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TOTAL SEDIMENT LOSS AND ITS CORRELATION TO SHEET EROSION IN SMALL WATERSHEDS

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I INTRODUCTION

The problem of determination and prediction of total annual soil loss from the small watersheds in hilly-mountainous regions is very important for the planning of intensive use and protection of agricultural land, amelioration systems and water accumulations.

It is well known that these data can be obtained on the most accurate way by long termed observation and measurements but in the hilly-mountainous regions and in small watersheds they are very rare.

Therefore studies of an indirect method for determination of total soil loss from small hilly-mountainous watersheds by the use of sheet erosion were initiated by the Forestry Faculty and Institute for Forestry in Belgrade, on several small watersheds all over the Republic Srbija(55.ooo km^2)

II METHODOLOGY OF INVESTIGATION

Qauntitative determination of water erosion i.e. sheet erosion under different physical-geographical conditions in hilly-mountainous regions is based on the results from the sample erosion plots.(fig. 1).

After several years of investigation it was possible to define run-off and soil - losses by mathematical equation of the following type: $y = a\,X^b$ for each experimental region according to the manner of soil utilisation.

The results of these investigation are published D j o r o v i ć M. 1975, 1976, and explained in detail on FAO,EFC, Meeting of Working Party on the Management of Mountain Watershed held in Ankara 1974.

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fig. 1

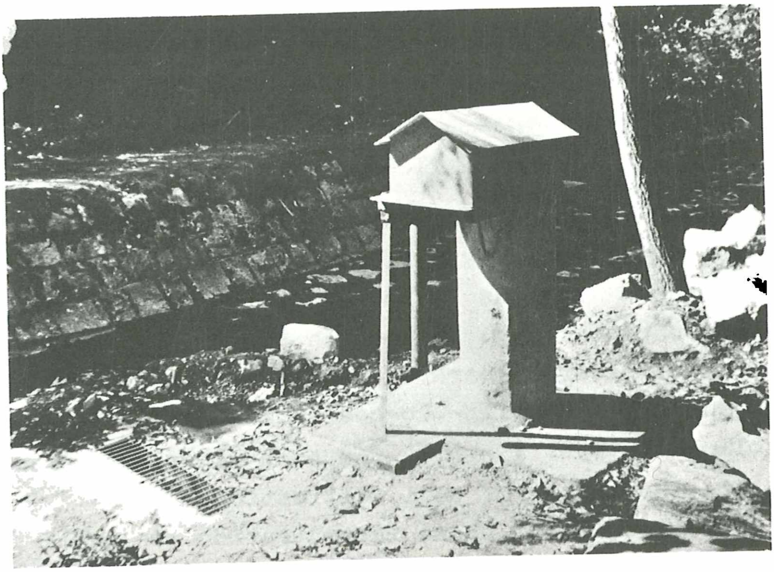

fig. 2

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Determination of the total amount of transported sediment out of the watershed was performed by the use of the weir,waterlevel recorder and standard sediment procedure(fig. 2)

III RESULTS

Water discharge and sediment transportation was a subject of observation for several years in experimental watersheds with area of 5.6, 7.82, 9.45, 6,8 and 16,o km^2.

Total production of sheet erosion was computed for each experimental watershed by the use of set of equations proposed by D j o r o v i ć M. 1975, 1976.

So, knowing the production and total sediment transportation it was possible to find out the coefficient of sediment transportation "f" for each experimental watershed.

Considering transportation of sediment on the year base, it is quite obvious that it depends on the stream density that does the transportation of sediment. It means that in this case the shape of the watershed(which is the most important factor for peak rate) is of the minor importances for the sediment transportation on one year base.

Having in mind this reason, we found out the functional dependability bitween coefficinet of sediment transportation "f" and the streem density "G" as following (fig. 3):

$$Y \quad o{,}89 - \frac{o{,}19}{X} \qquad /1/$$

where y= "f" = coefficient of sediment transportation

X= "G" = stream density that is defined on the following way:

$$"G" = \frac{L\ (km^{*})}{F\ (km^2)}$$

L = Sum of the total lenghth of all existing tributaries in km

F = area of the watershed in km^2.

