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Estimating Soil Erosion Exerted by Water in the Lower Sector of the Jiu River Floodplain and Băilești Plain

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Abstract

This paper aims to identify the main areas prone to soil erosion exerted by water within the Băilești Plain and in the lower section of the Jiu River Corridor, a region with a very high agricultural potential. The study is concerned with rainfall erosion. Computing this type of erosion helps us to give better solutions for mitigating topsoil loss rate. For quantifying the amount of soil eroded, we used and adapted RUSLE equation. The obtained values we computed for RUSLE within our area range between 0 and 8.89 t-1/ha-1/yr-1. The most exposed areas to soil erosion exerted by water are located on the steep slopes, in the North-East of our study area, where the rainfall erosivity factor has the highest values, soil erodability factor (K-factor) is also very high, and cover-management factor (C) has the biggest value.

Keywords: *soil erosion, RUSLE, Jiu River floodplain, Băilești Plain*

Rezumat. Estimarea eroziunii solului exercitată de apă în sectorul inferior al Jiului și în Câmpia Băilești

Scopul principal al acestui articol este de a identifica zonele din Câmpia Băileștiului și sectorul inferior al luncii Jiului, predispuse la eroziunea solului în urma acțiunii exercitată de apa din precipitații, regiunea având un potențial agricol foarte ridicat. Evaluarea acestei forme de eroziune ne ajută să oferim soluții mai bune pentru a reduce cantitatea de sol pierdut. Pentru a măsura cantitatea de sol pierdută, am folosit, și adaptat , ecuația RUSLE. Valorile RUSLE pentru zona noastră de studiu au oscilat între 0 și 8.89 t-1/ha-1/yr-1. Cele mai expuse zone la eroziunea solului sunt localizate pe pantele abrupte din Nord-Estul arealului studiat, acolo unde factorul erozivității pluviale are cele mai mari valori, factorul erodabilității solului este de asemenea foarte mare, iar valorile factorului C sunt foarte ridicate.

Cuvinte-cheie: *eroziunea solului, RUSLE, lunca Jiului, Câmpia Băilești*

Introduction

In this study, we focus our attention on soil erosion exerted by water. This type of erosion has a strong impact on soil productivity, drinking water, on carbon stocks, or even on the entire ecosystem (Panagos, 2015).

The amount of sediments resulting from soil has, also, a big impact on river beds and water quality in river systems. When the sediments are transported into the river systems, they can change the river bed morphology (Kim, 2004).

Soil erosion exerted by water is a scientific topic approached by many authors, the most vocals being the Americans. The first attempt to calculate field soil loss was known as the Musgrave Equation and has been widely used in the United States for estimating gross erosion from watersheds in flood abatement programs. This was happening in the earlies '40s, but soon after the Universal Soil Loss Equation (USLE) was developed (Wischmeier et al., 1978).

In 1997, Renard, K.G. proposed a revising Universal Soil Loss Equation, known as Revised Universal Soil Loss Equation (RUSLE). This new equation is "an erosion model predicting longtime average soil loss resulting from raindrop splash and runoff from specific field slopes in specific cropping and management system and from rangeland" (Renard et al., 1997).

At a European level, Panos Panagos published in 2015 in the Elsevier Journal (Environmental Science & Policy), a paper called: "The new assessment of soil loss by water erosion in Europe". Panagos used a modified version of the RUSLE model and introduced "some improvements to each of the soil loss factors, adapting them to the latest state-of-the-art data currently available at the European scale" (Pangos et al., 2015). According to Panagos soil loss map, our study area has values less than 2 t ha-1 yr-1.

In the Romanian literature, the first attempt to predict soil erosion rate was carried on by Moțoc M,. in 1975. Moțoc gave great attention to the rainfall erosivity factor, creating a map for all the country. Later, in 1982, Moțoc published a paper where he calculated the value for soil loss rate for the entire territory of Romania. The corresponding value for our study area was less than 1t/ha/yr (Moțoc, 1982).

Florea et al. (1976) produced the Soil Erosion Map of Romania, at the scale 1:500.000. According to this map, the North-East part of our study area is subject to moderate to strong water erosion, but most of the Băilești Plain is subjected to wind erosion (Florea et al., 1977).

A very helpful study was conducted by Popa N., who evaluated sheet and rill erosion within Tutova

Rolling Hills (East of Romania), more precisely in the Țărnii Valley, Crâng and Gheltag sites. Popa used the RUSLE method and the Caesium-137 isotopes technique to calculate soil loss rate within Țărnii Valley, and he stated that although the two methods were complementary, the Caesium-137 technique provides relevant results (Popa, 2017).

In 2004, Mihăiescu R., et al., evaluated soil loss risk within Someșul Mic watershed using Geographical Information System techniques. They obtained values ranging from 0 to 90 t/ha/yr.

