soil erosion sensitivity is defined as the possibility of soil erosion occurrence and identification of areas susceptible to soil erosion that form when only considering natural factors. The objective of this tool was to improve the resolution of European level soil vulnerability maps provided by the European Comission. Based on Geographic Information System (GIS) technologies, the influences of precipitation, soil and topography on soil erosion sensitivity were evaluated at a resolution of 10m using a modified version of the Revised Universal Soil Loss Equation (RUSLE) model. The input layers for the Basque Country (Rainfall erosivity, Soil Erodibility, and Topography) have been developed by NEIKER. The erosion-sensitivity is given in classes based on a personal communication of Panos Panagos (European Commission, Joint Research Centre (JRC)).
Erosion after severe fires is not considered in this map because USLE derived models for erosion estimation do not perform adequately when forest fires disrupt soil structure.

2. Development of the soil susceptibility map for Euskadi

An index of soil susceptibility to water erosion was created by combining spatiotemporal variations when only considering natural factors (climatic erosivity (factor R), soil erodibility (factor K), and landscape roughness(factor LS)). Soil erosion susceptibility has been defined as the simple multiplication of 4 soil erosion risk factors (similar to RUSLE):

Soil susceptibility to water erosion = R *K*LS*C

Land use and management influence the magnitude of soil loss. Among the different soil erosion risk factors, the cover-management factor (C-factor) is the one that policy makers and farmers can most readily influence in order to help reduce soil loss rates. However, the bare plot (no vegetation) is taken as a reference condition for soil erosion susceptibility with a C-factor value of 0.5 (personal communication of Panos Panagos (European Commission, Joint Research Centre (JRC)). This erosion susceptibility can be reduced with an appropriate cover management; forests have the lowest mean C-factor.

2.1. Development of the erosivity map for the Basque Country (R-factor)

Rainfall is one the main drivers of soil erosion. The erosive force of rainfall is expressed as rainfall erosivity. Rainfall erosivity considers the rainfall amount and intensity, and is most commonly expressed as the R-factor in the USLE model and its revised version, RUSLE (Panagos et al., 2015a). The development of rainfall erosivity factor for the Basque Country is described in another PLURIFOR tool named as: Monthly rainfall erosivity in Euskadi.

The mean R factor of the 81 precipitation stations in the Basque Country is 582 MJ mm ha^{-1} h^{-1} yr^{-1} with a high standard deviation of 289 MJ mm ha^{-1} h^{-1} yr^{-1} as expected due to high climate variability in the region (Figure 1). The smallest and highest R factor were 258 and 2543 MJ mm ha^{-1} h^{-1} yr^{-1} . The distribution of R-factor values is skewed to the right and there is also a north to south gradient (Figure 1).

The R-factor map of the 28 European Union Member States and Switzerland has an average value of 722 MJ mm ha^{-1} h^{-1} yr^{-1} and a standard deviation of 478.6 MJ mm ha^{-1} h^{-1} yr^{-1}. The range of R-factor in Europe is 51.4–6228.7 MJ mm ha^{-1} h^{-1} yr^{-1} (Panagos et al., 2015a). The smallest R-factors were calculated for two stations of the Ebro catchment (Spain), two stations in Slovakia (Gabcikovo, Komarno), and the stations in Tain Range (UK) and Inari Kaamanen (Finland) with values less than 100 MJ mm ha^{-1} h^{-1} yr^{-1}. The maximum values were calculated for five stations in Slovenia (Kneške Ravne, Vogel, Kal Nad Kanalom, Log Pod Mangartom and Lokvein) and one station in north-eastern Italy (Tramonti di Sotto, close to Slovenia) with values greater than 5000 MJ mm ha^{-1} h^{-1} yr^{-1} (Panagos et al., 2015a).

