UDC 631.4:114.2

Stanislav Torma[1], Gabriela Barancikova[1], Jarmila Makovnikovs[1], Stefan Koco[1], Anatoliy Lisnyak[2]

[1]Soil Science and Conservation Research Institute Bratislava, regional work place Presov, Prešov, Slovak Republic

[2]Ukrainian Research Institute of Forestry and agroforestry named by G.M. Vysotsky, Kharkiv, Ukraine

POSSIBLE WATER POLLUTION FROM THE AGRICULTURAL SOILS

The algorithm can on the base of known parameters classify each soil locality to the category of potential pollution water sources. More than 50 % of arable land in Slovakia has low potential to pollute the water sources bur almost 40 % of grassland belong to the category with strong and very strong potential pollution water sources.

Keywords: *organic/inorganic contamination, nitrogen/phosphorus pollution, soil categorization, water sources.*

Introduction. The soil together with the water belongs to the main subsystems of environment. The soil is determining factor for both water and biogenic elements cycle and also satisfies the basic human requirements, e.g. both food and fiber production. The water is substance of biosphere, it is the most wide-spread matter on the Earth and together with the soil has first-rate meaning for human nutrient security. The soil can pollute the water as well as the water can pollute the soil. The soil has the essential role at surface transport processes; it controls infiltration, redistribution and water accumulation, too. The water pollution (both surface and underground) by agricultural activity is relative serious problem. It can be caused not only by wrong application of chemical substances (fertilizers, pesticides, etc.), but by soil properties, too.

Transport soil function, as one of the main ecological functions, plays the dominant role in thinking of water pollution. The water sources pollution from the point of agricultural soils can be caused by nitrogen and phosphorus input (eutrophication) and both organic and inorganic pollutants input, as well (contamination).

The aim of this paper is not to evaluate the soil erosion, but the evaluation of soil transport function on the base of present knowledge of nutrient, organic and inorganic pollutants transport in the soil regarding not only horizontal, but also vertical transport, as well. The maps of potential water sources pollution were created on the base of algorithm based on the soil and localities parameters.

Materials and methods. The soil categorisation results from the transport soil function which includes transport of nutrient, organic and inorganic pollutants. Partial evaluation of individual transport processes was realized on the base of suitable measurable indicators, which affects mentioned ecological soil function [1]. The soil parameters which were needed for evaluation of partial transport were obtained from bonited soil-ecological unit (BPEU). Next soil parameters which can be not deduced from the BPEU, were obtained from Soil monitoring database. The maps were created by software ArcGIS 9.2.

Results and discussion. Both water and wind soil erosion causes the loss of the most fertile soil layer together with nutrients, organic matter etc. and decrease of microbiological activity, too. If the soil contents higher contents of nitrogen, phosphorus, organic or inorganic pollutants, the potential water pollution is possible, especially close to the water sources.

Nutrient transport. The nutrients (in our case nitrogen and phosphorus) are inseparable components of the soil and in contrast with organic or inorganic pollutants they are

purposely applied into the soil in framework of farming. The nutrient transport relates with soil water regime very close. The evaluation of nutrient transport consists from the vertical transport in framework of the soil profile (especially the nitrates leaching) and horizontal transport caused by locality slope. In case of **nitrogen,** five categories of soil ability to transport nitrogen were created by the mutual combinations of nitrified nitrogen amount in the soil and slope coefficients

The **phosphorus** transport in the soil depends on "soil volume", e.g. it is dependent on the soil depth and skeleton contents in the soil and naturally on the locality slope, too. The idea was that the not accumulated amount of phosphorus in the soil is from the soil transported. It follows that the soil ability to transport phosphorus is directly dependent on the locality slope and skeleton contents in the soil and indirectly dependent on the soil depth. The categorisation of soil ability to transport phosphorus was made on the base of the combination of mentioned soil and locality parameters. All parameters can be characterised by BPEU. The more detailed analyse of parameters and assignment coefficients to them was published by Torma [2].