In 2008, Horvath et al. made a quantitative estimation of soil erosion in the Drăgan river watershed (Apuseni Mountains) adapting the USLE equation to the Romanian scenario. The adaptation, known as the ROMSEM model, calibrates the factors to the pedo-climatic condition and characteristics of our country. The equation was proposed by Moțoc et al. in 1999 (Horvath, 2008). The Erosion Map of the Drăgan River Watershed shows results less than 3 t/ha/yr, most of the surface having a soil loss rate less than 0.5 t/ha/yr.

In 2015, Ovreiu A.B., et al., published in the Cinq Continents Volume (5), the paper "Analysing soil degradation through hydric erosion. Case study – Ialomița County, Romania". The authors used the USLE equation and the obtained values were mostly less than 1.5 t/ha/yr.

Also, in 2015 the USLE equation was used by Zisu I. and Năsui, D., for soil erosion assessment in the agricultural land from Lugoj Hills. The average value for the entire area was 1.12 t/ha/yr (Zisu et al., 2015).

The RULSE equation was used to create a soil loss susceptibility model in the Baraolt Depression (Eastern Carpathians) and the computed results were less than 2 t/ha/year of eroded soil (Csiszer, 2018).

Study area and data

The whole area analyzed in this study covers 3347.8 km^2 and it is located in the Southern part of Dolj County, Romania (Figure 1). Although the areas of interest are the Băilești Plain (2393 km^2) and the lower section of the Jiu River Floodplain (375.8 km^2), we extended the research within the Danube Floodplain, corresponding to Dolj County.

The study area is a part of the Moesian Platform, being a fluvio-aeolian plain, terraced and covered by loess and dunes (Coteț, 1957). The largest area is occupied by the 3rd terrace of the Danube, with a relative altitude of 27-35 m, which formed the Danube floodplain in Würm 2 - Würm 3 interstage. The 2nd terrace (of 13-27 m relative altitude) and the 1st terrace of the Danube (of 8-13 m relative altitude) are narrower, but are also covered with sand and dunes (Mihăilescu, 1969), and are located in the Southern part of the region, both meeting the Danube's Floodplain.

The absolute altitude of the area, according to SRTM digital elevation model, varies from 19 m in the South to 166 m in the North. The spatial arrangement of the altitude, which increases from Danube Floodplain (south) towards the Sălcuța Plain (north), is in strong relation with higher values of rainfall erosivity. This means that it can be a strong influence on RUSLE values, also.

The Băilești Plain is the most complex plain within Oltenia Plain, being located, as we already stated, on the Danube terraces in the South-West of Romania. On the Eastern side, the Băilești Plain is bounded by the lower section of the Jiu River Floodplain, known as Jiu – Jieț Floodplain. The two geophysical regions overlay mostly on a flat surface, where the slope is less than 3 degrees, but at their boundary, the slope goes above 13 degrees and it even touches 27 degrees on a line that comes from Podari till Valea Stanciului.

The lithology of the analyzed area indicates the presence near Băilești (city) of some deposits dating from the Lower Triassic, consisting of friable sandstone which tends to become whitish-green, gray or reddish sands. East of Cetate village, there is a clay sequence, which belongs to the Lower Triassic, but Triassic-medium deposits consisting of submarine limestones also appear. Near Băilești appears a clay-brown, gray-blackish horizon with thin anhydrite intercalations (Mihăilă, 1968).

The upper Triassic deposits consist of soft clays and marls, red-violet in color, with iterations of green clays and marls, whitish sands and reddish friable sandstone, partly quartzite and slightly feldspar. In the central part of our study area, the facies described are located under a predominantly sandstone facies interspersed with red clays. In the center of the Băilești Plain, there is also a horizon of dolomites, fine silty limestone, and brown limestone faults, dating from the middle Jurassic. Near Băilești, the calcareous sandstone of the middle Callovian lies directly on the upper Triassic deposits (Mihăilă, 1968).

The Sarmatian deposits are made of marls, partly sandy, with subordinate intercalations of sands and limestone. In the vicinity of the Băilești city, the Sarmatian stage wears a thicker facies, with gravel interspersed.

The youngest deposits from the studied area belong to the upper Holocene and are found in the Danube Plain, being made up of marsh deposits, especially blackish sandy silt. On the surface of the Băilești Plain and in the lower sector of the Jiu River corridor, there are deposits of dunes, made of fine sands, consisting of quartz (95%), mica, garnet, calcite and hornblende.

Below the Holocene deposits appear deposits of the upper Pleistocene. They are made of loessoid clay sands.

