

SOIL EROSION RISK IN CROATIA

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Abstract: Implications of soil erosion are of the utmost importance for the overall economic development, notably for agriculture, forestry and water management. For this reason, land management should involve permanent soil protection from erosion. This requires preparation of maps of soil erosion risk, as the basis for implementing the policies of soil protection steps. This paper presents results of the investigation which comprises the estimation of the water erosion risk on Croatian soils. For assessing a qualitative cartographic method according to the CORINE program was used depending on the maps of potential and actual erosion risk (scale 1:300.000) comprising the total territory in Republic of Croatia. In this reason pedocartographic investigations were applied with the GIS technology assistance. Research results indicate that the largest part of the Republic of Croatia has a low potential risk of soil water erosion, account for 42.3% of the total area of the country. A moderate degree of water erosion occurs on 24.1 % of the total area and high erosion risk can be estimated on 31.8% of the total area. In Croatia, however, a low actual erosion risk was assessed on 53.3% of the studied area, a moderate actual risk occurred on 31.5%, while a high actual risk accounted for 13.4% of the measured area.

According to our results, a low erosion risk occurs on 53.6% of the cultivated area, while a moderate degree on 23.1% and a high degree on 23.3%, respectively. The area endangered by moderate and high erosion risk indicates a probable great damage on the cultivated land in Croatia that calls attention to the execution of the risk decreasing steps. Moreover, in agricultural soils characterised by moderate and high erosion risks, further soil degradation forms can also be appeared as the consequences of the crop production technologies. The erosion risk maps of Croatia can be served as the main source of the information required for planning sustainable land use and soil protection both in national and regional relations.

Keywords: soil, water, erosion, CORINE program, map, Croatia

Introduction

It is well known that crop growth and yield will decline if the level of any soil degradation incidence (erosion, compaction etc.) extends above an value which will vary with different soils both in Croatia and in Central European (Birkás 2006; Várallyay 2006). Water erosion as one of the human-induced degradation types is really serious problem in Croatian relation. Moreover, loss of the soil caused by water (or wind) erosion it cannot be replaced by agricultural techniques. Implications of soil erosion are of the utmost importance for the overall economic development, notably for agriculture and forestry. Primary effects involve soil loss, that is, removal of the plough-layer from arable areas or the surface humus or/and lower horizons from other areas, which leads to reduced soil productivity, lower yields and smaller cropping areas, plant damage, decrease in soil depth, etc. Secondary effects are reflected in an increase of silt particles in canals, rivers, lakes and reservoirs, pollution of surface and ground waters caused by fertilizers and pesticides detached with soil particles (Basic et al. 2002). Damages to vegetation and changes of local climate, with more frequent and longer dry periods, intensify desertification processes. To conserve the existing soil resources and protect them from further damage, as for sustainable water management (Juhász 2007) a program should be designed for soil protection from erosion, as a basis for land management ensuring permanent soil protection from erosion. Aimed at designing such

a program, the project «*Execution of potential and actual soil erosion risk maps of the Republic of Croatia at a scale of 1:300000*» was started in 1997. This paper presents the methodology applied and the research results of the given project as well as the potential uses of the produced maps of soil erosion risk.

Materials and methods

Maps of potential and actual soil erosion risks for the Republic of Croatia were made using the method CORINE – soil erosion risk and important land resources (CEC 1992) according to the criteria and standards of designing maps at a scale of 1:300.000. This is a qualitative cartographic method that involves designing and overlapping of several layers-thematic maps, as presented in Figure 1.

Maps with texture classes, soil depth and stoniness were compiled from the Basic Soil Map of the Republic of Croatia, scale 1:50.000 and the Soil Suitability Map of the Republic of Croatia, scale 1:300.000 (Bogunovic et al. 1997). Maps of precipitation variability and climatic aridity were derived from climatic data for 70 meteorological stations, calculated with Fournier and Bagnouls-Gaussen-indices (Briggs 1998). Map of terrain slope was derived from contour lines with 50 m equidistance. Vegetation cover map was derived from the forest distribution map, scale 1:300.000.

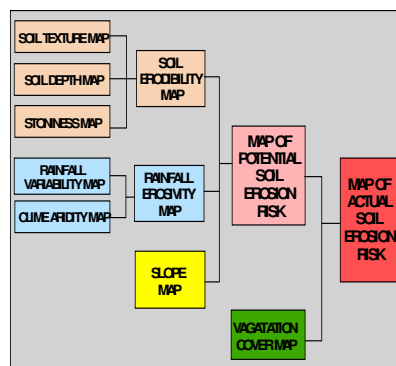


Figure 1. Scheme of the CORINE method

All research was done by the method of integrating digital maps using GIS tools of the NT Arc Info program package.

Results and discussion

Potential soil erosion risk

Potential risk of soil erosion by water is defined as the inherent soil susceptibility to erosion by water, not accounting for the vegetation cover or mode of utilization. This risk is thus the worst possible case; namely, assessment of the potential soil erosion risk is based on the assumption that the entire area under study is used as arable land. Major characteristics of a terrain that have dominant influence on the potential soil erosion risk include soil erodibility, precipitation erosivity and terrain slope, for which respective maps were made, and their further integration resulted in the map of potential soil erosion risk. Further elaboration and analysis of the given map revealed low potential risk on 2,397,409.8 ha or 42,3%, moderate potential risk on 1,366,411.3 ha or 24,1%, and high potential risk on 1,800,264.9 ha or 31,8% (Figure 2).

