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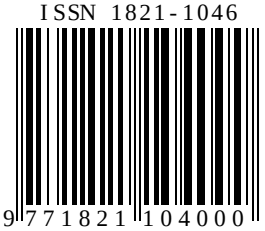

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THE INTENSITY OF EROSION IN THE CATCHMENT OF THE TORRENT LEŠJANSKI DO

Svetlana BILIBAJKIĆ[1], Tomislav STEFANOVIĆ[1], Radovan NEVENIĆ[1], Zoran PODUŠKA[1], Renata GAGIĆ SERDAR[1], Ilija DJORDJEVIĆ[1], Goran ČEŠLJAR[1]

Abstract: *This paper defines the state of erosion process in the catchments of the torrent Lešjanski Do and provides mean annual erosion sediment yield and discharge values. The mean coefficient of erosion for the catchment area of the torrent Lešjanski do amounts to Z=0.44, which classifies this area in the third category of destructiveness. The total sediment yield in the catchment area of Lešjanski do is* W_{ann}*=7 246.10* $m^3 year^{-1}$*, while the specific sediment yield amounts to* W_{year}*=620.92* $m^3 \cdot km^{-2} year^{-1}$*. The amount of sediment discharge in the catchments area is* G_{year}*=3 458.26* $m^3 year^{-1}$*.*

Key words: erosion processes, coefficient of erosion, sediment yield, sediment discharge

INTENZITET EROZIJE U SLIVU BUJICE LEŠJANSKI DO

Abstract: *U radu je definisano stanje erozionih procesa na području sliva bujice Lješjanski do i obračunata srednje godišnja produkcija i pronos erozionog nanosa. Srednja vrednost koeficijenta erozije za područje sliva bujice Lješjanski do iznosi Z=0,44 pa se područje može svrstati u III kategoriju razornosti. Ukupna produkcija nanosa na području sliva Lešjanskog dola iznosi* W_{god}*=7.246,10* $m^3 god^{-1}$*, a specifična produkcija nanosa* W_{god}*=620,92* $m^3 \cdot km^{-2} god^{-1}$*. Količina pronosa nanosa koja se odnosi sa područja sliva iznose* G_{god}*=3.458,26* $m^3 god^{-1}$*.*

[1] Institute of Forestry, Kneza Viseslava 3, Belgrade, Serbia
Translation: Dragana Ilić

Ključne reči: erozioni procesi, koeficijent erozije, produkcija nanosa, pronos nanosa

1. INTRODUCTION

Hugh Bennet, an American protagonist of the battle against soil erosion said: „Erosion is one of the most complex problems and at the same time one of the most vicious enemies of human economy. Erosion processes gradually degrade and destroy soil, take away nutrients and disturb the water regime. They can bring poverty and privation to the population of many, often vast areas and force people to migrate. Therefore many branches of economy must be simultaneously involved in the battle against soil erosion and its devastating consequences` (Gavrilovic S., 1972).

In recent times, the problem of soil erosion has become more evident due to the continuous growth of population and the increase in pressure on land resources.

2. THE AREA OF INVESTIGATION AND METHODS

Lešjanski do is a left tributary of the river Trgoviški Timok. The basin of the torrent is on the territory of the cadastral municipality of Donja Kamenica. It empties into the river Trgoviški Timok in the village Donja Kamrnica, situated 275 meters above sea level. It originates in the place called Goleme Livade (meaning vast meadows), at 650 m above sea level. Its flowing direction is southeast-northwest. The catchment is hilly with the average slope inclination of 30%. The area of the catchment is 11.67 km^2, the watercourse length 6.65 km, while the mean watercourse drop amounts to 5.5%

The investigations presented in this paper consist of three phases:

1. Investigation of the natural characteristics of the catchment
2. Assessments of the state and intensity of erosion
3. Calculation of the sediment yield.

Natural characteristics of the catchment Lešjanski do were investigated on the basis of digital cartographic material combined with field research.

Its climatic characteristics were determined using The National Hydro-meteorological Service dataset, obtained from the weather station Knjaževac and the precipitation station Donja Kamenica.

A digital geological map was created from a basic geological map at 1:100.000 scale.