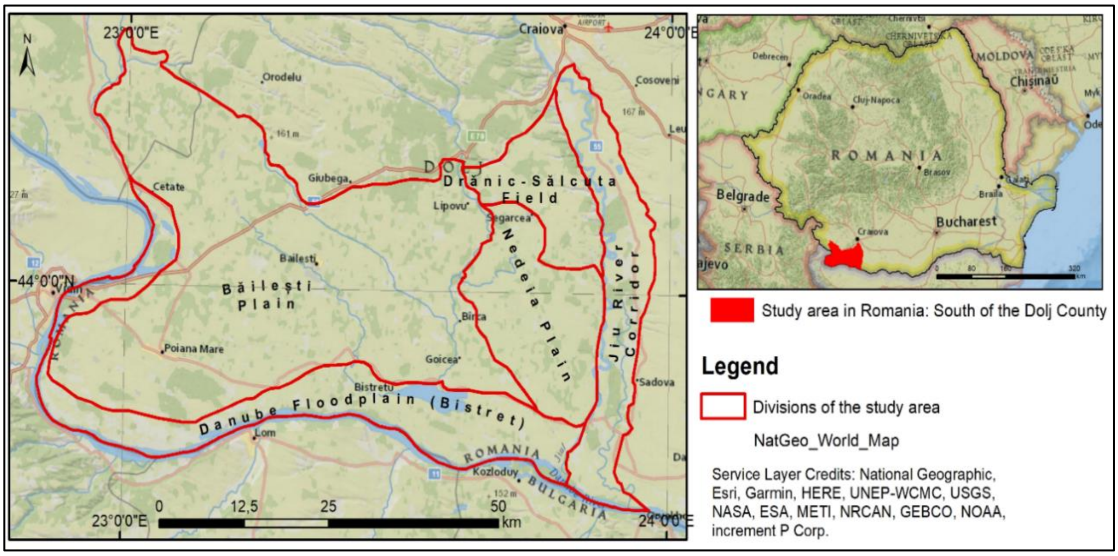

Fig. 1: Study area - divisions and geographical position within Romania

A bore located near Gîngiova indicates the presence in the bottom of some sarmatic organogenic limestones, over which non-cohesive sands overlap. They are dark-violet, gray and green and have silica knots. Above, there is a deposit of fine brown sands, then fallow non-cohesive yellow sands, Quaternary sands and gravels, and on the surface there are slightly dusty red sandy clay sands (Mihăilă, 1968).

The climatic condition subscribes the area to Cfa type according to Köppen and Geiger's classification (Köppen et al., 1936). The annual amount of rainfalls oscillates between 500 and 600 mm and the average temperatures range between 10 to 12ºC (NAM).

There were analyzed climate data coming from six stations (Table 1) located in the study area and near it.

Table 1 Meteorological stations

Station	Latitude	Longitude	Altitude a.s.
Craiova	44º18′ 37″N	23º 52′ 01″E	192 m
Bechet	43º46′ N	23º57′ E	35,6 m
Băilești	44º1′45″N	23º19′51″E	~80 m
Calafat	43º59′N	22º57′E	60,8 m
Drobeta Turnu-Severin	44º37′35″N	22º37′34″E	77 m
Caracal	44°6'0"N	24°21'25"E	~95

Source: National Administration of Meteorology (NAM)

At the Băilești weather station, located in the center of the study area, the month with the highest average rainfall quantity, calculated for the period 1961 -2015, was July. The average for this month was 61.6 mm. The months in which multiannual averages exceeded 50 mm were June (58.9 mm) and August (54.3 mm). The winter months had relatively low rainfall averages. For example, the average of January from 1961 to 2015 was 36.4 mm.

At the Bechet station, located in the southeast of the studied area, the month with the highest rainfall average was, as in Băilești, July, and the value was quite similar (61.7 mm). However, the month with the lowest multi-year average was February (31.2 mm).

In the western part of the studied area, at the Calafat weather station, the multiannual data indicate that the month with the lowest average of the rainfall quantities was January, but compared to the situations presented above, the average was higher (34 mm). But in the summer months, in the West of the studied area it rains less than in the center and South-East, a statement supported by the multiannual average for July (58.6 mm).

The seasonal rainfall data show that the highest average (1965 - 2015), corresponds to summer, and probably in this season a high amount of soil is lost due to the te rainfalls. At Băilești station summer average is 160.8 mm and the spring average is 145.9 mm. At this station, the lowest average corresponds to winter (122.6 mm). At Bechet station, the summer rainfall average is 157.2 mm and at Calafat station is 147.1 mm. In the North-East of the area, near Craiova, the summer rainfall average increase considerably, coming closer to 180 mm.

At Bechet station, winter rainfall average (103.6 mm) is very low comparative to Craiova (123.2), Calafat (116.2) and Băilești statios.

The highest autumn rainfall average data corresponds to the Băilești weather station (137.3 mm), followed by Craiova station (135.7 mm), Calafat (127.5 mm) and Bechet (122.9 mm) (NAM).

The study area is mostly (more than 90%) occupied by non-irrigated arable land and by pasture, according to Corine Land Cover database

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(https://land.copernicus.eu/pan-european/corine-land-cover/clc2018).

