

# GEOGRAFICKÝ ČASOPIS

48

1996

2

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## SUSCEPTIBILITY OF THE JABLONKA CATCHMENT TO SOIL EROSION

Lubomír Solín, Milan Lehotský: Susceptibility of the Jablonka catchment to soil erosion.  
Geogr. čas., 48, 1996, 2, 13 figs., 16 refs.

The paper is aimed at evaluation of susceptibility of Jablonka catchment to soil erosion on the basis relief and soil parameters. Four relief parameters (slope, aspect, profile curvature, counter curvature) calculated by using DMR were taken into account. Properties of soil are represented by stability of soil aggregates, soil texture and by regime of soil moisture. For the evaluation of landscape susceptibility to soil erosion, rule-based modelling is used coupled with GIS SPANS. The source of the formulation of decision rules for estimation of the relief and soil effects on spatial variability of soil erosion, are consequently and first of all general knowledge on the effect of these factors on origin of overland flow, which are the basic preconditions of the water soil erosion investigation.

**Key words:** soil erosion, index of erosion susceptibility, rational rule-based modelling, GIS

### 1 INTRODUCTION

Research of water soil erosion in Jablonka catchment ( $163 \text{ km}^2$ ) is a part of international project "The Response of Fluvial Systems to Large Scale Land Use Changes" coordinated by the Institute of Earth Sciences of Hebrew University Jerusalem. Within the mentioned project the Institute of Geography of the S.A.S. estimate the effect of land use changes as caused by collectivization process on geomorphological response of the fluvial system. The period before collectivization is characterized by the situation of the land use in the year 1955 and the period after

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collectivization by that of 1990. Geomorphologic response (erosion - accumulation relief forms) of the fluvial system is formed by erosion-accumulation processes. Analysis of spatial variability of water erosion of soil as corresponding to the structure of land use before and after collectivization, therefore belongs to the important sources to the solution of the mentioned task.

On the basis of field mapping of soil erosion in the year 1992 (substantial part of it was published by Stankoviansky 1995), empiric knowledge was obtained on spatial variability of soil erosion in the Jablonka catchment corresponding to the structure of land use after collectivization. Empiric knowledge of the spatial variability of soil erosion before the process of collectivization are scarce and they were obtained by Stankoviansky through consultations with local people.

An overall idea on spatial variability of the investigation of water soil erosion in the whole catchment for both periods can be obtained only after a scientific reasoning of the gathered empiric material, which is based on so far attained knowledge of the mutual relation between the landscape elements on one side and erosional process on the other. This knowledge allow also an opposite process i.e. by deduction to obtain an idea of the spatial variability of erosional process in cases where empiric findings are missing. The level of the knowing of the relation between the landscape elements and erosional process is contained in the models of soil erosion. The area of Jablonka catchment does not allow to investigate the spatial variability of erosional process applying mathematical models based on physical processes of soil erosion with spatially variable parameters, as it is too demanding on input data. A possibility of their application in GIS environment, though on a small model area in cadaster of the commune Kostolné ( $1.6 \text{ km}^2$ ) was demonstrated by Hofierka, Súri (1966). Empiric formulations (for instance USLE) making use of multiplying algorithm of erosion factors identified on basis of correlation - regression relations is possible to use also in regional dimension, but if it is not completed by the verification of empiric data, the obtained results are not trustworthy. Other suitable approach often used at the regional level is the one based on certain assertions utilizing rational rule-based modelling. An outcome of such approach to the research of soil erosion is a relative qualitative evaluation of the landscape susceptibility to soil erosion. Out of the two mentioned approaches for our aims it is better to use the second one. In contrast to empiric formulation with implicit Horton's conception of runoff affirming that the overland runoff is produced by the whole area of the catchment, the rational rule-based modelling facilitates consideration of variable source area concept of runoff as it corresponds more to the reality and allows for more detailed and more realistic picture of the spatial variability of water erosion processes.

Analysis of the spatial variability of soil erosion corresponding to the structure of land use before and after collectivization is divided into three stages:

i) evaluation of the susceptibility of the Jablonka catchment to soil erosion on the basis of relief and soil parameters. These are the most stable landscape elements from the point of view of their changes in time. Their susceptibility to water soil erosion represents a potential erosion changing in time but about its application the way of land use decides,

ii) evaluation of the land use structure susceptibility to water soil erosion corresponding to the period after collectivization,

iii) evaluation of the land use structure susceptibility to soil erosion before collectivization.

The contribution brings results obtained at the first stage of the research.

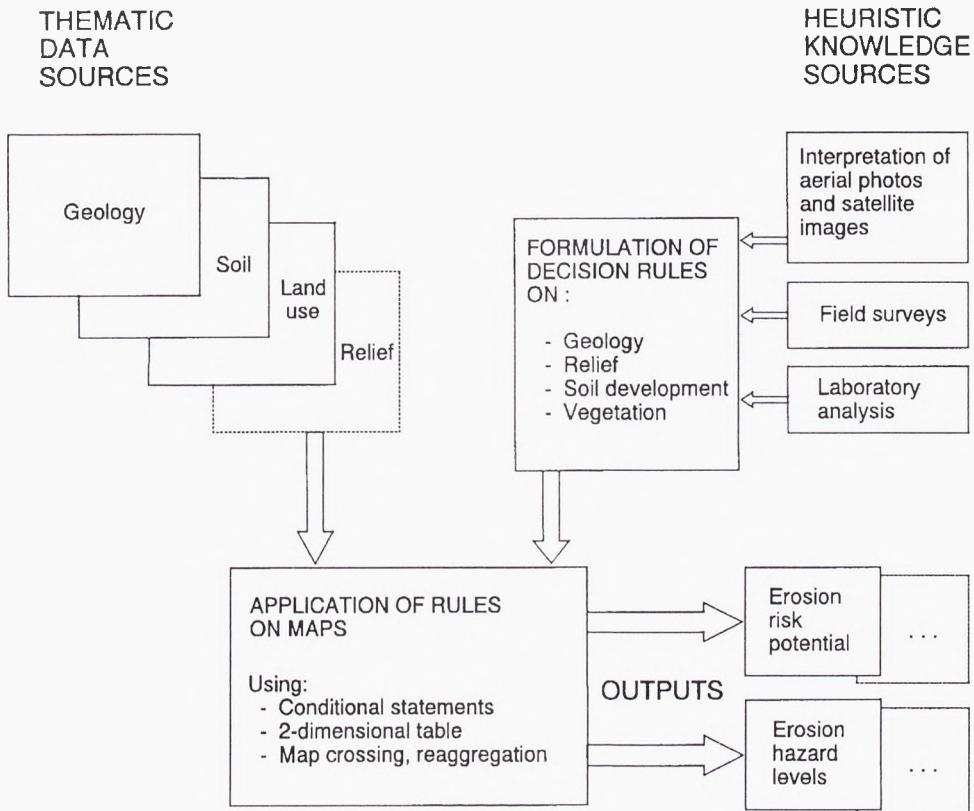


Fig. 1. Modelling diagram for relational rule-based erosion assessment using GIS  
(from A. M. J. Meijerink et al. 1994).