In short. proposed method for avaluation of total sediment transportation that could be expected in an average year from any small watershed in Republic Srbija has three steps:

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1. Avaluation of total sheet erosion by the use of adequate set of the equations.
2. Avaluation of stream density "G" and the coefficient of sediment transportation by the use of the equation /1/ or the diagramme on fig.3
3. The total sediment transportation for an average year for the given watershed is obtained multipling the total amount of sheet erosion with avaluated coefficient of sediment transportation.

As for an example we shall present the calculation of the total sediment transportation for the upper part of the watershed of river RaLja.

The total area of this watershed is 9,45 km^2 and 24 hydrological units are selected according to slope and soil utilization.

Calculated amount of sheet erosion for each selected unit is given in table 1 and total sheet erosion for whole watershed is 6 538,8 t/god./ P/

Coefficient of sediment transportation "f" is calculated using the stream density "G".

$$"G" = \frac{L}{F} = \frac{9{,}o}{9{,}45} = o{,}95$$

$$"f" = o{,}89 - \frac{o{,}19}{X} = o{,}89 - \frac{o{,}19}{o{,}95} = o{,}89 - o{,}2 = o{,}69$$

The total sediment transportation /T/ =P x"f"= 6 538,8 x o,69 = 4 411,7 t/year.

Measurement of sediment transportation in the period of seven years(197o-1976) in this watershed, showes that average total sediment transportation is 4 559,9 t/year, table 2 what is very close to the calculated amount.

Naturally, practical value of this method is limited to the experimental region, but it would be very interesting to check the proposed coefficient "f" and its dependability to stream density in other regions and countries.

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IV CONCLUSIONS

Production and transportation of sediments in small watersheds were studied for several years(five watersheds of the area up to 16 km^2).

Soil erosion losses i.e. sheet erosion was studied by the use of erosion plots and that investigation made possible to define the sheet erosion by the set of equations for various regions in Republic Srbija,(fig. 1.).

Total sediment transportation in experimental small watersheds was studied by the use of weir and usual procedure of sediment measurement.(fig.2,4,5).

On the base of calculated sheet erosion production and measured total sediment transportation it was possible to find out the coefficient of sediment transportation "f" and its functional dependability $"f" = o{,}89 - \frac{o{,}19}{X}$ where X- represents stream density .(fig. 3)

So in any small watershed in experimental region of SR Srbija (up to 2o km^2), calculation of sheet erosion and the use of proposed coefficient of sediment transportation make possible to calculate the total sediment transportation on one year base.