The soil is mostly chernozem with loamy, sandy and clay texture (Simulescu et al., 2016). The area has also fluvisosl, arenosols and solonetz.

The Băilești Plain is crossed by short rivers, such as Balăsan and Desnăţui and it has on its surface many gullies through which water flows during the rainy days.

The Jiu River floodplain has the aspect of a corridor and it's crossed by the Jiu river, who has a low speed in this area, and a sinuous flow, the sinuosity coefficient being 1.47 (Zamfir, et al., 2018). The right flank of the corridor is very steep being prone to erosion exerted by water.

Method

To quantify the soil loss rate, we used RUSLE equation (1) which takes into account five factors to estimate the amount of soil eroded by the action of water, namely: rainfall erosivity factor (R), soil erodability factor (K-factor), slope length and slope steepness factor (LS), cover factor (C), support practices factor (P) (Panagos, 2015). The mathematical formula is the product of all these factors (eq. 1).

E =R x K x C x LS x P (1)

To estimate rainfall erosivity factor or R-factor, we used monthly average rainfall data, starting from 1966 till 2015, and we applied a modified form of Fournier's equation (eq. 2), to identify pluvial aggressiveness (Arnoldous, 1980).

$$MFI = \sum_{i=1}^{12} \frac{p_i^2}{p} \qquad (2)$$

According to Arnoldus (1980), p_i is the average rainfall for the rainy month (mm), and p is the annual average rainfall. But, instead of this data we use the highest monthly rainfall average (as p_i) for the 1966-2015 time interval and the sum of the monthly average precipitation quantities (as p) for the whole period.

Coman, A. (2019), used the modified Fournier index to estimate rainfall erosivity, stating that Arnoldus (1980) showed that this index is a good approximation of R, to which it is linearly correlated. The data were available for the following station: Craiova, Caracal, Băilești, Bechet, Calafat and Drobeta Turnu-Severin. Thus, we calculated for each station the value of the rainfall erosivity factor and then we've interpolated a raster surface from points data using the inverse distance weighted (IDW) technique. We used ArcGIS Desktop 10.2.1 software and its extension, Spatial Analyst.

For the LS factor, we used a 30-meter resolution elevation data from the Shuttle Radar Topography Mission. The slope length and slope steepness factor (LS-factor) is a product of the two parameters, that describes the influence of topography on soil erosion risk and is one of five factors of the Universal Soil Loss Equation (USLE) and its revised version (RUSLE) (Schmidt, 2019).

First, we calculated the L factor (eq. 3) (Desmet et al, 1996).

$$L_{ij-in} = \frac{\left[(A_{ij-in}+D^2)^{m+1} - (A_{ij-in})^{m+1}\right]}{(D^{m+2}) \mathrm{x} \left(X_{ij}^{m}\right) \mathrm{x} (22.13)^{m}} \qquad (3)$$

Where: L_{ij-in} is the L factor, A_{ij-in} is the flow accumulation data, D is is the grid cell size in meters, m represents the length of the slope in meters and X_{ij} is $sin\alpha_{i,j}+cos\alpha_{i,j}$. e $a_{i,j}$ is the aspect of the grid cell (i,j) (Schmidt, 2019).

The m parameter (eq. 4) was calculated according to the formula (McCool, 1987): (4)

$$m = \frac{\beta}{\beta + 1}$$

and β (eq. 5) was calculated as it follows (McCool, 1987):

(5)

$$\beta = \frac{\frac{sin\theta}{0.0896}}{[3(sin\theta)^{0.8} + 0.56]}$$

Where θ is the slope raster (in degrees).

For the S factor, we applied McCool's equation for slopes with an inclination less than 9% (eq. 6) and the other greater or equal 9% (eq. 7) (McCool, 1987). The functions are as follows: (6)

S = 10.8 × sin Θ + 0.03, where slope gradient < 0.09

S = 16.8 × sin Θ − 0.5, where slope gradient ≥ 0.09.

(7)

To establish the K factor values, we used soil texture as an input and we applied the below formula (eq. 8) for estimating soil erodability (Wischmeier et al, 1978):

100*K=2.1*M1.14*(10-4)*(12 - a) +3.25*(b – 2) +2.5*(c – 3) (eq.8)

Where: M is the particle-size parameter defined above, M = (percent si +vfs)*(100 – percent of clay),

a = percent organic matter,

b = the soil-structure code used in soil classification,

c = the profile-permeability class.

To identify the percent of clay, silt and very fine sand for each type of soil we used Wischmeier nomograph (1978). We used the highest clay percent corresponding for each textural class. For b and c parameters we used Panos Panagos paper: Soil erodibility in Europe: A high-resolution dataset based on LUCAS (2014). After we calculated the K values for each textural class, we created a 30-m resolution raster.