## 2 METHODOLOGY

For the evaluation of landscape susceptibility to soil erosion rule-based modelling is used coupled with GIS SPANS. A scheme of the methodological procedure is presented in Fig. 1 and it contains four steps or components:

### *Component 1 - Basis of the knowledge for the evaluation of susceptibility of landscape to origin of soil erosion.*

Under the water soil erosion we understand destruction of the upper soil horizon by detachment or entrainment of soil particles by rain drops or overland runoff, caused by rain or snow melt. Kinetic energy of the rain drops controls splash erosion and an amount and intensity of precipitation or melting snow controls an amount of overland runoff. The proportion of the erosional effect of rain drops on overall soil erosion is nevertheless small if compared to erosion effect of the overland runoff (Morgan, 1979), therefore we do not take it in consideration and the erosion problem is perceived only as an effect of overland runoff.

The origin of the overland runoff is the basic precondition of the origin of soil erosion. Therefore the research of spatial variability of susceptibility of landscape to soil erosion is very closely linked to the spatial variability of overland runoff, too. The source of the formulations of assertions, or rules for estimation of the relief and soil effects on spatial variability of susceptibility of the Jablonka catchment to soil erosion, are consequently and first of all general information on the effect of these factors on the infiltration process, transport and evaporation of precipitation water. These processes decisively participate at the origin of the two basic genetic forms of the overland runoff: i) infiltration overland flow, and ii) saturation overland flow.

### ***Component 2 - Thematic maps of relief and soil parameters***

Relief is represented by four parameters: aspect, inclination, profile curvature and contour curvature. The values of the quoted parameters were calculated by means of Digital Relief Model (DRM) with resolution of 20x20 m in GIS-GRASS. Input data for the calculation of the quoted morphometric parameters were digitized contour lines with the range of 10 m of the topographic maps 1:25 000. The aspect is expressed in degrees ( $0^\circ$  = eastern orientation, further orientations were determined of the  $0^\circ$  clockwise). Values of the profile curvature are in interval from  $-2199 \times 10^{-6}$  to  $2344 \times 10^{-6}$  and the values of horizontal curvature from  $-2303 \times 10^{-6}$  to  $2099 \times 10^{-6}$ . Negative values express the convexness eventually divergence and the positive mean concaveness, eventually convergence of the slopes. Straight slopes in both cases are limited by the interval ( $-50 \times 10^{-6}$  -  $50 \times 10^{-6}$ ). Classes of single morphometric parameters are quoted in Table 1 and their map projection is at the Figs 3-5.

At the Jablonka catchment there are 17 soil units : 1. Stagno gleyic Cambisol (4% of the total area), 2. Luvic Cambisol (10%), 3. Dystric Planosol (3%), 4. Fluvi-eutric Gleysol (5%), 5. Eutric Cambisol (32%), 6. Albo-gleyic Luvisol (4%), 7. Calcaric regosol (1%), 8. Albic Luvisol (10%), 9. Rendzina (12%), 10. Cambisol Rendzina (10%), 11. Eutric Luvisol (2%), 12. Eroded Rendzina (0.5%), 13. Orthic Luvisol (0.2%), 14. Calcaric Fluvisol (0.2%), 15. Fluvi-eutric Calcaric Gleysol (2%), 16. Mollic Cambisol (2%), and 17. Stagno-gleyic Luvisol (3%). The soil units were clustered into various classes from the point of view of soil structure, texture and moisture regime, which are decisive parameters of soil for the origin of overland runoff.

Creation of soil aggregates is a result of natural agents active in soil-forming process. For each genetic soil horizon, therefore a structure of aggregates of certain size and form having certain degree of water stability is characteristic. For instance, the humus horizon is characterized by stable tiny-lumpy structure, elluvial horizons are characterized by unstable, platy to laminated structure and the illuvial horizon is remarkable for prismatic or pillar-like structure (Bedrna et al. 1968). After Fulajtar (1986) who expressed the aggregates stability of the soils in Slovakia by a coefficient of water stability calculated according to Baksheyev (Hraško et al. 1962), we have divided the soils of the Jablonka catchment to four classes. The coefficient of soil aggregate stability expresses ratio of stable to not stable aggregates. If this ratio is 1 : 1, the value of coefficient is 1. Prevailing of stable aggregates arise the value of coefficient over 1 and prevailing not stable ones lower it under 1. The soil texture of each soil unit, eventually subunit is represented by arithmetic means of percentual proportion of the particles smaller than 0.01 mm. For its calculation were used

Tab. 1. Relief parameters

parameter: aspect ( $^{\circ}$ )				
Class	number	degree of susceptibility to soil erosion	susceptibility	index to soil erosion
0-90	1	low		2
90-180	2	very low		1
180-270	3	moderate		3
270-360	4	high		4
parameter: inclination ( $^{\circ}$ )				
0-4	1	very low		1
4-10	2	moderate		3
10 & more	3	high		4
parameter: profile curvature				
convex	1	low		2
straight	2	moderate		3
concave	3	high		4
parameter: counter curvature				
divergent	1	low		2
straight	2	moderate		3
convergent	3	high		4

the soil samples of Complex Soil Reconnoitring. Arithmetic means oscillates within the interval of 33 to 53%. After Novak's classification (Bedrna et al. 1968) the quoted values correspond to the loamy to clay-loamy soils. While classifying the soil moisture regime we leaned on the work of Bedrna et al. 1989), who evaluated the soils of Slovakia from the point of view of ecological classification of the soil moisture regime, as elaborated by Kutílek (1978). Uvidic interval is characterized by prevailing interval of soil moisture full water capacity to field capacity, semiuvidic interval field capacity to the point of lowered accessibility and semiarid interval point of lowered accessibility to the fading point. Classification of soil types into classes from the point of view of the values of soil parameters is presented in Table 2 and map expression is presented by Figs. 6-8.

### **Component 3 - Formulation of decisive rules**

In relation to the relief parameters the following decisive rules were formulated on basis of which the degree of their effect on hydrological conditions of susceptibility to soil erosion was determined:

- aspect: it influences the amount of the solar energy coming to soil surface and effect of its action on the daily regime of air temperature. With the increasing amount of the solar energy and its higher effect of its action on the daily air temperature regime also the evaporation rises, the moisture reduces and infiltration capacity of the soil increases, and as a consequence the degree of susceptibility to soil erosion

Tab. 2 Soil parameters

parameter: stability of soil aggregates (coefficient of aggregate stability)			
class	soil units	degree of susceptibility to soil erosion	index of susceptibility to soil erosion
more than 2	9,13	very low	1
2.0-1.0	7,5,10,12,16	low	2
1.0-0.5	2,17,8	moderate	3
less than 0.5	1,3,4,6,11,14,15	high	4
parameter: soil texture (% of particles less than 0,01 mm)			
less than 39	11,14,15	very low	1
39-42	2,4,5,6, 8,13,16	low	2
42-45	1,9,12,17	moderate	3
more than 45	3,7,10	high	4
parameter: soil moisture			
semiaridic	9,12,13	very low	1
semiaridic-semiuvidic	5,7,10,16	low	2
semiuvidic	2,8,17	moderate	3
uvidic	1,3,4,6,11,14,15	high	4

lowers. Solar energy amount grows and the degree of susceptibility to erosion drops with the change of slope orientation in the strike N-S and the effect of its action on the daily air temperature regime grows and the degree of susceptibility to soil erosion decreases in the E-W strike.

