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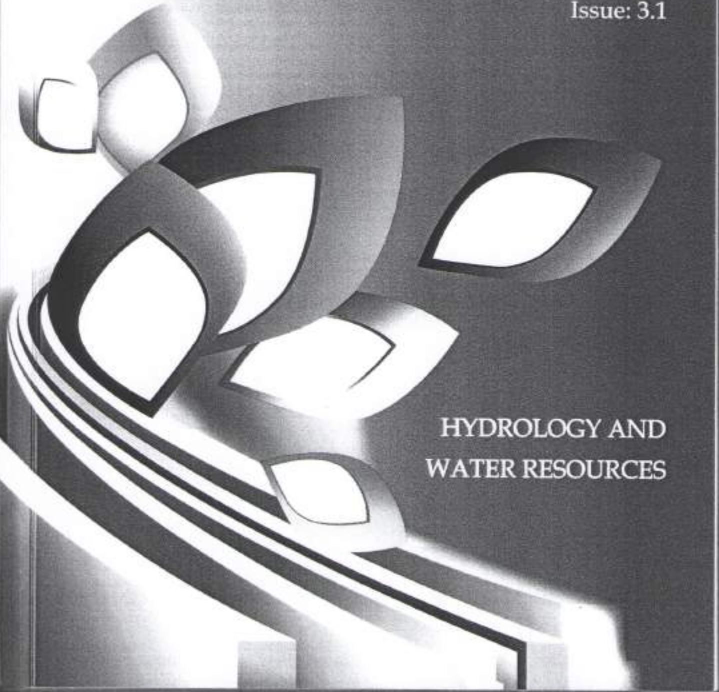

HYDROLOGY AND WATER RESOURCES

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CONCLUSION

In this study were analyzed seven indicators of water quality of river Slanic and river Trotus a period of five years. Several methods were used to determine the indicators: Mohr method, titration method with EDTA, method of determination by molecular and atomic spectophotometry, and gavrimetric method. The indicator concentrations for the Slanic River are higher downstream and lower upstream of Section Salt Solution. As for the Trotus River, the concentrations of the indicators are higher upstream and lower downstream of the salt mine. The presence of chlorides and sodium in the two rivers is due to the natural factors from the salty springs, the salty areas and the drainage of Pit Burlacu (formed by the exploitation of the area). The contribution by the salt mine which is in operation on the presence indicators analyzed in the two rivers is very low. All indicators analyzed within the surface waters of the Trotus and Slanic rivers are below the pollutant limit values according to NTPA-001/2005.

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ASSESSMENT OF COMPLIANCE WITH THE DELIMITATION EROSION CONTROL CRITERIA IN THE NITRICA RIVER BASIN, SLOVAKIA

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ABSTRACT

Article represents the calculation of the long-term average annual soil loss using the universal soil loss equation (USLE) in the model river basin. Soil loss will be assessed with respect to land use (in the categories: arable land, vineyard, garden, orchard and permanent grassland) and slope (in the categories: less than 12°, 12° – 20° and more than 20°). There is a Slovak technical norm: Hydromelioration – Erosion control protection of agricultural land. Based on this norm land users must comply with the delimitation criteria for the intervention of agricultural and forest land. It means that: A) slopes steeper than 12° shall not be used for growing crops and shall be grassed, B) slopes steeper than 20° shall not be used as grassland and must be afforested. Model river basin will be evaluated on the basis of these criteria. The current situation will be described. The new land use distribution will be modelled according to the results of the delimitation criteria. A detailed balance before and after will be processed. We try to deduce the consequences that may result from management in the model area due to non-compliance with the erosion control rules.

Keywords: erosion endangerment, the universal soil loss equation, delimitation erosion control criteria, land use changes, soil degradation, Slovakia

INTRODUCTION

Soil degradation is a global problem of the 21st century affecting up to 33% of the Earth's surface [1], and points to a decline in soil quality, with a consequent reduction in ecosystem functions and services [2]. Soil erosion is one of the most serious types and, in addition to other degradation factors, is highlighted in the thematic strategy for soil [3].