Factor C values were taken from Panagos et al. (2015) work, who calculated at the European level the impact of land cover and land use on soil erosion (Table 2). Although erosion is a natural process it has been increased dramatically by human land use, in some areas of our region of interest, the natural environment being replaced by agricultural fields, (Licurici, 2013; Răducă, 2019).

Panagos (2015) has estimated the soil erosion cover-management factor at the European scale proposing the LANDUM model for C-factor in combination with P-factor, named in his study the management factor (Panagos, et al., 2015). Panagos used in his study Corine Land Cover data and he calculated the C-factor for each class of land.

Table 2 C-factor per land-cover type

Label	CLC-code	C-factor
Artificial surfaces	112/121	0
Artificial, non-agricultural vegetated areas	141	0
Non-irrigated arable land	211	0.3
Rice fields	213	0.15
Vineyards	221	0.45
Fruit trees and berry plantations	222	0.3
Pastures	231	0.05
Complex cultivation patterns	242	0.2
Land principally occupied by agriculture…	243	0.2
Broad-leaved forest	311	0.003
Transitional woodland-shrub	324	0.05
Inland marshes	411	0
Water courses /bodies	511/512	0

Source: Panagos, et al., 2015

The C factor can be, also, calculated based on the Normalized Difference Vegetation Index, by applying the regression relationship (Fenjiro et al., 2020; Van Der Knijff et al. 1999):

$C = \exp[-\alpha*(NDVI/(\beta-NDVI))]$

Where:

α, β: Parameters determining the shape of the NDVI-C curve, with $\alpha = 2$ and $\beta = 1$ ((Fenjiro et al., 2020).

Discussion

Applying the aforementioned methods we obtained several maps. The first one (Figure 2) refers to R-Factor, or rainfall erosivity. Rainfall is one of the main drivers of soil erosion. The R-factor has values ranging between 6.21 and 9.03, and they increase from the Western part of the Bălilești Plain towards the North-East side of the lower section of the Jiu River Floodplain. The Western part of Băilești Plain has long periods of droughts and the sandy soils with weak structure are exposed more to deflation rather than erosion exerted by water (Marinică, 2014), that's why in this region R-factor has low values. The main part of the study area has values ranging between 6.59 and 6.97 (Figure 2). Among the climatic stations analyzed, the driest seems to be the Bechet station. Here, the multiannual (1966 – 2015) average of rainfall quantity is 524.2 mm. The corresponding value of R–factor for Bechet station was 7.8. The highest R-factor value was calculated for Craiova station (9.06), which suggests that the highest R-factor from our study area is registered North of Teasc. Dumitrașcu et al. (2017) considered that the MFI values calculated based on pluvial monthly and multiannual data for the Western part of the Romanian Plain and the Danube Valley, tend to be less than 60 and are integrated in a very low aggressiveness class. The soils within the Băilești Plain are mostly classified as chernozems. In the Northern part of the plain, more precisely, near Dărvari, Unirea, Moțăței, Giurgița and Drănic, the chernozems are having cambic properties with loamy texture. In the central part of the Băilești Plain are typical chernozems with a loamy-sand texture. North of Gighera, Afumați and Bistreț Lake there is a high accumulation sodium, which means the soil is classified as solonetz, and the texture varies from loamy to sandy-loam. After we applied Wischmeier formula for calculating the K-factor we obtained a map with values ranging from 0 to 0.27 (Figure 3). The lowest values are recorded in the South-West part of the Băilești Plain and in the Băilești - Afumați region. The highest values correspond to loamy-clay and clay texture and the lowest values of the K-factor correspond to the sandy and sandy-loam texture. We consider that the soil with a sandy and a sandy-loam texture is more exposed to soil erosion exerted by water due to the small cohesiveness of the sand particles. In the Sălcuța Plain, the typical soil is luvisol with a high content of clay. Within the Jiu River Floodplain are fluvisols with clay and sandy texture, which are often flooded (Soil Atlas of Europe, 2005). In the central part of the corridor, we can find solonetz with loamy-clay texture. RUSLE values vary with slope steepness and length (Foster, 1977). The LS-factor has values ranging from 0.03 to 67.9. The increasing values show a high probability for soil erosion and are located on the boundary between Băilești Plain and Jiu River Floodplain where the slopes are very steep. The histogram of the LS-factor shows that 98,5% of the study area has values ranging from 0.03 to 1.36 (figure 4).