- profile curvature: it affects the soil moisture through the concentration of the subsurface flow in the direction of the inclination gradient. With the change of the slope normal curvature from convex through straight to concave one, both, the concentration of the subsurface runoff and the soil moisture grow, the value of infiltration capacity drops and the degree of susceptibility to soil erosion grows.

- counter curvature: it affects the soil moisture through the concentration of the subsurface runoff along the contour line. With the change of horizontal slope curvature from divergent through straight to convergent the concentration of subsurface runoff grows, the soil moisture increases, the infiltration capacity lowers and the degree of the susceptibility to the origin of soil erosion rises.

- inclination affects the speed of overland runoff. With the increasing slope inclination the speed of flowing water increases and consequently increases the degree to susceptibility to erosion.

A scheme evaluating the susceptibility of the landscape to soil erosion of the created relief parameter classes is presented in Table 1. While evaluating the effect of inclination upon the soil erosion the 0-4° interval was allotted the susceptibility index -1, i.e. negligible from the point of view of susceptibility to soil erosion.

The evaluation of the soil parameters from the viewpoint of their effect on hydrological conditions of soil erosion leans on the following decision-making rules:

- soil structure: it affects the porosity and water stability of soil aggregates. With the change of the form of soil aggregates from spheric to square, prismatic and platy the water stability of soil aggregates as well as the diversity and size of the pores decrease and the value of aggregate stability coefficient lowers. The lower value of aggregate stability coefficient the higher amount of the overland runoff and lower resistance of soil particle to detachment, with the consequent growth of the degree of susceptibility to the origin of soil erosion.

- soil texture affects the porosity. With the growing soil particle size (gley particles - dust - dusty sand - sand) also the amount of the gravitational pores grows, infiltration capacity of soil increases, and the proportion of the overland runoff decreases resulting in a lower degree of soil susceptibility to soil erosion.

- moisture regime of the soil expresses the prevalence of the moisture situation during the year. With the change of the regime from uvidic through semiuvidic to semiaridic the occurrence of the soil moisture situation with increasing values of infiltration capacity is prevailed and consequently the occurrence of the overland runoff reduces, and the soil susceptibility to soil erosion decreases.

The evaluation scheme of soil susceptibility for the created soil parameter classes is presented in Table 2.

#### *Component 4 - Application of the decisive rules on maps of soil and relief parameters in GIS SPANS*

Decisive rules for the determination of the soil and relief parameters on water erosion were applied at three levels:

i) at the first level the schemes of susceptibility presented in Tables 1 and 2 were applied on the maps of soil and relief parameters,

ii) at the second level the relative weight of influence of particular soil and relief parameters on spatial variability of susceptibility to soil erosion were expressed and by overlaying the maps of their susceptibility the common influence of parameters of relief and soil respectively on susceptibility to soil erosion was expressed. The average value of overlay index was calculated as

$$I = \frac{\sum_{i=1}^n (x_i \cdot v_i)}{\sum_{i=1}^n (v_i)}$$

where  $I$  = index overlay average value

$x_i$  = value of the index of erosional susceptibility of the corresponding parameters of soil and relief

$v_i$  = weight of the influence of the single soil and relief parameters of the spatial differentiation of the erosional process

$n$  = number of map layers

In relation to inclination we used the negative values to express the significance of 0-4° class from the viewpoint of susceptibility to soil erosion. GIS SPANS attributes to the negative values in the method of index overlay a special significance and

these classes and the corresponding areas in map expression are excluded of further analysis, i.e. not even the mean values of susceptibility index is calculated for these areas at the mutual overlay of several map layers.

iii) at the third level a susceptibility to soil erosion in consequence of common effect of relief and soil was expressed by mutual overlay of the map of relief and soil susceptibility to the origin of soil erosion respectively.

### 3 THE ATTAINED RESULTS AND DISCUSSION

The spatial variability of the landscape susceptibility to soil erosion as a result of the single effect of relief a soil parameters is depicted on Figs. 2 - 8. The spatial variability of the susceptibility to soil erosion due to effect of relief (see Fig. 9) and soil (see Fig. 10) was obtained by mutual overlay - Figs. 2 to 5 and Figs. 6 to 8 respectively. Spatial variability of the susceptibility to soil erosion due to common effect of the relief an soil (overlay Figs. 9 and 10) is illustrated by the Fig. 11.

Besides the index of susceptibility to erosion a substantial effect on the result of the mutual overlay of the map layers of soil and relief parameters by the index overlay method exerted also the weight or importance of the effect of chosen parameters on spatial differentiation of the erosional process. Fig. 9 is a result of such a combination of relief parameters weights: aspect - 10%, inclination - 20%, profile curvature - 35%, horizontal curvature - 35%. Weights of soil parameters, on basis of which the Fig. 10 originated are as follows: stability of soil aggregates - 70% soil texture - 20% soil moisture 10%. while overlying relief as a whole and soil as a whole we ascribed greater weight to soil (60%) than to relief (40%). Changing of parameter weight brings about, of course, the change of their mutual overlay. The question "On basis of what criteria to ascribe weight to the single parameters"? is therefore a crucial one of the index overlay method. While ascribing the weights to relief parameters we departed from the assumption that the concentration of subsurface runoff and the overland runoff are the decisive factors affecting infiltration capacity of the soil and the volume of overland runoff, and consequently soil erosion. This was the reason why the parameters of curvature were ascribed the highest weight. The significance of relief inclination starts to be significant only by  $4^{\circ}$  class and appears only after the origin of the overland runoff on the soil surface. Ascribing higher weight to the soil aggregates stability than to soil texture and soil moisture regime we took into consideration also the fact that in contrast to the two last mentioned parameters the soil aggregates stability expresses more comprehensively the soil permeability and resistance of the soil particles against the removal. Allotting bigger relative importance to the effect of soil than that of relief while expressing their common effect on the origin of soil erosion leans on the assumption that the relief parameters can at the inclination over  $4^{\circ}$  create very favourable conditions for the origin of surface runoff on one side, but on the other the actual origin of the overland runoff can be prevented by soil permeability and resistance of the soil particles to removal. Spatial variability of susceptibility of the common effect of relief and soil to the origin of soil erosion with weights of soil 60 and relief 40% also corresponds to the empiric knowledge obtained by the field research. For the comparison, the Figs. 12 and 13 depict spatial variability of susceptibility to soil erosion of the common effect of relief and soil with equal weight for both of these landscape elements (relief = 50, soil 50%), eventually with the weights relief 60 and soil 40%.