According to Antal, Streďanský [4], there is no natural soil surface that would not be threatened by soil erosion. Soil erosion is a naturally occurring process that affects all forms of landscape. In agriculture soil erosion refers to the casting of the surface layer of the field by natural physical forces of water and wind or by forces associated with agricultural activities such as soil cultivation [5, 6].

The accuracy of soil loss assessment by models depends to a large extent on how model parameters describe the important characteristics of the catchment [7]. Many researchers are focusing on the evaluation of parameters provided by geographic information system (GIS) and remote sensing data. These techniques are useful for

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quickly assessing the spatial distribution of erosion in large areas and may cover remote areas where no measurements are actually made [8, 9].

The most popular and most widely used is the universal model of loss equations (USLE) developed by the authors [10]. The model formula, expressed as a logical product, combines all the major natural and anthropogenic factors that shape the type and extent of soil erosion.

Delimitation erosion control criteria

The term delimitation of the soil fund (interconnection of the types of land) can be understood as the division of the total area of the solution territory on the delimitation categories. The first aid in delimiting types of land is a slope. With an increasing slope, the intensity of water erosion of the soil increases. From the point of view anti-erosion protection we need to know especially in delimitation of the soil fund the delimitation criteria for the distribution of the solution territory to the agricultural and forest soil fund [4, 11].

If the agricultural and forestry soil fund to be used rational and as possible in order to take account of the conditions, it is necessary to delimit the agricultural and forest soil fund. In the delimitation of the soil fund, to solved the distribution of individual types of land, i.e., arable land, special culture and grassland as well the soils design for the forest soil fund for afforestation. It's essential to definite boundaries between agricultural land, forest soil fund and urban area.

At the draft localisation individual culture should be consideration given to criteria and characteristics such as climatic, geological, pedological, hydrological, mechanical accessibility, erosion, depth of soil profile, depth of groundwater, etc.

The aim of the report is determine the intensity of water erosion by a universal soil loss equation in the Nitrica river catchment. From the calculation of the soil loss values in the model river catchment, we will evaluate the compliance with the delimitation anti-erosion criteria according to valid standards.

MATERIAL AND METHODS

The Nitrica River is located in the northern part of western Slovakia. The catchment passes through two counties (Trenčiansky and Žilinsky), five districts (Bánovce nad Bebravou, Ilava, Partizánske, Prievidza and Žilina), and the catchment area consists of 52 cadastral territories. The watercourse forms a diverging river line, it is the right-hand tributary of the Nitra River with a length of 51.4 km and a flat catchment area of 318.5 km². The nitric streams are the Škrípsky brook, Jasenina, Šindeliarska, Nevidzianka, Sečiansky brook, Dlžinský brook (left streams) and Krstenica, Bystrička, Rudnianka, Rokoska, Diviacky brook, Sučiansky brook, Čihoc, Hradištnica (right streams). The catchment area falls into the geomorphological units of Strážovské vrchy, Podunajská vrchovina and Hornonitrian basin. The area is formed by a rugged highland terrain with an average slope of 27.5 % and an elevation in the range of 185 m. m. to 1213 m n. m. The better part of the basin is located in the Strážovské vrchy, which are part of the mountain ranges and magmatic rocks [12].

From the climatic point of view, the south-west lowland part belongs to the temperate climate zone, a slightly warm with cold winters with average temperatures in January -3 °C and July 16 °C. The north-eastern mountainous part belongs to a slightly warm district, a damp highlands with average temperatures in January -5 °C and in July around 13 ° C. The number of summer days (temperature above 25 °C) in the year is 50 or less. The long-term average annual temperature for the period 1992-2016 is 9.81 °C and the average annual rainfall is 785 mm. The area in the river valley is typically agriculture, with a high slope of grassland and forests.

In order to define the area of interest and to determine the inputs for the calculation of the water erosion intensity for the Nitrica river catchment the documents were used: vector map, base map in scale 1 : 10 000, georeferenced ortofotomap, water management district map in scale 1 : 50 000, geological map of Slovakia in scale 1 : 50 000, updated map BPEJ, factor R map for SR.