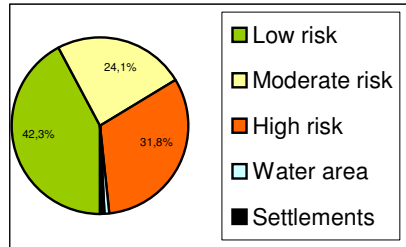


Figure 2. Degrees with potential soil erosion risks

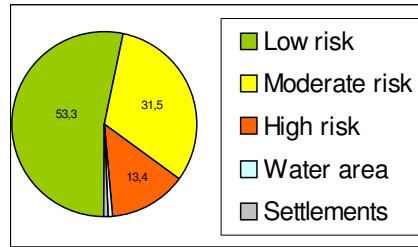


Figure 3. Degrees with actual soil erosion risks

Actual soil erosion risk

Actual risk of soil erosion by water is the risk of erosion, regarding to the current soil cover and the actual land use. In the regions with the type of vegetation cover representing arable areas, i.e., all areas that are not under forests or permanent grasslands, for this reason the potential risk, at the same time, corresponds to the actual risk of soil water erosion. In the regions with the vegetation cover type representing areas under forests or permanent grasslands, the extent of the risk of soil erosion by water is really lower compared to the extent of potential risk owing to the protective role of this vegetation cover (CEC 1992, Pottyondy et al. 2007). Thus, map of the actual soil erosion risk was derived by integrating the map of the potential erosion risk with the vegetation cover map. Inventory of areas under particular degrees showed that the most wide-spread class is the one indicating low actual risk of soil erosion by water, which accounts for 3,020,690.3 ha or 53.3% of the Croatian territory. The degree of moderate actual soil erosion risk covers 1,796,921.0 ha or 31.5%, while the degree of high actual erosion risk occurs on 746,474.8 ha or 13.4% (Figure 3).

Actual soil erosion risk on agriculture land

In Table 1. results of the actual risk of soil erosion on cultivated agricultural land in Croatia is summarised.

Table 1. Area of class of actual soil erosion risk on agriculture land in Croatia

Class of actual soil erosion risk	Area	
	ha	%
Low	1.723.210,5	53,6
Moderate	743.130,7	23,1
High	746.474,8	23,3
Total	3.212.816,0	100

On 53,6% of agricultural land the determined water erosion risk was low, on 23,1% it was moderate, and on 23,3% it was high. The land area characterised by moderate and high risk indicates a great danger of water erosion risk on the larger part of the cultivated agricultural land in Croatia (46,4%). Erosion is usually manifested as the sheet erosion, however, rill and gully erosion forms can also be found in any micro-

regions. In order to protect the soils with moderate and high erosion risk from further degradation, they should be, above all, carefully managed and then adequately protected from erosion within regular agricultural production. As we suggested, modifications of the soil tillage methods and crop production technologies, have been shown to offer opportunities to reduce greatly incidence of water erosion problems (mainly at actual moderate and low risk).

Conclusions

Soil erosion risk in the territory of the Republic of Croatia was assessed using the CORINE method, a qualitative cartographic method, and involved production of maps of potential and actual soil erosion risks at a scale of 1:300.000. These maps served for determination of discrete degrees of potential and actual risks, as well as of their distribution. Besides, the Geographic Information System of soil erosion in Croatia was established, which enables users to retrieve all the required information, from data about the main input parameters to final results of erosion risk assessment, in a relatively simple and fast way. Research results and the possibility of their cartographic presentation provide a complete picture of soil production capacities in Croatia, and may serve to plan agricultural land use and protection in agriculture, water management, forestry and environmental protection, all in compliance with sustainable development at both national and regional levels. The soils with moderate and high risk (46,4% of total agriculture land) of soil erosion, should be carefully managed and adequately protected within regular agricultural production.

References

- Basic F.-Kisic I.-Nestroy O.-Butorac A.-Mesic M. 2002. Soil erosion in different tillage systems in agroecological conditions of central Croatia. Proceedings of the 1st Alps-Adria Scientific Workshop, (ed. Gyuricza C.), Opatija, 4-8 March, 194-199.
- Birkás M., Dexter, A. R., Kalmár, T. Bottlik, L. 2006. Soil quality – soil condition – production stability. *Cereal Research Comm.* 34.1. 135-138
- Bogunović M.-Vidacek Z.-Racz Z.-Husnjak S.-Sraka M. 1997. The practical aspects of soil suitability map of Croatia. *Agronomy Journal* 5-6, 363-399
- Briggs D.J.1998. A provisional method for calculating BGI index. Nene - University College Northampton, UK
- CEC- Commission of the European Communities (1992): CORINE soil erosion risk and important land resources in the southern regions of the European Community. Brussels and Luxembourg, 97 pp
- Juhász C.-Kovács E.-Tamás J. 2007. Leonardo pilot project for sustainable water management in central Europe. *Cereal Research Communications* 35:2. 565-568
- Pottyondy A.-Centeri C.-Bodnár A.-Balogh A.-Penksza K.2007. Comparison of erosion, soil and vegetational relation of extensive Pannonian meadows under mediterranean and submediterranean effects. *Cereal Research Communications* 35:2. 949-952
- Várallyay G.2006. Soil degradation processes and extreme soil moisture regime as environmental problems in the Carpathian Basin. *Agrokémia és Talajtan.*55.(1-2)9-18.