Classic, eventually conventional approach to the estimation of relief effect on

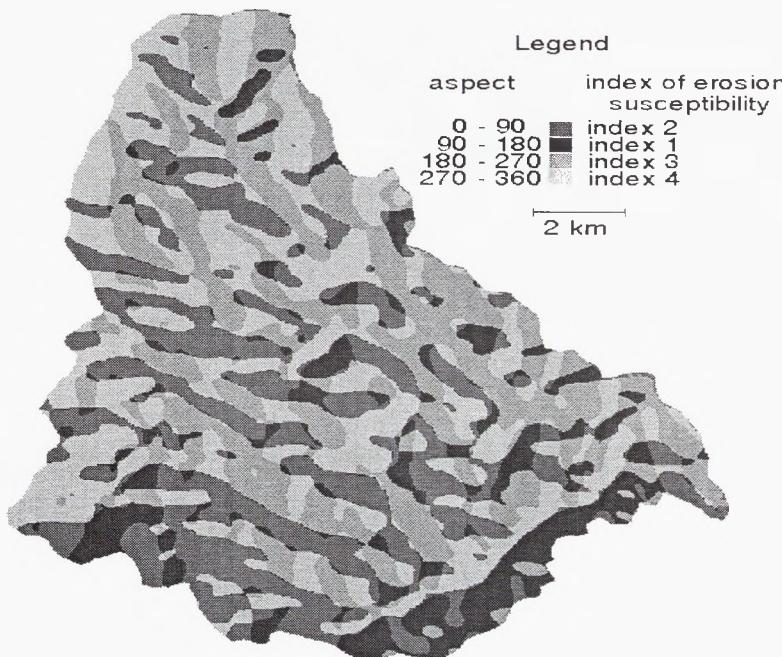


Fig.2. Susceptibility of aspect to soil erosion.

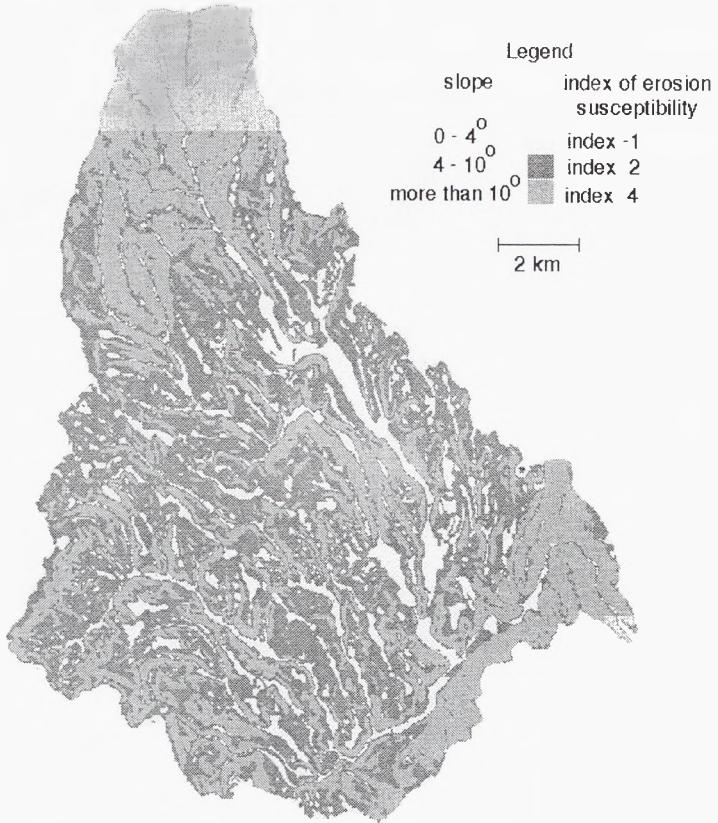


Fig.3. Susceptibility of slope to soil erosion.

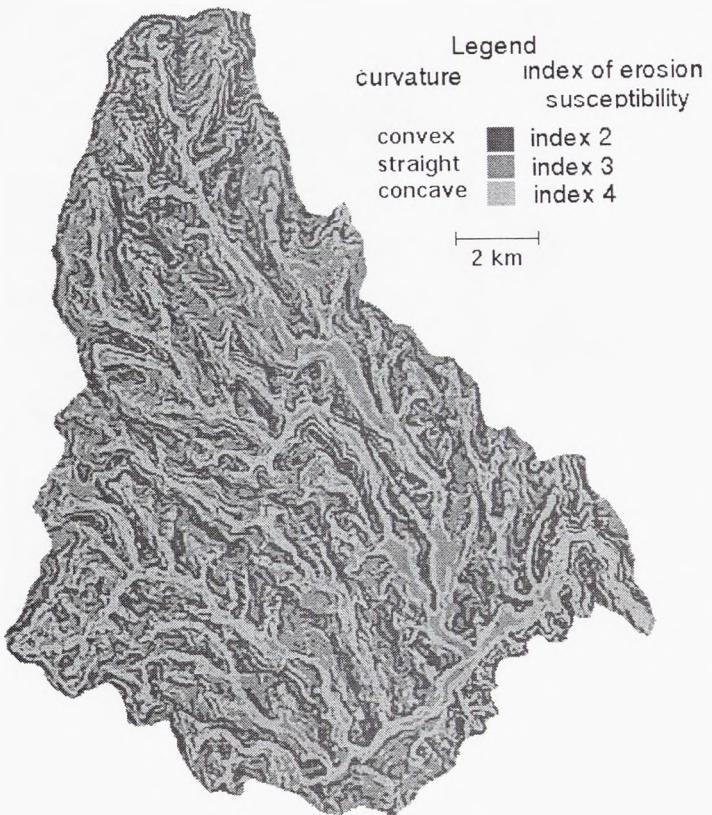


Fig.4. Susceptibility of profile curvature to soil erosion.

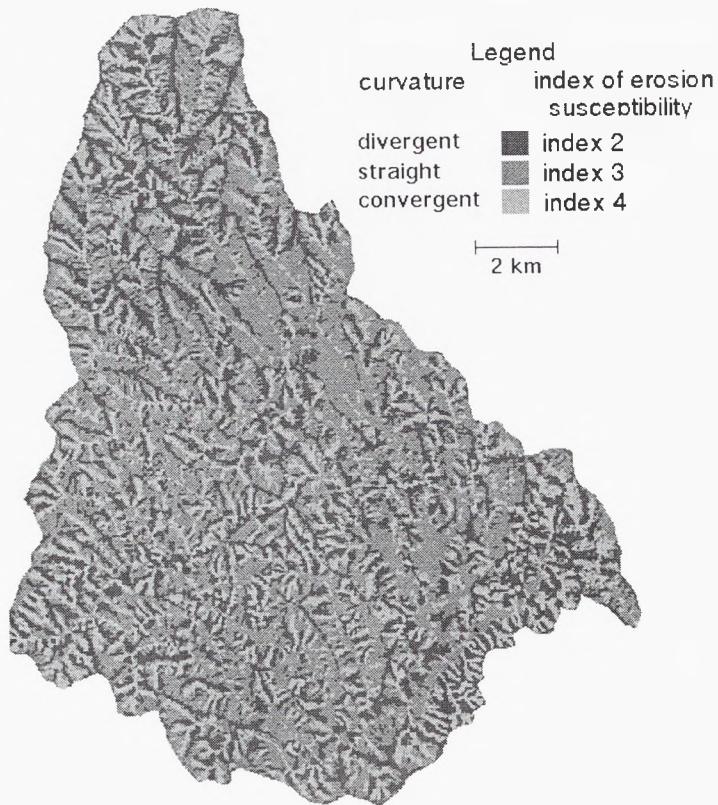


Fig.5. Susceptibility of countour curvature to soil erosion.