Table 1 SHEET EROSION PRODUCTION IN WATERSHED RALJA

Number of unit	F km^2	Slope in degrees	%	Soil utilization	Sheet erosion in t/year	Applied sheet erosion equation
1.	0,2o	11	19,4	ochard under grass	2,36	$y=1,58X^{1,5826}$
2.	0,22	11	19,4	vineyard	57o,14	$y=215,oX^{1,29o2}$
3.	0,9o	11	19,4	plough land	821,2o	$y=76.oX^{1,2926}$
4.	0,18	1o	17,6	forest	4,08	$y= 1,58X^{1,11714}$
5.	0,22	1o	17,6	grass cover	2,22	$y= 1,58X^{1,5826}$
6.	0,3o	11	19,4	grass cover	3,54	"
7.	1,35	11	19,4	plough land	1232,oo	$y= 76,oX^{1,2926}$
8.	0,2o	11	19,4	grass cover	2,35	$y= 1,58X^{1,5826}$
9.	0.18	11	19,4	ochard under grass	2,12	$y= 1,58X^{1,5826}$
1o.	0,1o	11	19,4	vineyard	259,15	$y= 215,oX^{1,29o2}$
11.	1,8o	11	19,4	ploughland	1642,5	$y=76,oX^{1,2926}$
12.	0,23	9	15,8	forest	4,62	$y= 1,58X^{1,1171}$
13.	0,21	9	15,8	ploughland	147,o	$y=76,oX^{1,2926}$
14.	0,42	16	28,7	ploughland	635,8	"
15.	0,24	16	28,7	forest	9,4	$y=1,58X^{1,11714}$
16.	0,4o	8	14,o	grass cover	2,81	$y=1,58X^{1,5826}$
17.	0,25	8	14,o	forest	4,39	$y=1,58X^{1,11714}$
18.	0,35	8	14,o	ploughland	2o9,5	$y= 76,oX^{1,2926}$
19.	0,12	15	26,8	vineyard	471,84	$y= 215,oX^{1,29o2}$
2o.	0,15	15	26,8	grass cover	2,95	$y=1,58X^{1,5826}$
21.	0,21	15	26,8	ploughland	291,o	$y=76,oX^{1,2926}$
22.	0,7o	9	15,8	ochard under grass	5,96	$y=1,58 X^{1,5826}$
23.	0,3o	9	15,8	ploughland	21o,o	$y=76,oX^{1,2926}$
24	0,22	9	15,8	grass cover	1,87	$y= 1,58X^{1,5826}$

F= 9,45 km^2 P = 6538,8 t/year

Table 2 SEDIMENT TRANSPORTATION IN THE WATERSHED OF THE RIVER RALJA,

PROFILE "MISA"- 197o-1977

	Month												Mean values per	
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	month gr/sec	year ton
197o	16,8	14,4	9,6o	36,90	203,8	71,76	141,5	33,6	16,9	17,18	6o,o	17,02	53,29	1.680,5
1971	45,39	17,22	192,77	138,87	47,1o	21,72	5o,95	42o,1o	28,92	18,74	2,o2	2,84	82,22	2.592,9
1972	9,83	8,o7	4,2o	18,39	12,o8	747,94	4483,oo	12,58	18,oo	84,72	19,66	6,56	452,o8	14.256,8
1973	18,35	8,98	11,82	3o1,14	118,37	215,85	43,47	76,oo	17,57	2o,4o	11,79	12,43	71,4o	2.251,7
1974	14,88	6,2o	4,74	11,24	42,o1	2o3,o3	39,38	135,38	21,84	64,8o	36,86	28,45	5o,73	1.599,8
1975	1,74	6,82	12,77	5,58	12,74	11o,98	557,4o	19o3,97	11,17	9,2o	24,29	5,41	221,84	6.995,9
1976	28,o8	32,36	28,75	65,26	29,18	55,oo	9,o8	59o,6o	93,5o	12,83	8,15	14,3o	8o,59	2.541,5
													T= 144,6 gr/sec.	4.559,9

NNG o,82 gr/sec 19.o8.1974

SG = 144,6 gr/sec.

VVG 13o.87o,oo gr/sec 26.o7.1972.