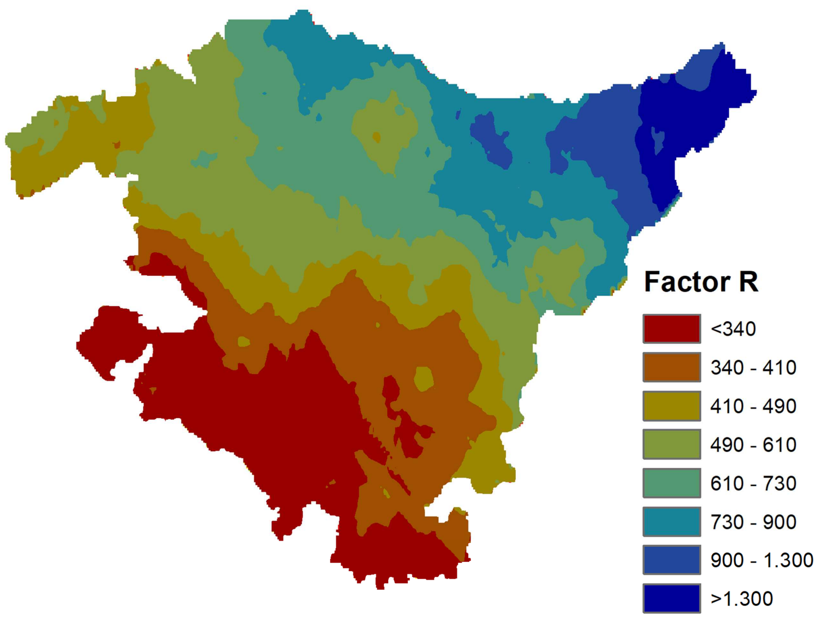


Figure 1: High-resolution (10m grid cell) map of rainfall erosivity in the Basque Country.

2.2. Development of the soil erodibility map for the Basque Country (K-factor)

The K factor is a lumped parameter that represents an integrated annual value of the soil profile reaction to the process of soil detachment and transport by raindrops and surface flow (Renard et al., 1997). As such, soil erodibility is best estimated by carrying out direct measurements on field plots (Kinnell, 2010). However, since field measurements are expensive and often not easily transferable in space, researchers investigated the relation between “classical” soil properties and soil erodibility. The K-factor has been defined as:

$$K= TF*(12-OM)+SF+PF$$

where TF is the texture factor, OM is the organic matter content in %, SF is the structure factor and PF is the permeability factor.

For the estimation of the soil texture (TF), structure (SF) and permeability (PF), classes described in the US Department of Agriculture's National Soils Handbook No. 430 (USDA, 1983) were assigned according to soil texture classes (Rawls et al., 1982). Soil organic matter map for the Basque Country has been also used for K-factor calculation.

The mean K factor for the basque Country is 0.04 t ha h ha^{-1} MJ^{-1} mm^{-1} with a standard deviation of 0.008 t ha h ha^{-1} MJ^{-1} mm^{-1} (Figure 2). The mean K factor for the Basque Country is above the European mean which is 0.032 t ha h ha^{-1} MJ^{-1} mm^{-1} with a standard deviation of 0.009 t ha h ha^{-1} MJ^{-1} mm^{-1} (Panagos et al., 2014). The range of values is 0.004–0.076 t ha h ha^{-1} MJ^{-1} mm^{-1} for Europe and 0.001-0.07 t ha h ha^{-1} MJ^{-1} mm^{-1} for the Basque Country.