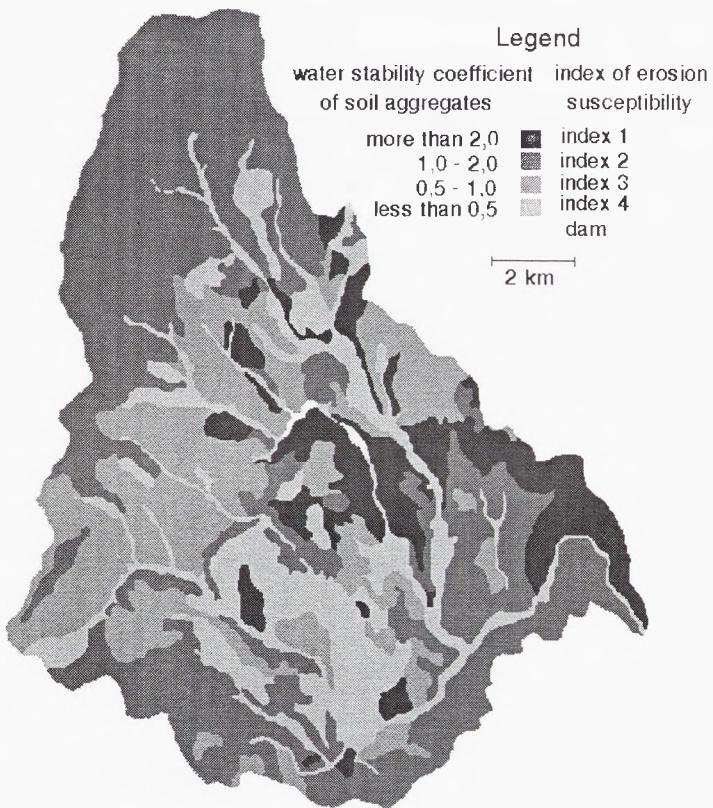


Fig.6. Susceptibility of soil aggregate stability to soil erosion.

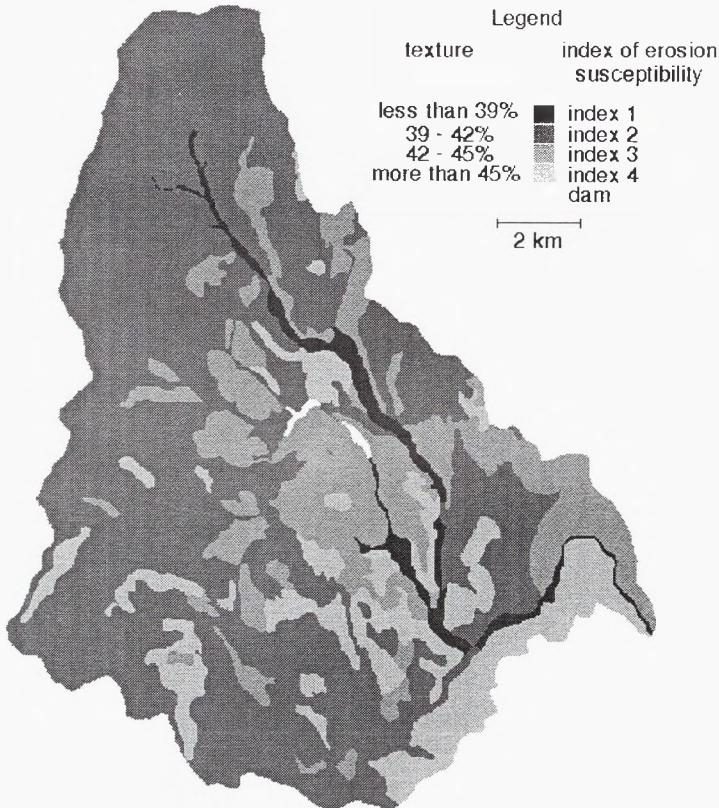


Fig.7. Susceptibility of soil texture to soil erosion.

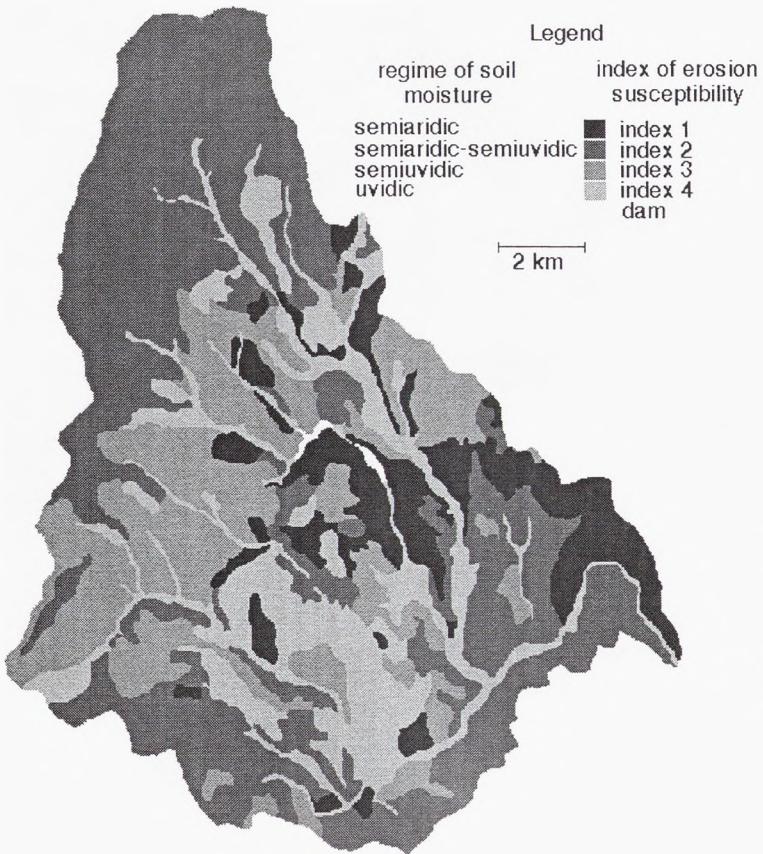


Fig.8. Susceptibility of soil moisture regime to soil erosion.