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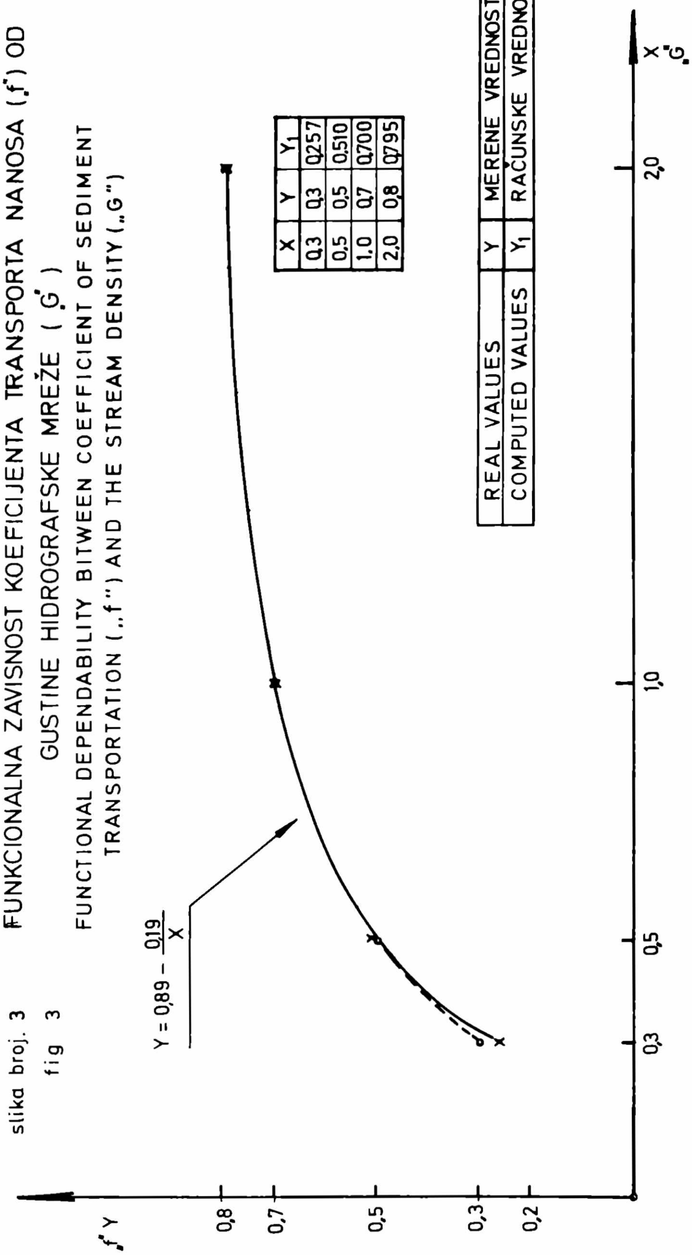
slika broj. 3
fig 3

FUNKCIONALNA ZAVISNOST KOEFICIJENTA TRANSPORTA NANOSA („f") OD GUSTINE HIDROGRAFSKE MREŽE („G")

FUNCTIONAL DEPENDABILITY BITWEEN COEFFICIENT OF SEDIMENT TRANSPORTATION („f") AND THE STREAM DENSITY („G")