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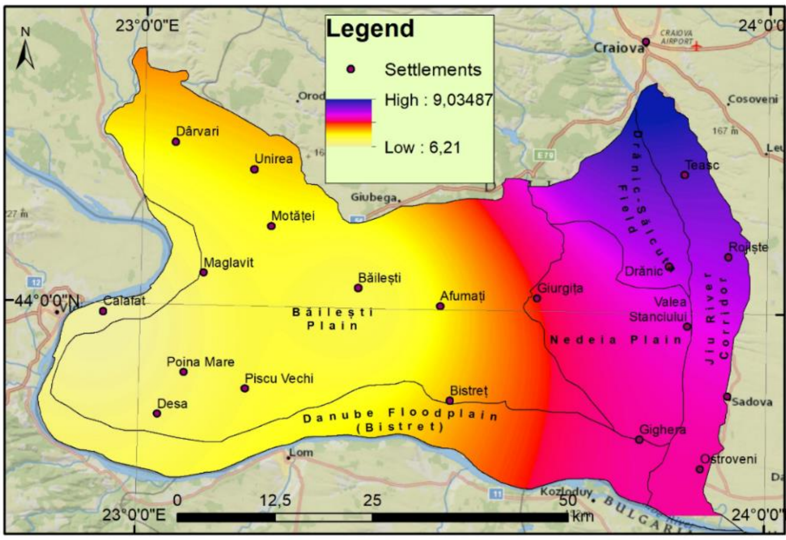

Fig. 2: Rainfall erosivity, R-factor (MJ mm ha^{-1} h^{-1} yr^{-1})

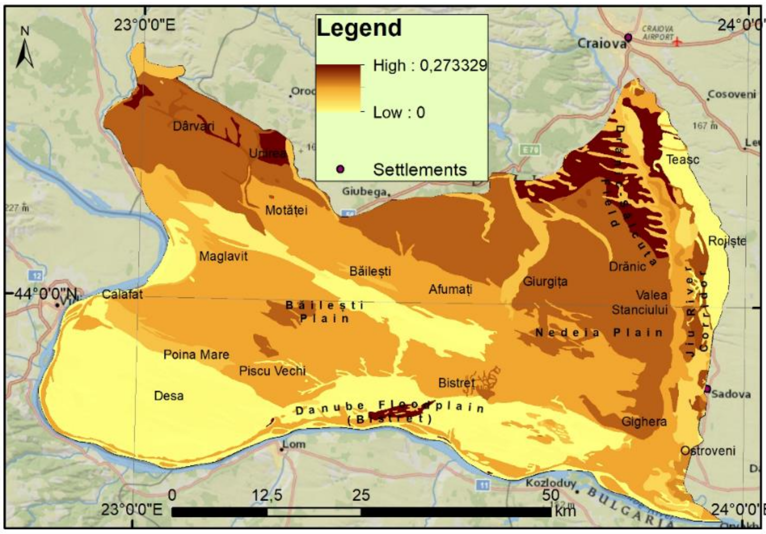

Fig. 3: Soil erodability, K-factor (t ha h ha^{-1} MJ^{-1} mm^{-1})

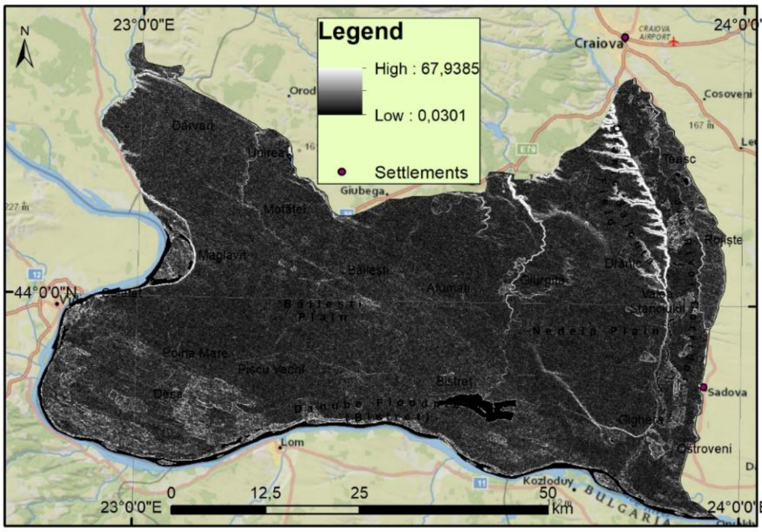

Fig. 4: LS-factor

Land use and land cover factor (Figure 5) influence the magnitude of soil loss. According to Panagos (2015), C-factor values range between 0 and 0.5, and the most frequently are those ranging between 0.31 and 0.45. The highest values of C-factor correspond to vineyards and non-vegetated areas, and the lowest to artificial surfaces and water bodies.

