Extended abstract

Soil Water Erosion in Slovakia - Problems and Solutions

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Abstract
In the Slovak Republic, the moderate up to the extreme potential erosion risk was assessed for 65% of agricultural soil fund. We have analyzed universal erosion control principles, established legislative documents associated with soil erosion control, relationship between water erosion intensity and existence of soil, as well as computing methods, used in erosion control. The results of these analyses show that if the actual legislative acts will be applied in practice, soon or later the soil layer on specific sites will by totally devastated. We have also found out that application of STS No. 75 4501 protects soil better than application of Act No. 220/2004.

***Keywords*: water erosion, erosion control principles, intensity of soil formation, acceptable intensity of erosion, acceptable length of slope**

Introduction

Agriculture, as areally most extended human activity, significantly affects not only the food-supply of population (in former times it was considered the most important function of agriculture), but it widely influences also the environmental protection and management as well as the rural social structure.

Soil, together with water and vegetation, creates the conditions required for existence of life on the Earth. Therefore it is necessary to take care of a soil and to protect and use it not only in such a way that we preserve its present quality and acreage, but also that we will improve potential for a production as well as the other irreplaceable functions of a soil.

To protect soil involves also eliminating its degradation. According to Bielek (1996) there are 7 principal forms of soil degradation. Erosion of a soil is considered to be the most important form of physical soil degradation in Slovakia and water erosion the most significant problem of agricultural soils in Slovak Republic.

According to data presented in Table 1, the moderate up to the extreme potential erosion risk was assessed for 65% of agricultural soil fund of Slovak Republic.

Table 1 Potential water erosion risk for agricultural soil fund (ASF) of Slovak Republic (Ilavská, 1998)

Characteristic of water erosion risk	**Acreage in ha**	**% of ASF**
none or low risk	1 065 420	45
moderate risk	473 520	20
high risk	426 170	18
extreme risk	402 490	17

Material and methods

Problems of water erosion in Slovakia and possible management of erosion control and soil conservation in the conditions of Slovak Republic were solved:

a) according to analysis of universal soil erosion control principles,
b) according to serious analysis of established legislative documents associated with soil erosion control,
c) by analysis of relation between water erosion and existence of soil,
d) by comparison of current computing methods, which are necessary for design of erosion control measures.

Results and discussion

<u>a) Soil erosion control principles</u>

According to research and study of processes, which are associated with water erosion of soil, we can declare that the general principles of erosion control, aimed reducing its intensity include(Antal, 2005):

1. protection of the soil surface against the effect of the kinetic energy of rain drops and of the runoff ;
2. increasing the infiltration capacity of the soil to reduce volume and velocity of runoff;
3. improving the aggregate stability of the soil to decrease the soil erodibility;
4. increasing surface roughness to reduce the velocity of runoff ;

increasing the retention and accumulation capacity of the soil surface to reduce volume and velocity of runoff;

5. controlling the runoff from sloping land to reduce the rill and gully formation and safely dispose of excess water.

b) Analysis of actual legislation and regulations

The most important legislative acts aimed at soil conservation in Slovak Republic are:

- Act No. 220/2004-Soil Protection Law,
- Slovak Technical Standard No. 75 4501-Conservation of Agricultural Soils. Basic regulations.

After Slovak Technical Standard No. 75 4501, the erosion-control measures are divided into the following types and subtypes:

1. anti-erosion land organisation, that including mainly:
   - distribution and location of woodland, grassland and cropland;
   - shape, size and position of fields;
   - grazing land management;
   - communication network.
2. anti-erosion agricultural practices, that including mainly:
   - contour cultivation;
   - mulching;
   - crop rotation;
   - tied ridging.
3. biological measures, that including mainly:
   - strip cropping;
   - conservation grassing;
   - conservation forestation.
4. technical (mechanical) measures, that including mainly:
   - terrain regulation;
   - terracing;
   - waterways.

Act No. 220/2004 contains following erosion control measures:

- seeding of special purpose agricultural and protective vegetation;
- contour cultivation;
- changing the crops with protective effect;
- intercrop for mulching combined with no-tillage farming practice;
- no-tillage farming practice;
- conservation crop rotations containing change of crops with protective effect;
- other measures, which will by defined by responsible office according to degree of soil loss .