The boundary of the Nitrica river catchment was determined on the basis of the Digital Model Relief (DMR) created from the basic map of the Slovak Republic at a scale of 1: 10000. In the DMR formation an interpolation method with 5x5 m raster resolution was used. A vector map was used to create a map of the current landscape. The cadastral map is a large scale map showing all real estates and cadastral areas registered in the cadastre in layers KATUZ, KLADPAR, LINIE, POPIS, TARCHY, ZAPPAR, ZNACKY, ZUOB, OBVODOKO, OBVODPPU.

ArcGIS software has been used to analyze the erosion risk of the soil by water erosion. The modified USLE equation from Wischmeier, Smith was used [10, 13]. The slope length and slope factor was replaced by the LS factor. The equation has the form (1):

$$S P = R . K . L . S . C . P \qquad (1)$$

Sp – loss of soil caused by water erosion [$t.ha^{-1}.year^{-1}$], R – rainfall-runoff erosivity factor [$MJ.ha^{-1}.year^{-1}$], K – soil erodibility factor [$t.MJ^{-1}$], L – slope length factor, non-dimensional, S – slope steepness factor, non-dimensional, C – cover management factor, non-dimensional, P – support practice factor, non-dimensional.

To determine the R factor, values with ombrographic records [14] were used, which were processed in the form of map R for the whole area of SR. We used an interpolation method in the ArcGIS environment to create the raster layer R - factor. We chose the ombrographic stations in the area and its surroundings so that the stations are evenly distributed. The nearest ombrographic stations that came into the calculation were Malé Bielice (14.92), Trencin (14.21), Žilina (14.42), Mlyňany (28.62) and Nitra (24.62). The R factor value was determined and used in the range of 12.5 - 22.5.

For the soil in the model territory the K factor range of the main soil units [12] was used: 0.13-0.72.

When calculating the LS factor, we also included barriers such as: watercourses, roads, urban areas, non-woody vegetation and forests. The topographic factor was 0-385 with an mean value of 17.5.

Factor C values for individual elements of the secondary landscape structure were taken from Alena [15]: 0.005 for grassland; 0.45 for orchard; 0.40 - 0.45 for arable land; 0.45 for gardens; 0.80 for vineyard and field roads; 0.50 for non-woody vegetation..

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In determining factor P, a value of 1 was chosen for the studied area, as data on soil management was missing.

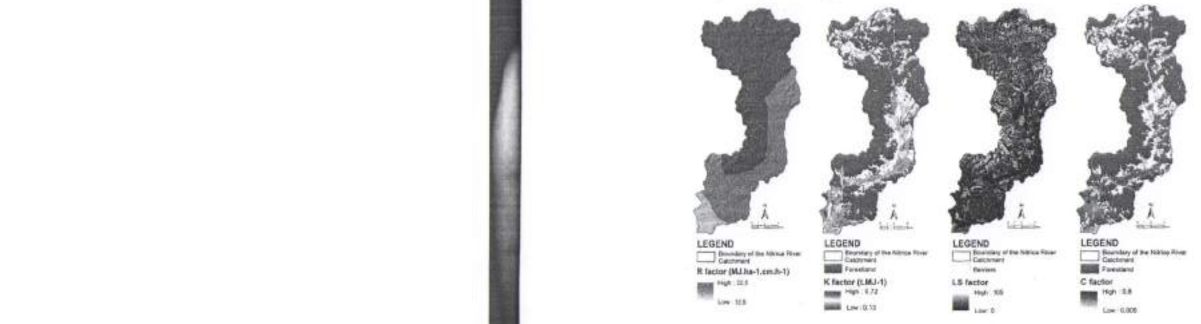

Fig. 1 Map of universal soil loss equation factors of the USLE river catchment of the Nitrica River.

According to equation (1), we calculated the potential and calculated erosion of the agricultural land.

Fig. 2 Map of potential (right) and calculated (left) intensity of water erosion in the Nitrica river catchment.