Inorganic pollutants transport. Mercury, cadmium, lead, nickel, chrome, arsenic, copper, zinc and cobalt are the inorganic elements which are defined as risk elements according to the Act Nr. 220/2004 about soil use and conservation. The process that controls inorganic pollutants distribution in ecosystem includes several main physical, chemical and biological processes. To the most important ones belong the adsorption, change reactions, dissolution and redox processes. The pollutants that are not immobilised by soil can be transported to the ground or surface water resources in dependence on type of water regime and pores system in the soil. The rating access based on scoring of individual parameters was used at evaluation. Makovnikova, Barancikova and Palka [3] referred about more detailed access to the selection of individual parameters and categorisation of transport soil function in relation to inorganic pollutants. The total contents of the inorganic pollutants, particle size, contents and quality of organic matter in the soil, thickness of humus horizon and soil pH value are the parameters that characterise the soil on the one hand and slope as parameter of locality on the other hand are the minimal set for evaluation of soil ability to transport inorganic pollutants.

Organic pollutants transport. The evaluation of soil ability to transport organic pollutants concerns these organic pollutants, which are characterised by low water solubility and slow degradation. Polyaromatic hydrocarbons, polychlorinated biphenyls and all halogenic aromatics belong to risk substances according the Act Nr. 220/2004 about soil use and conservation.

The soil potential to immobilise the organic pollutants depends not only on affinity of the substance to soil phases, but on precipitation in given locality, as well. Next factor that influences transport of organic pollutants is slope. Barancikova and Madaras [4, 5] referred about specific and detailed access to the choice of individual parameters for evaluation of organic pollutants transport in soil profile. The minimum set of data for evaluation contains these parameters are, as follows: contents and quality of organic matter in the soil, thickness of humus horizon, clay contents, soil depth, precipitation amount and locality slope.

The proposal of algorithm for evaluation of soil ability to avoid water sources pollution. The algorithm for evaluation of soil ability to avoid water sources pollution was created on the base of evaluation partial transport processes (transport of nutrients, organic and inorganic pollutants). This algorithm is presented by code XYZ, which consists from three digits (from 1 to 5). These digits represent the evaluation of partial transport of nutrients, organic and inorganic pollutants. The greatest share in complex evaluation has the nutrients transport (60 %) and it is placed on the first place of the code. On the second

place is inorganic pollutants transport with 30 % share and the third is organic pollutants transport with only 10 % share. The final categories of potential pollution of water resources are presented as the combination three mentioned categories taking into account their percentage share, e.g. the X parameter is multiplied by 0,6, Y parameter by 0,3 and finally Z parameter is multiplied by 0.1. Final sum determines the category of potential water sources pollution.

Category of potential water sources pollution	Coefficient
1. Very low	1.0 – 1.8
2. Low	1.9 – 2.6
3. Middle	2.7 – 3.4
4. Strong	3.5 – 4.2
5. Very strong	4.2 – 5.0

Exception from these categories is the combination of parameters XYZ, where minimum on random place the digit 5 occurs, e.g. very strong transport for random partial parameter. The locality with such combination is automatically classified in category 5 – with very strong potential of water sources pollution. More detailed information about creation of final algorithm can be found in one of our previous paper [6].

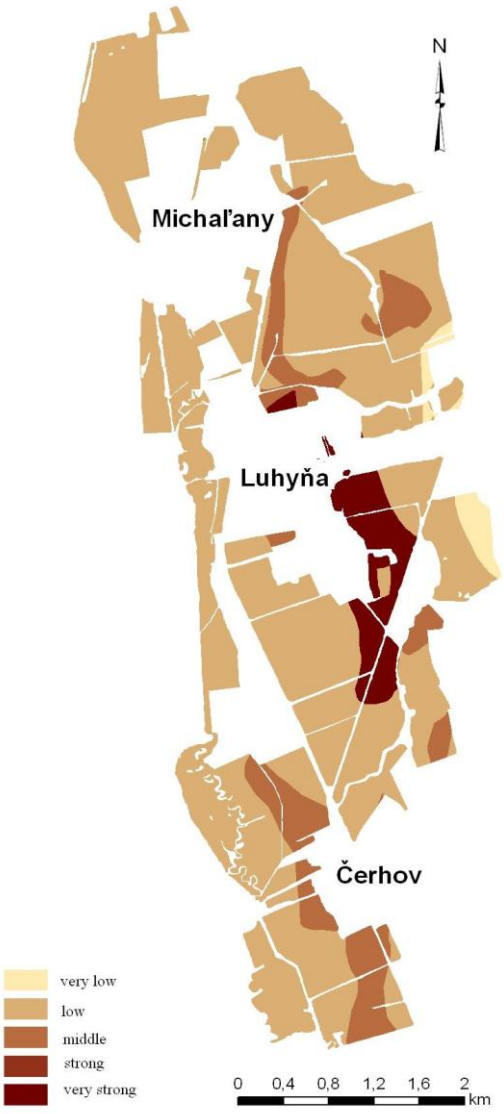

Fig. 1. The final soil categories of chosen agricultural farm from the point of view of potential water sources pollution

Soil categorisation from the point of view of water sources pollution in framework of chosen agricultural farm. The share of individual soil categories clearly documents about favourable situation in chosen agricultural farm from the point of view of possible water sources pollution. More than 80 % soils of total area belong to the categories with low and very low ability to pollute the water sources. This is given not only with soil location on the plane, deep humus horizon and high content of clay particle in the soils but also both with favourable pH value of the soil and sufficient content of humus with high quality, as well.