X	Y	Y_1
0,3	0,3	0,257
0,5	0,5	0,510
1,0	0,7	0,700
2,0	0,8	0,795

REAL VALUES	Y	MERENE VREDNOSTI
COMPUTED VALUES	Y_1	RAČUNSKE VREDNOSTI

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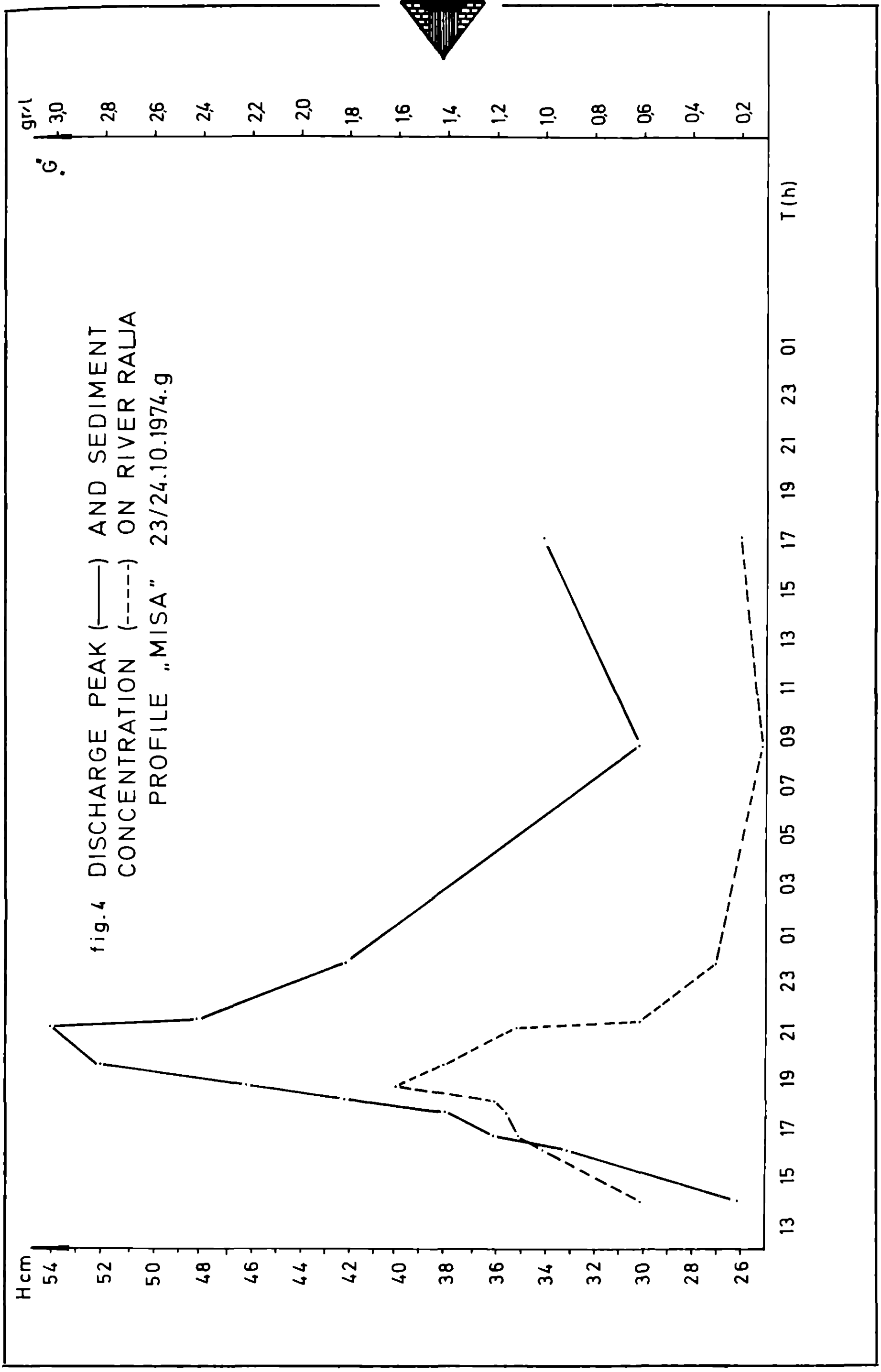