The slope of the slope depends on the delimitation criteria for determine forest and agricultural land. The criteria for delimitation of the soil fund from the standpoint of anti-erosion protection according to STN 75 4501 have been used [4]. Areas that do not meet delimitation criteria such as arable land on slopes larger than 12° and sites of permanent grassland over 20°. Consequently, the calculation of the soil yield after the change of land types according to the delimitation criteria was carried out.

In tab. 1 we report the loss of soil of land values. From tab. 2 shows that the area of arable land of the model area of 4 041 ha can be expected to lose soil by 18 707 $t.year^{-1}$. At 69 % of the model area (Tab. 3), at a slope of less than 12°, we expected a loss of soil 16 985 $t.year^{-1}$.

Tab. 1 Calculated intensity of water erosion in model river catchment

Soil Erosion Class ($t.ha^{-1}.year^{-1}$)	Area (ha)	Area (%)	Mean Erosion ($t.ha^{-1}.year^{-1}$)	Annual Soil Loss ($t.year^{-1}$)	Annual Soil Loss (%)
< 10	9,152.05	93.58	1.023	9,360.16	37.91
10 – 20	400.10	4.09	13.900	5,561.37	22.52
20 – 30	101.30	1.04	24.158	2,447.25	9.91
30 – 50	59.51	0.61	37.794	2,248.96	9.11
50 – 100	59.79	0.61	67.849	4,056.50	16.43
100 – 280	7.57	0.08	132.862	1,005.10	4.07
280 >	0.04	0.00	316.326	11.86	0.05
Entire Catchment	9,780.35	100.00		24,691.19	100.00

Tab. 2 Calculated intensity of water erosion in the model river catchment with respect to the land type

Land Type	Area (ha)	Area (%)	Mean Erosion ($t.ha^{-1}.year^{-1}$)	Annual Soil Loss ($t.year^{-1}$)	Annual Soil Loss (%)
Arable Land	4,040.99	41.32	4.629	18,706.58	75.76
Vineyard	10.08	0.10	12.016	121.15	0.49
Gardens	33.61	0.34	12.168	408.90	1.66
Orchard	138.39	1.42	6.462	894.34	3.62
Grassland	5,557.28	56.82	0.821	4,560.23	18.47
Entire Catchment	9,780.35	100.00		24,691.19	100.00

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Tab. 3 Calculated intensity of water erosion in model river catchment according to slope of territory in degrees

Slope Angle (°)	Area (ha)	Area (%)	Mean Erosion (t.ha^{-1}.year^{-1})	Annual Soil Loss (t.year^{-1})	Annual Soil Loss (%)
< 12	6,749.83	69.01	2.516	16,984.67	68.79
12 - 20	2,224.85	22.75	2.332	5,187.52	21.01
> 20	805.67	8.24	3.127	2,519.00	10.20
Entire Catchment	9,780.35	100.00		24,691.19	100.00

Table 1, 2 and 3 show that the expected loss of soil is predominantly on arable land (76 %) and on grassland (18 %). Alarming is the finding that erosion also manifests itself at a slope greater than 12°, where only the occurrence of grassland is anticipated. On the basis of the delimitation criteria, of the model area where these criteria are not met. The area of 142.98 ha with a slope greater than 12° is used as arable land. These areas should be grassed according to the delimitation criteria. Area of 1 029.33 ha with a slope greater than 20° is used either as arable land or grassland. These areas should be delimited in forestland.

In the model area, these non-delimitated areas were spatially determined and subsequently re-determined on the basis of the correct delimitation criteria. Loss of soil has been calculated again. In tab. 4 is a summary of the results.