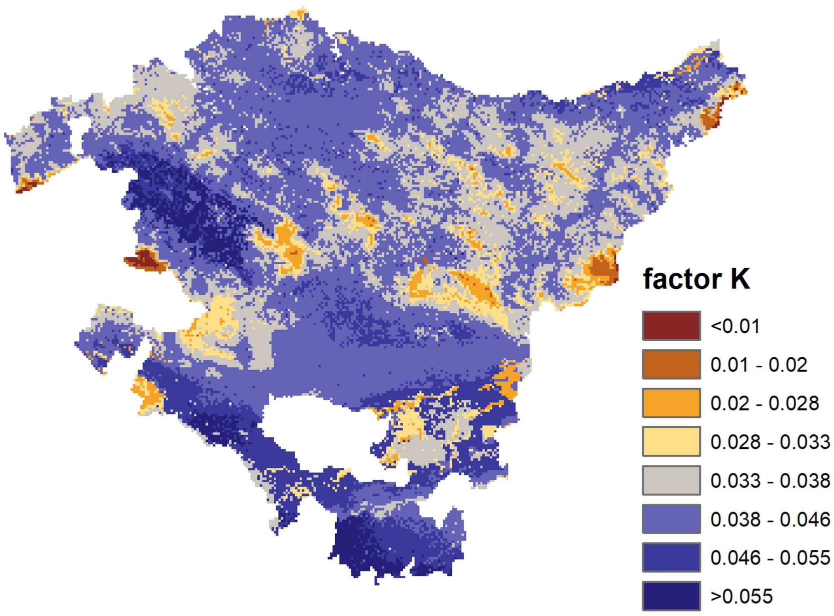


Figure 2: High-resolution (10m grid cell) map of soil erodibility for the Basque Country.

2.3. Development of the landscape roughness map for the Basque Country (factor LS)

LS factor map for the Basque Country has been developed with high-resolution DEM (5m grid cell) following the method described in Panagos et al., 2015b).

The mean LS factor for the Basque Country is 7.4 with a high standard deviation of 15.7 reflecting the high complex topography, characterized mainly by undulating relief. At European scale, Austria has the highest mean LS-factor (5.2) followed by Slovenia, Greece, and Italy, each with mean LS-factors greater than 3 (Panagos et al., 2015b).

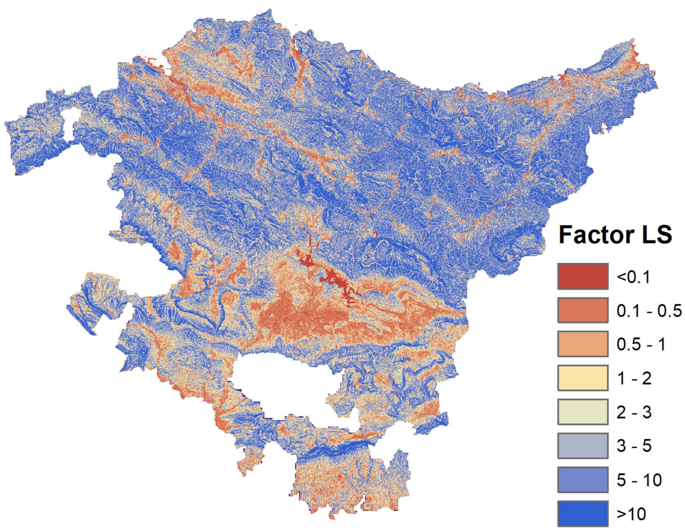


Figure 3: High-resolution (5m grid cell) map of LS for the Basque Country.

2.4. Classification of erosion-sensitive areas. The above presented maps were then multiplied by each other to get the soil erosion suisceptibility map that was classified as it follows:

Erosion prone areas were classified as (Panagos personal communication):

< 1 Mg ha^{-1} year^{-1} = very low
1-2 Mg ha^{-1} year^{-1} = low
2-5 Mg ha^{-1} year^{-1} = medium low
5-10 Mg ha^{-1} year^{-1} = medium
10-20 Mg ha^{-1} year^{-1} = medium high
20-50 Mg ha^{-1} year^{-1} = high
>50 Mg ha^{-1} year^{-1} = very high