A dataset on spatial and quantitative distribution of certain soil types in the catchment area Lešjanski do was obtained on the basis of previously digitalized pedological map on a scale R=1:50000 and The Pedological Study of the Timok basin.

A land use map was made by using a 1:25000 scale topographic map and satellite photos and by direct recognition of the terrain.

The intensity and distribution of erosion processes were determined on the basis of a digitalized map of erosion, made by the method of prof. Gavrilovic. It combines the use of satellite photos and terrain recognition.

The total amount of the sediment produced in the catchments was calculated by the erosion potential method of prof.dr Gavrilovic.

3. RESEARCH RESULTS

The shape and the size of the catchment area are the parameters that indicate a potential occurrence of a sudden and concurrent concentration of flood water from the catchment area.

The main catchment parameters that affect the genesis of the erosion processes and sediment discharge are shown in Table 1.

Table 1. *Analysis of the natural characteristics of the catchment*

Parameter	Symbol	Torrent Leršjanski do
Catchment area	F (km^2)	11,67
Catchment perimeter	O (km)	19,12
Watercourse length	L (km)	6,65
Coefficient of the catchment shape by prof. Gavrilovic	A	0,561
Module of the basin watershed development	E	1,561
Morphological coefficient	n	0,264
Density of the hydrographic network	G ($km\ km^{-2}$)	1,839
Coefficient of the catchment asymmetry	a	0,848
Coefficient of the watercourse meandering	K	1,120
Mean catchment altitude	N_{mean} (m)	508,14

The presented catchment parameters indicate that intensive erosion processes and sediment discharge can be expected.

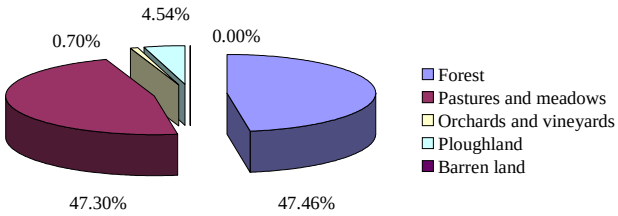
The parent rock of the catchment consists of sandstone, limestone and claystone. The soil types registered on the left bank of the catchment are acid brown soil and loessivized acid brown soil, while humus and brownised humus are present on the right bank.

The mean air temperature measured over a longer period of time at the weather station Knjaževac is 10.2^0C. The coldest month is January, with the mean monthly temperature of -1.2^0C, while July is the hottest with the mean monthly air temperature of 20.5^0C. Mean annual precipitation for the relevant precipitation station in Donja Kamenica is H_{mean} = 639.90 mm.

The hydrographic network is well-developed. The main stream has nine tributaries, seven left and two right ones.

The vegetation cover is comprised mainly of forest (47.46%), meadows and pastures (47.30%), ploughland (4.54%) and orchards and vineyards (0.7%).

Diagram 1. *Land use types in the catchment Lešjanski do*



The data on the state of erosion processes were obtained by visiting the terrain and mapping the occurrences of erosion. Recognition of the terrain was carried out in 2008 and 2009. It was done in summer and autumn in order to make the assessment of the erosion intensity on the areas covered by broadleaved species as accurate as possible.

Mapping the intensity of the erosion processes was done in the field, visually, on a topographic map, on a scale R=1:50.000. In order to obtain the best possible description of the terrain characteristics, a detailed office analysis of topographic maps and satellite photos of the investigated area was carried out prior to the collection of field data on the intensity and distribution of erosion processes.

Table 2. *Mean erosion coefficient (Z_{mean}) in the catchment Lešjanski do*

Categories of erosion	Area km^2	%	Mean coefficient of erosion Z
Excessive	0,00	0,00	1,25
Strong	0,19	1,63	0,85
Medium	6,24	53,47	0,55
Weak	5,24	44,90	0,30
Very weak	0,00	0,00	0,10
Total	11,67	100,0	0,44

By visiting the terrain and classifying the investigated area according to the level of erosion endangerment, it was concluded that erosion processes of all categories of destructiveness (from strong to very weak) are present in the area, in different degrees.