On the other hand, only 6 % soils of total area has strong and very strong ability to pollute water sources, especially due to great slope or little soil depth (shallow soils with their profile less than 0.3 m).

More than 12 % soils of total area belong to the category of middle ability of water sources pollution with nutrients, organic and inorganic pollutants.

Soil categorisation from the point of view of water sources pollution in framework of the whole Slovak Republic. The greatest share of arable land in framework of the whole Slovak Republic has the category with low ability to pollute water sources (table 1). To this category belong the deep soils (more than 0.6 m) with neutral pH value and

sufficient content of high quality organic matter, e.g. deep Mollic Fluvisols calcaric and Haplic Chernozems, located in the first place on Danubian lowland and particularly on East-Slovakian lowland. The relative great area of the soil occurs in category with strong and very strong ability to pollute water sources – 11.88 %. To these soils belong especially flat soils (less than 0.3 m), acid Eutric Cambisols with low quality humus which are located mainly in alpine localities in middle and northern Slovakia.

The worse situation is with grassland, where almost 40 % of its total areal belongs to the strong and very strong ability to pollute the water resources. But the grass itself has sufficient ability to prevent the pollution.

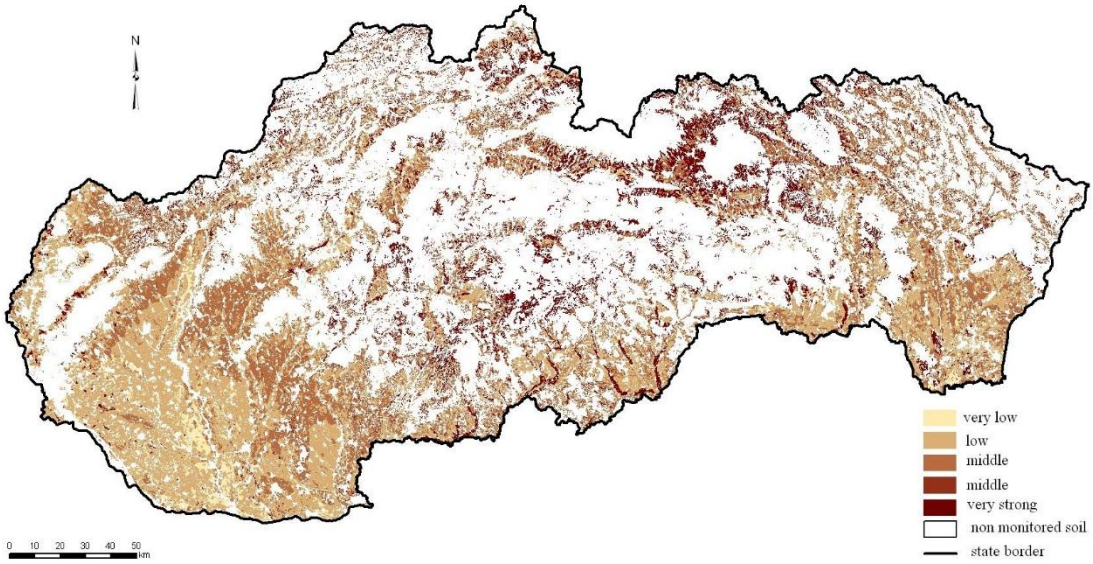

Fig. 2. The final soil categories of Slovak Republic from the point of view of potential water sources pollution

1. The area and share of individual soil categories with various ability to pollute water sources

Category	Arable land		Grassland	
	Area (ha)	Share (%)	Area (ha)	Share (%)
1 – very low	42986	3,07	9431	1,59
2 – low	713551	50,96	133224	22,53
3 – middle	477518	34,10	224396	37,95
4 – strong	14523	1,04	52358	8,85
5 – very strong	151777	10,84	171941	29,08