fig. 4 DISCHARGE PEAK (——) AND SEDIMENT CONCENTRATION (----) ON RIVER RALJA PROFILE „MISA" 23/24.10.1974.g

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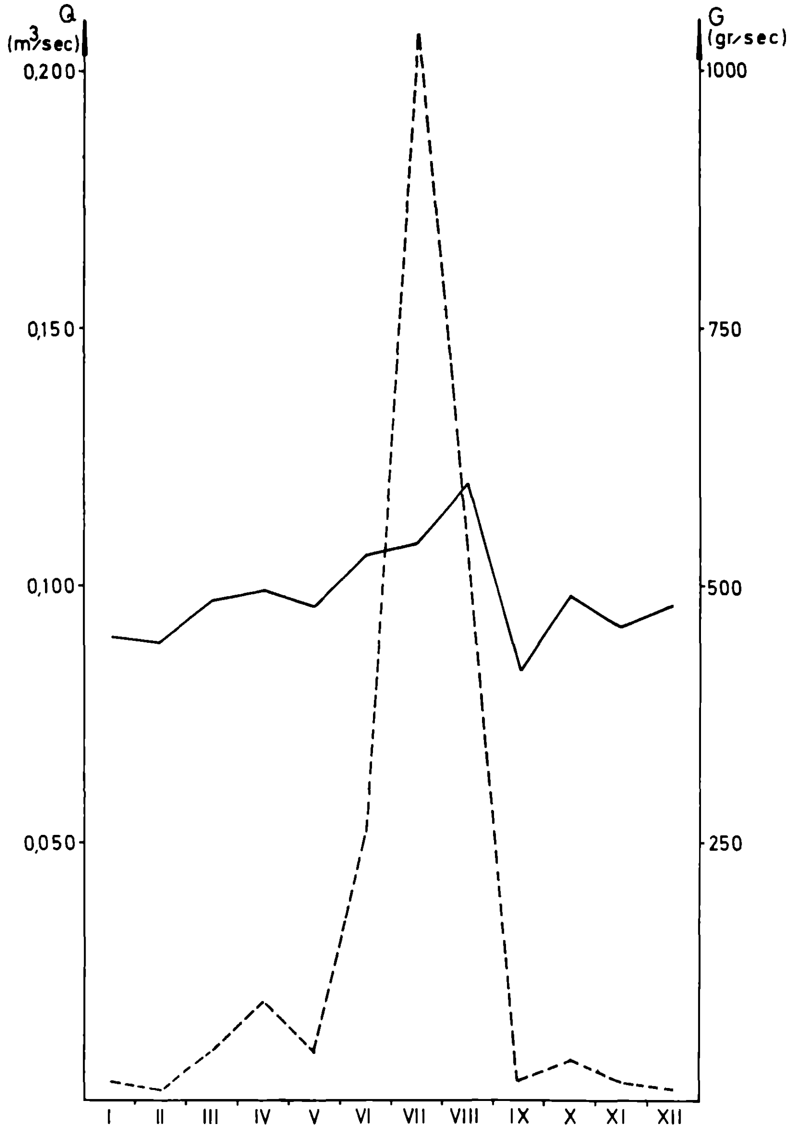
fig. 5 AVERAGE MONTH WATER DISCHARGE (——) AND TRANSPORT OF SEDIMENT (- - - -) FOR THE PERIOD 1971-75 PROFILE „MISA" RIVER RALJA



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RÉSUMÉ

La production et le transport des alluvions dans les bassins versants torrentiels ont fat l'objet de notre etude (sinq bassins versants d'une surface F 16 km^2)
On a étudué l'erosion superficielle du sol à moyen de parcelles expérimentales. A partir de résultates des mésures, on a établi les équations de l'érosion pour les regions differentes da la République de Serbie (fig. 1)
Le transport solide dans les cours d'eaux a été mésuré par la méthode classique du prélevement(fig. 2,4,5)
La rélation entre l'intensité d'erosion superficielle, calculée à partir des équtions données et le transport solide mésuré dans les rivière , peut être exprimée par le cofficient du transport des alluvions (f) dans un bassin versant. Ce coefficient(f) depend de la densité du réseau hydrographique(x) du bassin versant: $f = 0{,}89 - \frac{0{,}19}{X}$ (fig. 3)
L'application de nos équations pour l'intensité d'érosion et le coefficient du transport rend possible le calcul du transport solide(la quantité totale annuelle) dans les petits bassins versants(F 2o km^2) dans la région considerée de la Serbie.

LITERATURE

Djorović,M., 1974 Experimental determination of the intensity of water erosion on the territory of SR Srbija, Yugoslavia, FAO,EFC,Working party on the management of mountain watersheds,Ankara 3- 13 June.

Djorović,M., 1975 Gubici zemljišnog materijala i vode dejstvom erozije s raznih tipova zemljišta u SR Srbiji, Posebno izdanje IŠDI br. 37,Beograd

Djorović,M., 1976 The effects of manner of soil utilization and slope on erosion and run-off, Zemljište i biljka, Vol. 25, No 1-2, 55-72.

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