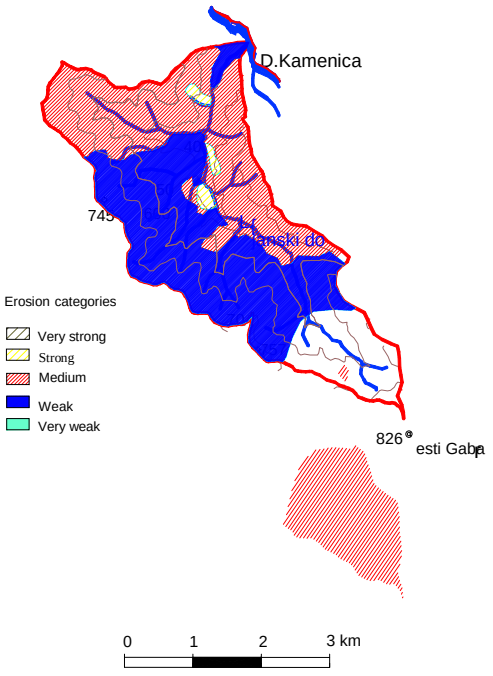


Figure 1. *Erosion map of the catchment Lešjanski do*

There is no area in the catchment subjected to excessive erosion, while the strong erosion processes are reported on only 1.63% of the catchment area. Medium erosion is reported on 53.47% of the area, while 44.90% of the catchment area is affected by weak erosion. The mean coefficient of erosion for the whole catchment is $Z_{mean} = 0.44$, which shows that it is prevailed by medium erosion.

The analysis of the state of erosion processes in the catchment and the dataset on distribution of erosion processes of different categories of destructiveness enable us to calculate the sediment yield or the volume of the sediment, which Lešjanski do discharges into the river Trgoviški Timok.

The total amount of the sediment produced in the catchments is calculated by prof. Gavrilovic`s method.

The analytical-quantitative-qualitative determination of the total mean annual amount of sediment produced in the catchment was done according to the following formula of prof. S.Gavrilovic:

$$W_{year} = T \times H_{year} \times \pi \times \sqrt{Z_{mean}^3} \times F$$

where:

W_{year} – total annual sediment yield in $m^3 \cdot god^{-1}$

T – temperature coefficient of the area

$$T = \sqrt{\frac{t_0}{10} + 0.1}$$

t_0 – mean annual air temperature, ^0S

H_{ann} – mean annual precipitation, in mm

Z_{sr} – coefficient of the catchment erosion

F – catchment area, in km^2

Out of this amount of sediment, produced in the catchment, the following sediment amount reaches the investigated profile:

$$G_{year} = W_{year} \times R_t$$

where:

G_{year} – total amount of sediment that reaches the investigated profile, in $m^3 \cdot god^{-1}$

R_t – coefficient of sediment retention

$$R_t = \frac{(O \times D)^{0.5}}{0.25(L + 10.0)}$$

O – catchment perimeter, in km

D – mean altitude range of the catchment, in km

L – main watercourse length , in km

The total sediment yield in the area of Lešjanski do catchment is 7246.10 $m^3 year^{-1}$, while the specific sediment yield amounts to 620.92 $m^3 \cdot km^{-2} year^{-1}$.

Out of the amount of sediment produced in the investigated catchment, 3 458.26 $m^3 god^{-1}$ reaches the Trgoviški Timok.

4. CONCLUSION

The mean erosion coefficient of the catchment area of the torrent Lešjanski do amounts to Z_{mean}=0.44, which classifies this catchment in the third category of destructiveness. Regarding the type of erosion, surface and combined erosion types are dominant, with the sporadic presence of deep erosion.

The total sediment yield in the catchment Lešjanski do is W_{year}=7 246.10 m^3year^{-1}, while the specific sediment yield amounts to W_{year}=620,92 $m^3 \cdot km^{-2}year^{-1}$.

The amount of the sediment discharge that refers to this area amounts to G_{year}=3 458.26 m^3year^{-1}.

On the basis of the calculated values of the erosion coefficient Z, sediment yield and discharge of the studied area, it can be concluded that medium erosion is the most dominant category of erosion.

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Ilija DJORDJEVIĆ, Goran ČEŠLJAR

Summary

This paper defines the state of erosion processes in the catchment Lešjanski do and calculates the mean annual erosion sediment yield and discharge.