Conclusions. One of the potential pollutants of water sources can be often also an intensive and wrong use of agricultural soils. The transport soil function plays in it a very important role because due to both vertical and horizontal transport of nutrients can come to hydrosphere eutrophication and the pollutants occurred in the soil can pollute the water sources. All this results in deterioration their quality. Mentioned algorithm can on the base of known parameters classify each soil locality to the category of potential pollution water sources. More than 50 % of arable land in Slovakia has low potential to pollute the water sources bur almost 40 % of grassland belong to the category with strong and very strong potential pollution water sources. It is due to the fact that the grassland are situated mainly on Cambisols which are usually flat, have low sorption capacity and are located on slopes of alpine part of northern and middle Slovakia.

Acknowledgments. This paper was supported by the Slovak Research and

Development Agency under contract No. APVV-0124-06.

References: **1.** Acton, D.F. and Gregorich, L.J. (1995): Understanding soil health. In: ACTON, D.F., GREGORICH, L.I. (eds.). The health of our soils – toward sustainable agriculture in Canada. Centre for Land and Biological Resources Research, Research branch, Agriculture and Agri-Food Canada, Ottawa, Ontario, 1995, p. 5-10. **2.** Torma, S. (2002): Transportna funkcia pody vo vztahu k zivinam. (The transport soil function in relationship to the nutrients) In: Poda – jedna zo zakladnych zloziek zivotneho prostredia. (Soil – one of basic part of environment) Zbornik referatov z vedeckej konferencie vo Zvolene, Bratislava, 2002. ISBN 80-85361-98-1. s. 145-148. (in Slovak). **3.** Makovnikova, J., Barancikova, G. and Palka, B. (2007): Approach to the assessment of transport risk of inorganic pollutants based on the immobilisation capability of soil. Plant, Soil and Environment, 2007, vol.53, No.8, s. 365-373. **4.** Barancikova, G. and Madaras, M. (2003): Attempt to assessment of non-production soil functions – filtration of organic contaminants. Ekológia, vol.22, c.3, p. 223-336. **5.** Barancikova, G. and Madaras, M. (2005): Transport organickych kontaminantov v podnom prostredi. (The transport of organic pollutants in the soil) Proceedings from 13th International Poster Day: Transport of Water, Chemicals and Energy in the System Soil-Crop Conopy-Atmosphee, Bratislava. ISBN 80-85754-15-0. p. 20-26 (in Slovak). **6.** Barancikova, G., Makovnikova, J. and Torma, S. (2009): Navrh hodnotenia pod z hladiska znecistenia vodnych zdrojov. (The proposal for soil evaluation from the point of view of water sources pollution) In: Mimoprodukcne funkcie pody a krajiny na uzemiach ovplyvnovanych antropogennou cinnostou. (Non-productive soil and land functions on region influenced by man). Michalovce. CVRV – Vyskumny ustav agroekologie Michalovce, 2009. ISBN 978-80-89417-09-4 . s. 5-13. (in Slovak).

С. Торма, Г. Баранчікова, Ж. Маковніковс, С. Коцо, А. Лісняк

МОЖЛИВЕ ЗАБРУДНЕННЯ ВОДИ ВІД СІЛЬСЬКОГОСПОДАРСЬКИХ ҐРУНТІВ

Вивчено алгоритм потенційного забруднення водних джерел на основі відомих параметрів ґрунтів місцевості. Більше 50% орних земель у Словаччині має низький потенціал до забруднення водних джерел, але майже 40% пасовищ відносяться до категорій із сильними й дуже сильними потенційними можливостями забруднення води.

Ключові слова: *органічне/неорганічне забруднення, азотне/фосфорне забруднення, класифікація ґрунту, джерела води.*

С. Торма, *Г. Баранчикова, Ж. Маковниковс, С. Коцо,* ***А. Лисняк***

ВОЗМОЖНОЕ ЗАГРЯЗНЕНИЯ ВОДЫ ОТ СЕЛЬСКОХОЗЯЙСТВЕННЫХ ПОЧВ

Изучен алгоритм потенциального загрязнения водных источников на основе известных параметров почв местности. Более 50% пахотных земель в Словакии имеет низкий потенциал к загрязнению водных источников, но почти 40% пастбищ относятся к категориям с сильными и очень сильными потенциальными возможностями загрязнения воды.

Ключевые слова: *органическое/неорганическое загрязнение, азотное/фосфорное загрязнения, классификация почвы, источники воды.*