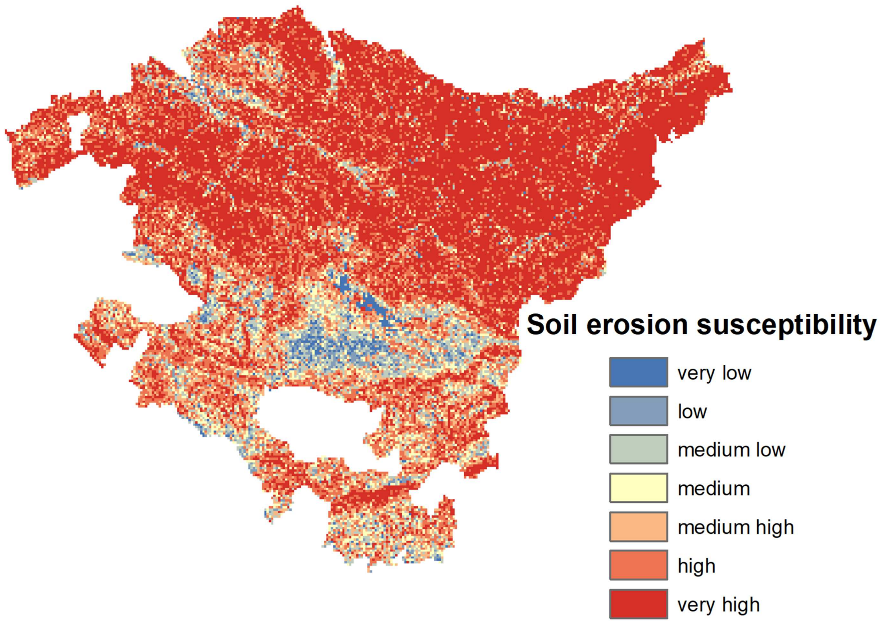
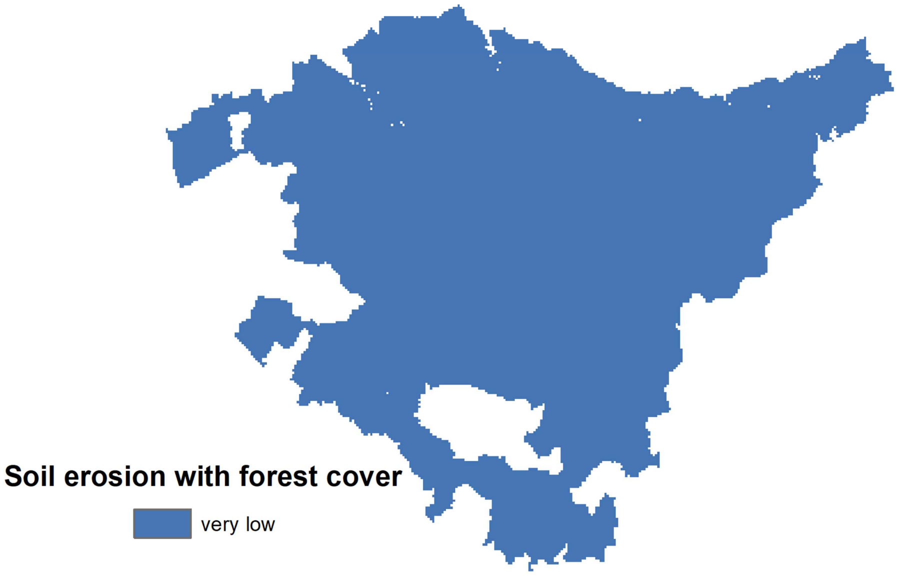


Figure 4: High-resolution (10m grid cell) map of soil erosion susceptibility for the Basque Country.

Human activity and agricultural/forestry practices are the main drivers for soil erosion trends (Garcia-Ruiz et al., 2013). In terms of land management, the C-factor can be changed by farmers'or forest owners´ interventions. As forests have the lowest C-factor, continuous cover forestry might be a forestry practice that policy makers should take into account. As an example, Figure 5 represents the soil erosion that could present the Basque Country if the whole Country was covered by forests (C-factor= 0.0001).



3. Conclusions and research gaps

Overall, soil erosion susceptibility in the Basque Country is very high. The only area with low susceptibility is the Llanada Alavesa and Rioja Alavesa with a medium susceptibility. Soil protection measures should definitely be taken in Basque land areas where soil erosion susceptibility is high or very high. An example of such a measure might be the continuous cover forestry.

4. References

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