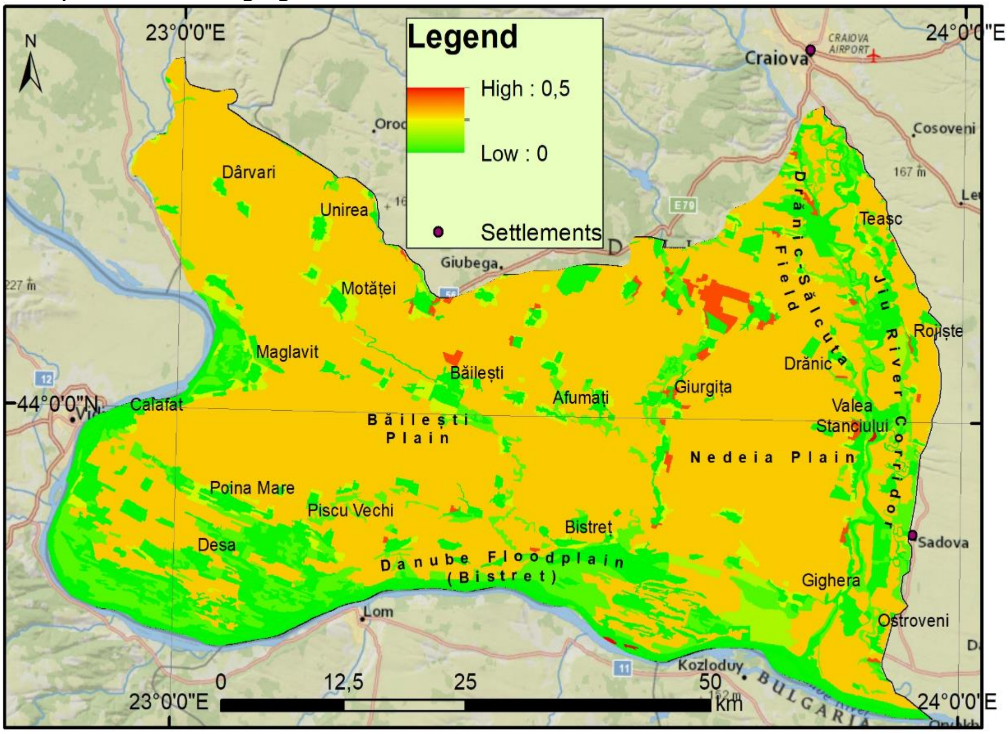

Fig. 5: C and P - factor

More than 80% of the study area is occupied by non-irrigated arable land. The main crops cultivated in the plain are wheat, maize, sunflower, rapeseed, barley and oats. The crops are rotated each year to maintain soil productivity.

According to Corine Land Cover classification, more than 5% of the area is occupied by broad-leaved forest. The roots of the trees hold the topsoil and the rate of erosion exerted by water is very low. This broad-leaved forest is located in the South-West part of the Băilești Plain (Desa, Poiana Mare, Piscu Vechi) and in the Jiu River Floodplain. In the Sălcuța Plain (North-East of the region) there is also an important area occupied by broad-leaved forest, and even if the slopes are high, the RUSLE values are low.

Within the study area, there are some open spaces with little or no vegetation standing on sand and dunes. Their distribution is more visible within the Jiu River Floodplain and in the Danube Floodplain. The sand and dunes, because of lack of cohesion, are prone to erosion exerted by water, but because of the low slopes the rate of soil loss it is also very low. The unstable sand and dunes are exposed more to wind erosion and deflation. Soil erosion by water can be a major problem if it has high values (more than 2 t/ha/yr, Panagos et al., 2015)). The greatest impact is on the soil productivity, and, as a boomerang effect, on people's lives.

Analyzing the spatial distribution of soil loss rate exerted by water (Figure 6), we can observe that there is a spatial correlation between high slopes and high rates of soil erosion.

North of Gighera, following the line that separates the Danube Valley from the fourth terrace of the Danube, the slopes vary between 7 and 14 degrees. Here, the soil loss rate has an average of 1.5 t/ha/yr. The value of the R-factor has an average of 7.5 and the soil texture is sand-loamy. In the Ciupercenii Noi – Desa area water erosion susceptibility is high (Ionuș, 2013). In the Sălcuța Plain, North of Drănic, soil loss rate goes to 8.89. In the lower section of the Jiu River Floodplain, running a zonal statistical analysis has shown us that the low value of soil loss rate is 0 and the highest is 8.89 t/ha/yr. The mean values is 0.036 t/ha/yr and the standard deviation is 0.074 t/ha/yr, the slope is above 10 degrees and the R factor is higher than 8.

We have also run the Band Collection Statistics function from Arcgis 10.2.1 to have a better view on the relationship among the rasters data involved in this study. The results (Table 3) show that in some cases there is a positive correlation and in others it is negative. Analyzing Table 3, we can observe the positive correlation between RUSLE data and the raster data of every factor used to compute the soil loss rate.