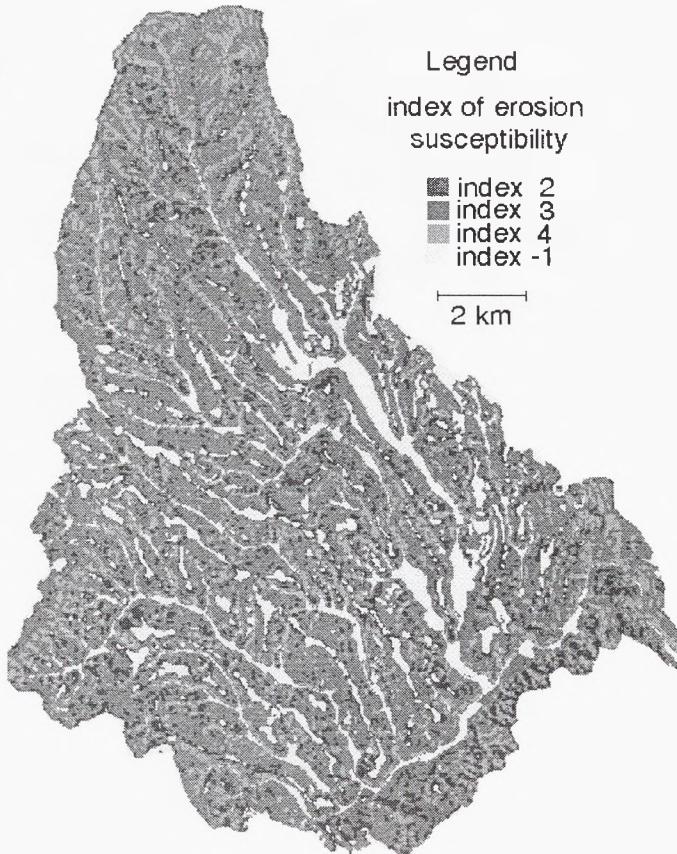


Fig.9. Susceptibility of relief to soil erosion.

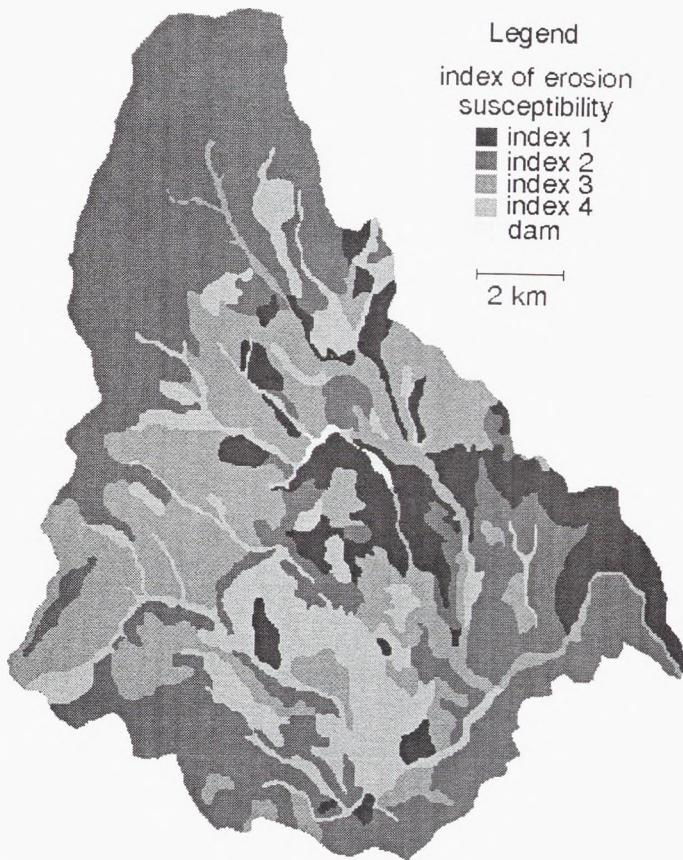


Fig.10. Susceptibility of soil to soil erosion.

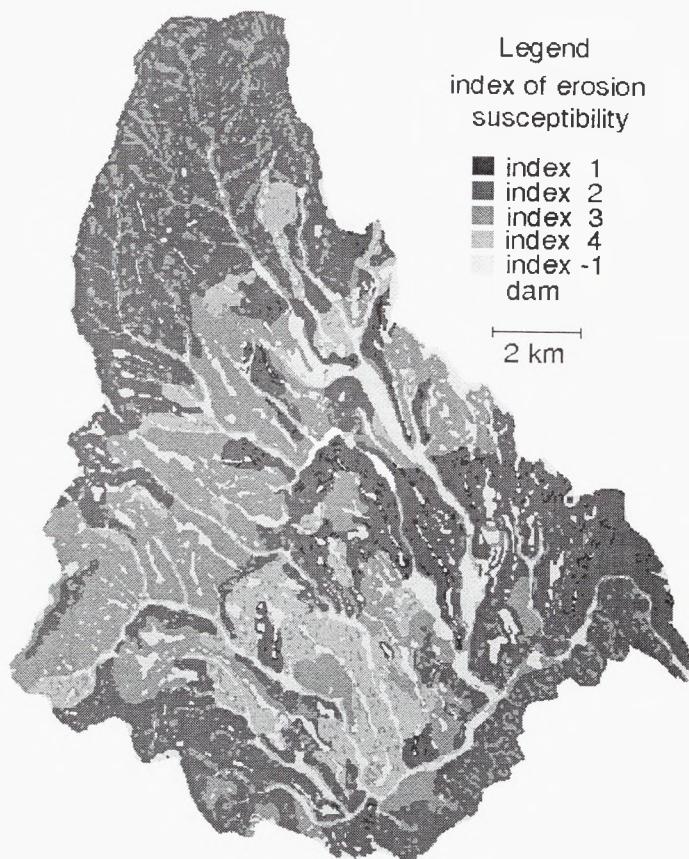


Fig.11. Susceptibility of join effect of relief and soil to soil erosion  
(relief weight = 40 %, soil weight = 60%).

spatial variability of soil erosion on regional spatial dimension takes in consideration only the morphostructural properties of the relief (for instance, Bučko 1980, Bučko and Zachar 1980). Solution of the problem of the spatial variability of soil erosion in GIS environment allows to work with the detailed morphometric relief parameters also at the regional level. The contribution embodied by the use of GIS SPANS technology with mutual map overlays of the single parameters by the index overlay method is also in the fact that the calculation of the mean value of erosion susceptibility index is realized on the basis of weighted arithmetic means, i.e. the index value of each parameter is weighted by the effect weight of each parameter on spatial differentiation of erosional process. Such way of calculation of the mean index value of overlay is practically not used with the classic way of map overlay for its labouriousness.

There are also other evaluation schemes of landscape's susceptibility to the soil erosion, eventually its erosional risk using rational rule-based modelling. They are based first of all on multiplying combination of the relative values of chosen erosional factors and expressing rather the risk of erosional threat to landscape represented by already existing overland runoff than by the possibility of the preconditions of its origin. For instance, Minár and Tremboš (1994) offer the relation based on multiplying combination of the factor inclination (S), rock resistance (L) and slope length for the expression of the relative threat represented by gully erosion (V).

$$V = S \cdot D/L$$

A serious fault of this, as well as other similar formulations is that no uniform evaluating scheme of erosional risk, either for the classes of the single factors or for the evaluating of erosional risk due to combination of relative values of single erosional factors is used (category of very high erosional risk has for instance a value 5 with one factor, valued 4 with another and the results of the mutual combination is valued 20).

In relation to the development of mathematical models of soil erosion with spatially distributed parameters coupled with GIS, for instance WEPP (Lane and Neairng 1989), EUROSEM (Morgan et al. 1992), ERDEPP (Moore and Burch 1986, Mitášová et al. 1966) a logic question emerges, whether the use of the methodological procedures that are less exact, using general knowledge on relationship between soil erosion and landscape elements for the formulation of certain causal assertion is still justifiable or topical.

