# Rainfall erosivity as an indicator of potential threat to erosion vulnerability in protected areas of Vojvodina (North Serbia)

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## Introduction

Soil erosion is one of the main environmental problems in Southeastern Europe. The major climatic variable affecting water erosion is precipitation. In order to illustrate the role of rainfall erosivity, it is necessary to examine the changes in the amount of precipitation over a certain period of time. Recent studies indicate that climate variabilityon global basis will affect the changes in precipitation in Southeastern Europe. Sinceclimate change is an inevitable natural process, it is necessary to make certain predictions based on analysis of all available rainfalldata in order to protect potentially endangered ecosystems and important areas of distinct natural values. Erosion and precipitation distribution are important elements concerning the implications of climate variability in the Panonnian basin. Vojvodina (North Serbia) is a region located in its eastern part. It is widely known as an important regionwhich consists of a great number of protected bio and geo-diversity areas. Therefore, it is very important to draw attention to the above mentioned areas vulnerabletopluvial erosion in order to create and implement adequate preventive and mitigation measures (Lukić et al., 2016).

## Data and methods

A database of the Republic Hydrometeorological Service of Serbia for the period of 1948 - 2014 for the 12 meteorological stations was used to present the amount and seasonal distribution of precipitation in the Vojvodina region (Meteorological Yearbook of Serbia, 1948-2014). Three indices are used for investigation of aggressiveness of erosion caused by rainfall regime: Precipitation Concentration Index (*PCI*), Fournier Index (*FI*) and Modified Fournier Index (*MFI*). *PCI* is used as an indicator of rainfall concentration and its annual distribution, while Fournier indicesare

implicating rainfall aggressiveness(Oliver, 1980; Arnoldus, 1980). Using the data obtained from the analysis of relationship between the *PCI* and *FI/MFI*, it is possible to describe the evolution of rainfall aggressivity during 1948 - 2014 in erosion-vulnerable protected areas of Vojvodina.

## Results and discussion

Before presenting the results, it is necessary to point out some essential information's concerning the investigated meteorological stations. The number of stations for each part of Vojvodina (Bačka, Banat and Srem)are not evenly distributed because of data shortage. Also, some possible anomalies in the obtained results are explained by the different altitudes of the stations. *PCI* indicates that the precipitation throughout Vojvodina is mostly moderately concentrated (values vary from 11.5-11.9). The multiannual average values of the *FI* is ranging from 21.04 (Palić) to 26.91 (Vršac). The *MFI* shows more accurate data, and is therefore used for cartographic representation (Figure 1-A). The highest and lowest values correspond to *FI* (64.72 Palić – 77.84 Vršac), and according to these values of both indices, territory of Vojvodina is classified as low value erosive class. Linear trend indicates a positive movement of both indexes in 11 out of 12 stations. During the period of 68 years, only Sremska Mitrovica has a decline in the average annual amount of precipitation, and therefore all three indexes shows negative trends. Since the increase of rainfall erosivity indices (*FI/MFI*) is evident, it is necessary to point out the potentially endangered areas of the Vojvodina region. Over 60% of the territory of Vojvodina is covered with eolian sediments (loess and loess like sediments), some of which are a significant element of geodiversity and geoheritage (Vasiljević et al., 2011). The most significant loess profile is the "Čot" in StariSlankamen village, but numerous profiles of the Titel, Srem and Tamiš loess plateau have high geoheritage values as well. Furthermore, a great number of protected areas are located in the vicinity of stations with relatively high values. Probably the most vulnerable protected areas are Special Nature Reserve "Deliblatskapeščara" and areas of exceptional natural beauty "Vršačkibreg".

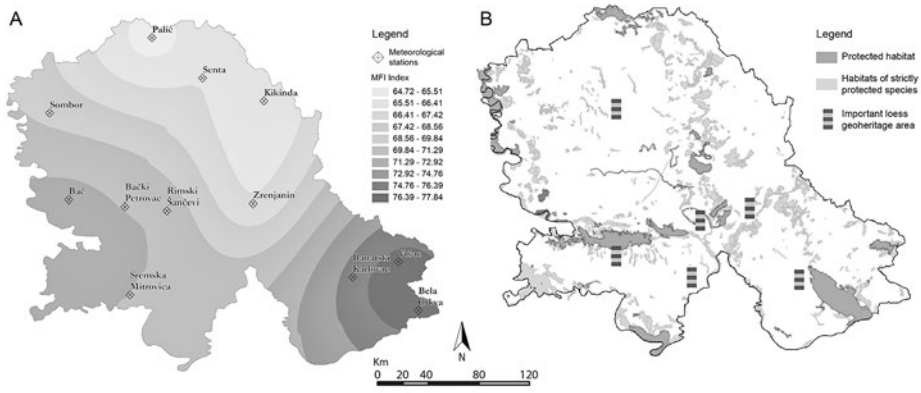


Figure 1. *A) Values of Modified Fournier Index in the Vojvodina region; B) Location of the natural wealth of Vojvodina. Source adapted fromTomić et al., 2004*

They are located in the southeastern part of Vojvodina, where the values for meteorological stations Vršac, Bela CrkvaandBanatski Karlovac are the highest. Moreover, in the vicinity of RimskiŠančevi, BačkiPetrovac and Bač is National Park "Fruška gora", Special Nature Reserve "Koviljsko-petrovaradinski rit", Nature park "Tikvara" etc. These stations have relatively high values and display a further increase of rainfall erosivity. Also, it is important to point out that even the numerous protected areas in the northern parts of Vojvodina are endangered, even though indices display lowestvalues and regular spatial distribution (Figure 1).

## Conclusion

The observed trends in rainfall aggressivity (*FI/MFI*) exhibit a positive relationship with the precipitation concentration (*PCI*). Results presented in this study may contribute to improved understanding of the regional dynamics of the main climatological agent of erosion in Vojvodina. Furthermore, it could aid in creating suitable mitigation and protection strategies to reduce the impacts of erosion not only in the investigated area, but in the surrounding regions (with similar geo and bio diversity) as well.


Arnoldus, H. M.,(1980). An approximation of the rainfall factor in the Universal Soil Loss Equation. In: de Boodts M, Gabriels D. (eds.) Assessments of Erosion. John Wiley and Sons Ltd., Chichester, 127-132.

Lukić, T., Leščešen, I., Sakulski, D., Basarin, B., Jordaan, A., (2016). Rainfall erosivitiy as an indicator of sliding occurrence along the southern slopes of the Bačka loess plateau: A case study of the Kula settlement, Vojvodina (North Serbia). Carpathian Journal of Earth and Environment Sciences, 11, 303-318

Oliver, J. E., (1980). Monthly precipitation distribution: A comparative index. Professional Geographer, 32, 300-309.

Republic Hydrometeorological Service of Serbia, Meteorological Year book 1948-2014. Belgrade.

Tomić P., Romelić J., Kicošev S., Besermenji S., Stojanović V., Pavić D., Pivac T., Košić K., (2004) Zaštićena prirodna dobra i ekoturizam Vojvodine, Departman za geografiju, turizam i hotelijerstvo, Novi Sad, 6-138 (in Serbian)

Vasiljević, Dj. A., Marković, S. B., Hose, T.A., Smalley, I., Basarin, B., Lazić, L. &Jović, G., (2011a). The Introduction to Geoconservation of loess-palaeosol sequences in the Vojvodina region: Significant geoheritage of Serbia. Quaternary International, 240, 108-116. doi: http://dx.doi.org/10.1016/j.quaint.2010.07.008