Lešjanski do is a left tributary of the river Trgoviški Timok. The catchment area is 11.67 km^2, the watercourse length is 6.65 km, and the mean watercourse drop is 5.5%.

The parent rock of the catchment consists of sandstone, limestone and claystone. The soil types registered on the left bank of the catchment are acid brown soil and loessived acid brown soil, while humus and brownised humus are present on the right bank.

The mean air temperature measured over a longer period of time at the weather station Knjaževac is 10.2^0C. The mean annual precipitation for the relevant precipitation station in Donja Kamenica is H_{mean} = 639.90 mm.

The hydrographic network is well-developed. The main stream has nine tributaries, seven left and two right ones.

The vegetation cover is comprised mainly of forest (47.46%), meadows and pastures (47.30%), ploughland (4.54%) and orchards and vineyards (0.7%).

The intensity and distribution of the erosion processes were determined by using the digitalized map of erosion, made by the method of prof. Gavrilovic. It combines the use of satellite photos with the field mapping of erosion processes.

The total amount of the sediment produced in the catchment was calculated by the erosion potential method of prof. dr Gavrilovic.

The total sediment yield in the catchment area of Lešjanski do is 7 246.10 m^3year^{-}

[1], while the specific sediment yield amounts to 620.92 $m^3 \cdot km^{-2} year^{-1}$. Out of the amount of sediment produced in the investigated catchment, 3 458.26 $m^3 god^{-1}$ reaches the river Trgoviški Timok.

On the basis of the calculated values of the erosion coefficient Z, sediment yield and discharge in the studied area, it can be concluded that medium erosion is the most dominant category of erosion.

INTENZITET EROZIJE U SLIVU BUJICE LEŠJANSKI DO

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Radovan NEVENIĆ, Zoran PODUŠKA, Renata GAGIĆ SERDAR,
Ilija DJORDJEVIĆ, Goran ČEŠLJAR

Rezime

U ovom radu je definisano stanje erozionih procesa na području sliva bujice Lešjanski do i obračunata srednje godišnja produkcija i pronos erozionog nanosa.

Lešjanski do je leva pritoka Trgoviškog Timoka. Površina sliva iznosi 11,67 km^2, dužina toka je 6,65 km, a srednji pad toka je 5,5%.

Geološku podlogu u slivu grade peščari, krečnjaci i glinci. Od tipova zemljišta na levoj strani sliva su rasprostranjena kiselo smeđa i lesivirano kiselosmeđa zemljišta a na desnoj strani crnica i posmeđena crnica.

Srednja temperatura vazduha u višegodišnjem periodu na klimatološkoj stanici Knjaževac iznosi 10.2^0C. Srednja godišnjih suma padavina za merodavnu padavinsku stanicu Donja Kamenica iznosi H_{sr} = 639,90 mm.

Hidrografska mreža je razvijena. Glavni tok prima devet pritoka i to sedam levih i dve desne.

Vegetacioni pokrivač čine pretežno šume (47,46%), livade i pašnjaci (47,30%), oranice (4,54%) i voćnjaci i vinogradi (0,7%).

Intenzitet i rasprostranjenost erozionih procesa definisani su na osnovu digitalizovane karte erozije koja je urađena po metodi prof.Gavrilovića korišćenjem satelitskih snimaka, obilaskom terena i kartiranjem erozionih pojava.

Srednji koeficijent erozije za sliv iznosi Z_{sr} = 0,44 pa se područje može svrstati u III kategoriju razornosti.

Ukupna količina nanosa koja se produkuje u slivu sračunata je po metodi potencijala erozije prof.dr.Gavrilovića.

Ukupna produkcija nanosa na području sliva Lešjanskog dola iznosi 7.246,10 $m^3 god^{-1}$, odnosno specifična produkcija nanosa iznosi 620,92 $m^3 \cdot km^{-2} god^{-1}$. Od količine nanosa koja se produkuje u istraživanom slivu u Trgoviški Timok dospeva 3.458,26 $m^3 god^{-1}$.

Na osnovu sračunatih vrednosti koeficijenta erozije Z, produkcije i pronosa nanosa na istraživanom području najzastupljenija kategorija erozije je srednja erozija.

Reviewer: Ph.D. Stanimir Kostadinov