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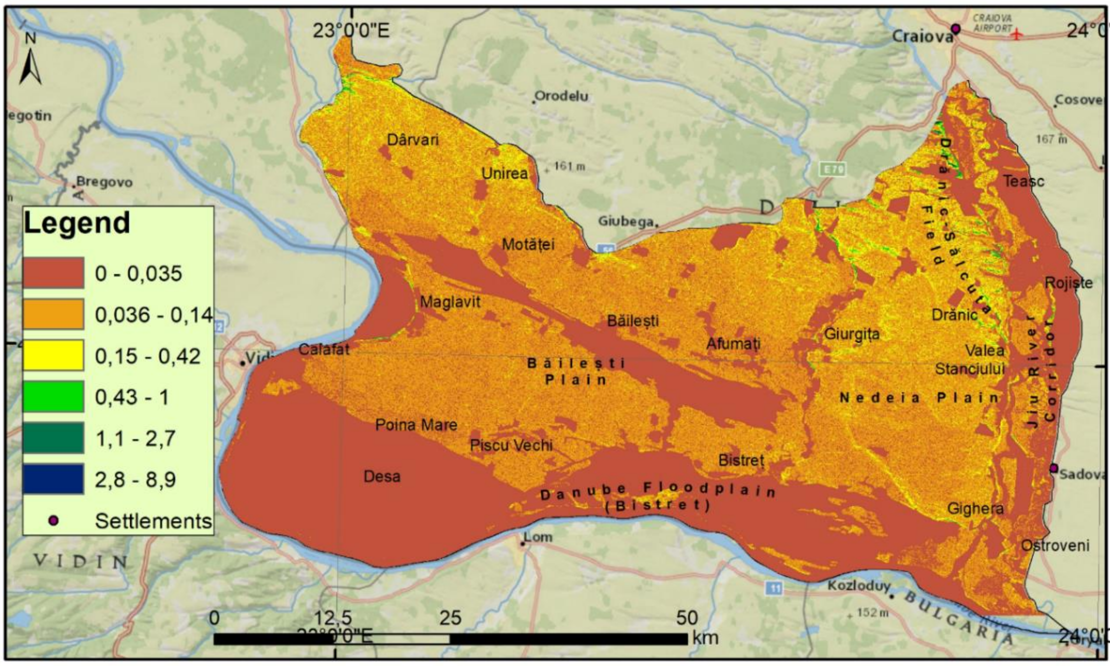

Fig. 6: Soil loss map (t-1/ha-1/yr-1)

The highest correlation is between RUSLE and K-factor. This means that as the values in RUSLE cells increase, so do the values of the K-factor cells. But this means that the highest RUSLE values won't occur necessary on the sandy and sandy-loam texture.

Table 3 Pearson's Correlation between RUSLE and the factors used to compute it

Layer	RUSLE	R	LS	K	C	SLOPE	DEM
RUSLE	1.00000	0.21178	0.06571	0.47287	0.37382	0.06614	0.39577
R	0.21178	1.00000	0.08637	0.34940	0.02954	0.07553	0.36193
LS	0.06571	0.08637	1.00000	-0.02651	-0.17137	0.91144	0.07197
K	0.47287	0.34940	-0.02651	1.00000	0.33642	-0.03867	0.59486
C	0.37382	0.02954	-0.17137	0.33642	1.00000	-0.18921	0.27488

We can also observe that as the altitude increase so does the soil erosion rate. RUSLE values increase also as the C-factor values go higher. The relationship between R factor (rainfall erosivity) and RUSLE shows a positive correlation, this means that when R-factor goes up, RUSLE values have the same path. The lowest correlation is between LS-factor and RUSLE values.

Conclusion

RUSLE is a very good technique to quantify the soil loss rate, but it seems to be more accurate for small areas or catchments. The biggest problem for wider areas is obtaining the data for calculating the factors involved in the equation.

Estimating the amount of soil eroded by water depends on the local conditions who can change drastically in a short period, one of the most unstable aspects being the weather. We think is better to run an analysis on the soil loss rate taking into account the "history" of the area, at least from a climatic point of view, or, of course, you can calculate the soil loss rate exerted by water after a short and intense rain from a very small region.

Thinking on the Băilești Plain and on the lower section of the Jiu River Floodplain, we can conclude that the erosive impact of water coming from rain is very law. This is happening because most of the region is flat, and even if the rain has a big intensity, the erosive power decreases due to slopes with low inclination. But where the slopes are steep, the soil loss rate increases, and this is happening in the North-East of our study area and on the rivers valleys sparsely vegetated.

In the regions where the soil loss rate exceeds 2 t/ha/yr, soil protection measures should be taken. These measures should concern with planting trees, stop deforestation and adapt the agricultural practices to slopes.

An aspect that caught our attention is that RUSLE doesn't take into account the erosive action exerted by rivers on their banks, and we think this also should be computed.

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Author contribution

The first author (Zamfir, A.,) proposed that the estimation of soil loss rate to be based on the RUSLE method. The author gathered the references data and made the GIS processing, applying the RUSLE method. The second author (Crișu, L.,) was concerned with the Băilești Plain and described its main aspects.

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