Tab. 4 Calculated intensity of water erosion in the model river catchment with respect to the land type after application of delimitation criteria

Land Type	Area (ha)	Area (%)	Mean Erosion (t.ha^{-1}.year^{-1})	Annual Soil Loss (t.year^{-1})	Annual Soil Loss (%)
Arable Land	3,816.51	42.99	4.629	17,667.41	76.50
Vineyard	10.08	0.11	12.016	121.15	0.52
Gardens	33.61	0.38	12.168	408.90	1.77
Orchard	138.39	1.56	6.462	894.34	3,87
Grassland	4,879.10	54.96	0.821	4,003.72	17.34
Entire Catchment	8,877.69	100.00		23,095.52	100.00

It can be said that applying correct, delimitation criteria according to the standard STN 75 4501, the land types were changed. The change was to 1 172 hectares, which reduced the value loss of soil by 1 596 t.year^{-1}.

CONCLUSION

The universal soil loss equation was applied to the Nitrica river catchment in 52 cadastral territories, with an area of 9780 ha. The R factor value was used in the range of 12.5 - 17.5. According to the main soil units factor K values were used in the range of 0.13-0.72. Using barriers (for which waterways, roads, urban areas, non-forest vegetation and forests were considered) LS factor values were calculated in the range 0-385 with an average value of 17.5. Factor C values for individual elements of the secondary landscape structure were used: 0.005 for grassland; 0.45 for orchard; 0.40 - 0.45 for arable land; 0.45 for gardens; 0.80 for vineyard and field roads; 0.50 for non-forest woody vegetation. Factor P was chosen as the value 1. The delimitation criteria for the intersection of forest and agricultural land depend on slope. Was the defined locality, that are does not meet delimination criteria. Estimation of calculated water erosion in the model territory is 24 691 t.ha^{-1}year^{-1} with a mean value of 85 t.ha^{-1}year^{-1}. Estimation of arable erosion, which covers 48 % of the territory, is 18 706 t.ha^{-1}year^{-1}. Estimation of erosion on land with a slope greater than 12° is 16 985 t.ha^{-1}year^{-1} at an area of 4 041 ha. We have found that the delimitation criteria are not applied to the area of 781 ha. The correct realisation of the delimitation criteria would be to reduce the intensity of water erosion in the model area by about 1 596 t.ha^{-1}year^{-1}.

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ASSESSMENT OF THE NEGATIVE WASTE WATER IMPACT AND IMPROVING THE REGULATION OF ANTHROPOGENIC INFLUENCE ON WATER BODIES OF THE BAIKAL NATURAL TERRITORY

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ABSTRACT

The paper deals with the need to improve techniques and methods of valuation acceptable impacts on the ecosystem of the lake. Baikal. A study is made of the negative influence of discharges of harmful (polluting) substances on the unique ecological system of Lake Baikal. The scientific substantiation has been developed for the normative of maximum permissible impacts on the lake's ecological system and the methods of determining them. On the basis of a statistical processing of hydrobiological and hydrochemical data for Lake Baikal, collection and analysis of initial information on the main components of the chemical balance in Lake Baikal, assessments of the anthropogenic load on the lake, and calculations of the balances of pollutants, we determined the normative of permissible impacts on the ecosystems of Baikal and its hollows regarding inputs of chemical substances and suspended solids as well as microorganisms. The developed scientifically-based recommendations include proposals for regulating the masses and concentrations of harmful substances by discharged into the lake Baikal and its tributaries, the amount of emissions and discharges to the Baikal Natural Territory, the adjustment of the list of standardized substances to the lake, the establishment of standards for the permissible impact for the main sources of negative impact.

Keywords: anthropogenic impact, harmful substances, normative of maximum permissible impact, system of state standardization, Lake Baikal.

INTRODUCTION

Federal Law (FL) № 94 "On the Protection of Lake Baikal" defines the special status of Lake Baikal. Baikal as a unique ecological system, which is an object of the World Natural Heritage of UNESCO, and introduced the concept of "Baikal Natural Territory" (BNT) [1]. The requirements established by the Law to preserve the lake and rational use of the natural resources of its basin differ from the legal regime established by the Water Code of the Russian Federation [2] for water bodies in the territory of Russia. In accordance with Article 6 № 94-FL "On the Protection of Lake Baikal" [1], in ecological zones at the BNT, activities that are negatively impacted on the lake

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