Our reply is affirmative. Spatiality is a basic attribute of the geographic research but not always we fully realize the relation between the spatial dimension on one side and the problem formulation and choice of methods for the solution on the other. In the sphere of soil erosion research on plot dimension or catchment dimension (catchment of the order I) that are relatively homogeneous from the viewpoint of the physical-geographical properties, the formulation of the problem soil erosion research as an estimation of absolute values of eroded, eventually accumulated soil material in certain time intervals or within certain time span with the use of distributed erosion-accumulation models is justified. At this level the detection of distributed values of input parameters is from the viewpoint of the scope of field measurements and the involved financial means still viable. Regional spatial dimension represents a spatially extensive and from the viewpoint of physical-geographical properties very heterogeneous space. Therefore the formulation of the problem soil erosion research as an estimation of absolute values of eroded, eventually accumulated material using mathematical models of erosional process with distributed parameters is so far not

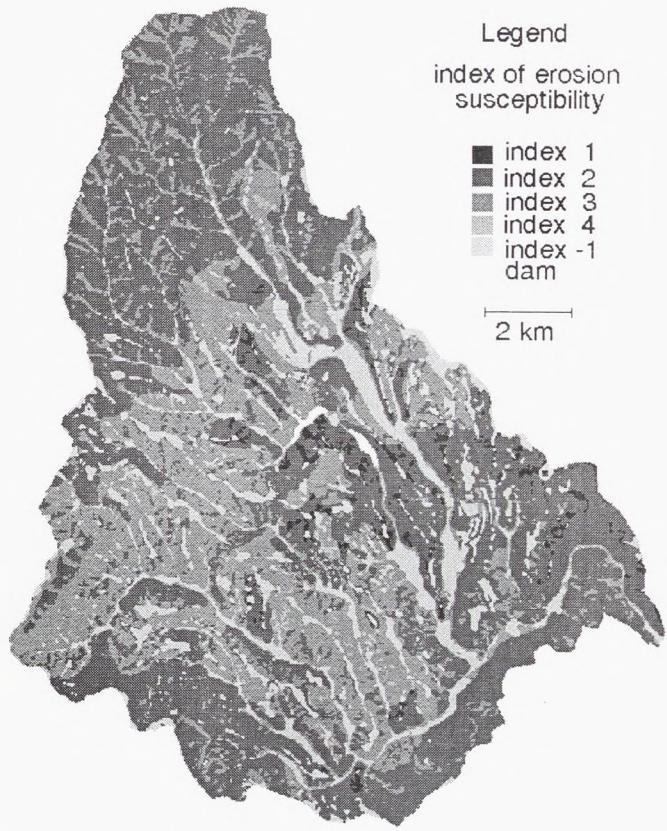


Fig.12. Susceptibility of join effect of relief and soil to soil erosion (relief weight = 50 %, soil weight = 50%).

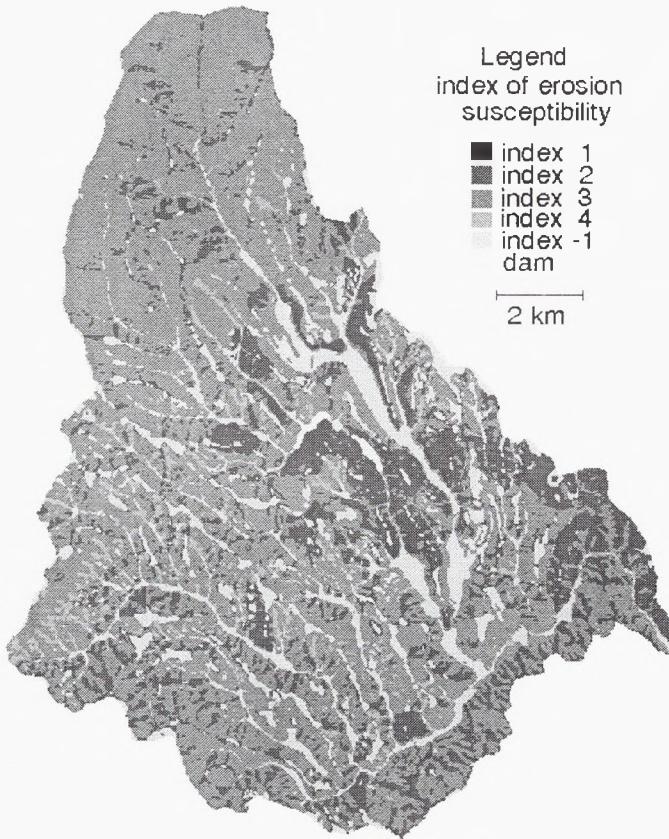


Fig.13. Susceptibility of join effect of relief and soil to soil erosion (relief weight = 60 %, soil weight = 40%).

realistic, if we bear in mind the immense amount of field research and measurement necessary. Spatial heterogeneity of the physical-geographical properties of the landscape influences also the spatial differentiation of erosional process. Certain combination of the physical-geographical conditions can create favourite hydrological conditions for erosional process and in turn, other combination can cause the given territory to be from the viewpoint of erosional process fairly stable. That is why enlightenment of the spatial differentiation of erosional process and classification of landscape form the viewpoint of erosional susceptibility is a key problem of the soil erosion research at the regional level. With the change of formulation of the problem changes, of course, also the methodological apparatus used for the solution. Instead of the distributed erosion-accumulation models it is relevant to use the qualitative relational rule-based modelling at the regional spatial dimension.

## CONCLUSION

The contribution is a result of one concluded partial investigation of the spatial variability of erosional process in the Jablonka catchment. Evaluation of the common effect of the relief and soil on water soil erosion (potential soil erosion) was realized through the application of the rational rule-based method coupled with GIS SPANS. As the basic precondition to the origin of soil erosion is the overland runoff, basic evaluation schemes of erosion susceptibility of the relief and soil parameters were formulated from the viewpoint of their effect on creation of overland runoff. The mutual overlay of the maps of erosional susceptibilities of the relief and soil parameters in GIS environment by the index overlay method a map of erosion susceptibility of soil and relief as a whole was produced. Their mutual overlay, again by index overlay method, allowed creation of spatial variability of potential erosion in the Jablonka catchment.

## ACKNOWLEDGEMENT

The contribution was worked out with financial support of the USAID grant no 5544-G-2060-00. Program in Science and Technology Cooperation. Office of the Science Advisor, and of the Grant Agency VEGA Ggrant no 2/1059. The authors are also grateful to J. Hofierka for the calculations of the morphometric relief parameters in GIS GRASS.

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## NÁCHYLNOSŤ POVODIA JABLONKY NA VODNÚ ERÓZIU PÔDY

Príspevok je zameraný na relatívne hodnotenie vplyvu reliéfu a pôdy na priestorovú variabilitu vzniku vodnej erózie pôdy v povodí Jablonky, ktoré má rozlohu  $163 \text{ km}^2$ . Metóda hodnotenia je založená na príčinných tvrdeniach alebo premisách, ktoré vychádzajú zo všeobecnych poznatkov o vzájomnom vzťahu medzi eróziou pôdy a prvkami krajiny aplikovaných v GIS SPANS. Jednotlivé kroky uvedeného prístupu sú znázornené na obr. 1. Zásadnou podmienkou pre vznik erózie pôdy je vytvorenie odtoku na povrchu pôdy. Hodnotiacie kritéria na vyjadrenie vplyvu parametrov reliéfu a pôdy na priestorovú variabilitu vzniku erózie pôdy boli sfomulované z hľadiska ich vplyvu na tvorbu povrchového odtoku.

Reliéf je charakterizovaný štyrmi morfometrickými parametrami a to orientáciou voči svetovým stranám, sklonom, normálou krivostou a horizontálnou krivostou. Na výpočet ich hodnôt bol použitý DMR. Triedy jednotlivých morfometrických parametrov sú uvedené v tab.1. a ich mapové zobrazenie je na obr.2 - 5. V povodí Jablonky sa vyskytuje 17 pôdných typov, ktoré boli zoškupené do rôznych tried z hľadiska pôdnej štruktúry, textúry a režimu vlhkosti, teda faktorov, ktoré majú rozhodujúci vplyv na tvorbu povrchového odtoku. Zaradenie pôdných typov do tried z hľadiska hodnôt pôdných parametrov je uvedené v tab. 2 a mapové vyjadrenie je na obr.6 - 8.

V súvislosti s parametrami reliéfu boli sfomulované nasledujúce rozhodovacie tvrdenia, na základe ktorých bol určený stupeň náchylnosti parametrov reliéfu na vznik erózie pôdy:

- orientácia voči svetovým stranám: ovplyvňuje množstvo slnečnej energie dopadajúcej na povrch pôdy a efektívnosť jej pôsobenia na denný chod teploty vzduchu. So zvyšujúcim sa množstvom slnečnej energie a vyššou efektívnosťou pôsobenia na denný chod teploty vzduchu sa zvyšuje výpar, znižuje vlhkosť a zvyšuje infiltráčnu kapacitu pôdy, v dôsledku čoho sa stupeň náchylnosti na vznik erózie pôdy znižuje. Množstvo slnečnej energie narastá a stupeň náchylnosti na vznik erózie pôdy sa znižuje so zmenou orientácie svahov v smere sever - juh a efektívnosť pôsobenia na denný chod teploty vzduchu narastá a stupeň náchylnosti na vznik erózie pôdy sa znižuje v smere východ - západ;

- normállová krivost: ovplyvňuje vlhkosť pôdy cez koncentráciu podpovrchového odtoku v smere gradientu sklonu. So zmenou normállovej krivosti svahov od konvexných cez priame po konkávné

narastá koncentrácia podpovrchového odtoku, zvyšuje sa vlhkosť pôdy, klesá hodnota infiltračnej kapacity a zvyšuje sa stupeň náchylnosti na vznik erózie pôdy;

- horizontálna krvosť: ovplyvňuje vlhkosť pôdy cez koncentráciu podpovrchového odtoku pozdĺž vrstevnice. So zmenou horizontálnej krvosti svahov od divergentných cez priame po konvergentné narastá koncentrácia podpovrchového odtoku, zvyšuje sa vlhkosť pôdy, znižuje infiltračná kapacita a zvyšuje sa stupeň náchylnosti na vznik erózie pôdy;

- sklon: ovplyvňuje rýchlosť povrchového odtoku. So zväčšujúcim sa sklonom svahov sa zvyšuje rýchlosť tečúcej vody a narastá stupeň náchylnosti na vznik erózie pôdy.

Hodnotiacia schéma náchylnosti na eróziu vytvorených tried parametrov reliéfu je uvedená v tab. 1.

Hodnotenie pôdnich parametrov z hľadiska ich náchylnosti na vznik erózie pôdy sa opiera o tieto rozhodovacie tvrdenia:

- štruktúra pôdy: ovplyvňuje pôrovitosť a stabilitu pôdnich agregátov. So zmenou tvaru agregátov pôdy v smere guľovitý, kockovitý, hranolovitý a doskovitý klesá vodostálosť agregátov, ako aj rôznorodosť a veľkosť pôrov, zmenšuje sa množstvo zrážkovej vody, ktoré je pôda schopná prijať, a zväčšuje sa podiel povrchového odtoku, v dôsledku čoho narastá stupeň náchylnosti na vznik erózie pôdy;

- textúra pôdy: ovplyvňuje pôrovitosť. S narastaním velkosti pôdnich častíc (ilovité častice - prach - praškový piesok - piesok) narastá i množstvo gravitačných pôrov, zvyšuje sa infiltračná kapacita pôdy, znižuje sa podiel povrchového odtoku a klesá stupeň náchylnosti na vznik erózie pôdy.

- režim vlhkosti pôdy vyjadruje prevládanie vlhkostného stavu počas roka. So zmenou režimu od uvidického cez semiuvidický až po semiaridický narastá prevládanie vlhkostného stavu pôdy so zvyšujúcimi sa hodnotami infiltračnej kapacity, v dôsledku čoho sa zmenšuje výskyt povrchového odtoku a klesá náchylnosť na vznik erózie pôdy. Hodnotiacia schéma náchylnosti na eróziu pre vytvorené triedy pôdnich parametrov je uvedená v tab. 2. Aplikácia hodnotiacich kritérii na parametre reliéfu a pôdy sa uskutočnila v prostredí GIS SPANS (obr. 2 - 8). Prekryvom mapových vrstiev eróznej náchylnosti na vznik erózie pôdy parametrov reliéfu a pôdy metódou index overlay sa vyjadrila náchylnosť na vznik erózie reliéfu ako celku (obr. 9) a pôdy ako celku (obr. 10), ako aj prvkov krajiny. Vzájomným prekryvom máp eróznej náchylnosti reliéfu ako celku a pôdy ako celku opäť metódou index overlay, sa vyjadrila náchylnosť ich spoločného účinku na priestorovú variabilitu vzniku vodnej erózie pôdy (obr. 11).

Obr.1. Schéma metodického postupu výskumu erózie pôdy s využitím GIS.

Obr.2. Vplyv aspektu na vznik vodnej erózie pôdy.

Obr.3. Vplyv sklonu na vznik vodnej erózie pôdy.

Obr.4. Vplyv normálovej krvosti na vznik vodnej erózie pôdy.

Obr.5. Vplyv horizontálnej krvosti na vznik vodnej erózie pôdy.

Obr.6. Vplyv stability pôdnich agregátov na vznik vodnej erózie pôdy.

Obr.7. Vplyv textúry pôdy na vznik vodnej erózie pôdy.

Obr.8. Vplyv režimu pôdnej vlhkosti na vznik vodnej erózie pôdy.

Obr.9. Vplyv reliéfu (ako celku) na vznik vodnej erózie pôdy.

Obr.10. Vplyv pôdy (ako celku) na vznik vodnej erózie pôdy.

Obr.11. Vplyv spoločného účinku reliéfu a pôdy na vznik vodnej erózie pôdy  
(váha reliéfu = 40%, váha pôdy = 60%).

Obr.12. Vplyv spoločného účinku reliéfu a pôdy na vznik vodnej erózie pôdy  
(váha reliéfu = 50%, váha pôdy = 50%).

Obr.13. Vplyv spoločného účinku reliéfu a pôdy na vznik vodnej erózie pôdy  
(váha reliéfu = 60%, váha pôdy = 40%).