Another, relevant difference between Act No. 220/2004 and STS No. 75 4501 is in the definition of acceptable soil loss.

c) Water erosion and existence of soil

By the analysis of relation between water erosion intensity and its sustained existence is necessary to regard especially the following facts (Antal, 2005):

1) Water erosion is a natural process, which cannot by stopped by human measures or interventions. The only thing, which can be affected by conscious or unconscious human activity, is the increase or decrease of water erosion intensity.
2) Precipitation, as the most important factor, influencing the water erosion rate, has accidental character. Therefore by the assessment of rainfall characteristics, including the evaluation of erosive effect of the rain have to be used corresponding work (computing) methods, which are for example statistical methods and probability theory.
3) Soil, as another important factor, which influences the water erosion rate, is defined as natural (not artificial) formation. It has a long-term process of formation (soil formation process) and it is not only formed at specific place, but it can also disappear from this place, for example as the action of soil erosion process.

4) Existence of soil is threatened if:

$$i_{EP} > i_{TP} \quad (1)$$

where i_{EP} - water erosion intensity
i_{TP} - intensity of soil formation process

5) The values of soil formation intensity, expressed as a time, which is required for generation of 1 cm of soil thickness, are in range from 10 to 1000 years.
6) In the conditions of Slovak Republic, that 1 cm of soil is formed in 200 years. From equation (1) results that the soil existence in our condition is threatened when water erosion intensity exceed the value i_{EP}>0,05 mm per year, let us say if the soil loss from 1 ha per year is greater than 0,5 m^3, or 0,7 t (for ρ_d=1,4 $t.m^{-3}$).

Table 2 Values of acceptable and limit intensity of soil water sheet erosion

The depth of soil [m]	**$S_{p,accep}$ [t/ha/year]**	**$S_{p,lim}$ [t/ha/year]**
< 0,30	1,0	4,0
0,30 - 0,60	4,0	10,0
0,60 - 0,9	10,0	30,0
> 0,9	10,0	40,0

- We recommend to compare this value with so-called limit values of soil loss according to Act No. 220/2004-Soil Protection Law($S_{p,lim}$ **)** or with so-called acceptable values of sheet erosion intensity according to STS 75 4501: Conservation of Agricultural Soils. Basic regulations ($S_{p,accep}$ **)** - Table 2.

d) Computing methods
Groundwork for design of erosion control measures is Universal Soil Loss Equation (USLE), which helps us to estimate, if it is necessary, to apply any erosion control measures on the specific field. Mean annual soil loss from a specific field can be computed as:

$$S_P=R.K.L.S.C.P \quad (2)$$

In Slovak Republic we also use so-called the acceptable length of slope-l_{max} that can be calculated, for example, by the next equation (Antal, 2005):

$$l_{max} = v_k^2 . \square / 87. \square . i . \sqrt{I} \quad (3)$$

where R, K, L, S, C, P. - factors in the Universal Soil Loss Equation (USLE)
v_k - critical velocity of runoff for the given soil (Table 3) - [m/s]
□ - Basin's roughness coefficient
□ - runoff coefficient
i - rainfall intensity for the design return period (Tab. 3) - [m/s]
I - hydraulic (slope) gradient - [m/m]

Table 3 Estimate values of v_k (STS No. 75 4501)

Soil texture type	**v_k [m/s]**
Sand	0,305 – 0,397
Loamy sand	0,264 – 0,343
Sandy loam, Loam	0,248 – 0,322
Clay loam	0,245 – 0,318

We can find a number of similarities between Equation (2) and Equations (3). In both types of equations are directly regarded rainfall characteristics (R, i), characteristics of soil (K, v_K, τ_K, γ, φ) and slope gradient (S, I). Slope length (L, l_{max}), as well as vegetative cover and erosion control measures (C, P, γ, φ) are also indirectly regarded in both types of equations.

Table 4 The design return period for project of the anti-erosion measures

Type of land use	Return period in years
Field plant production far from settlement	5
Field plant production in contact with settlement	10
Permanent meadow and pasture	5
Special plant production on the slope less than 10 %	5
Special plant production on the slope 10-45 %	10
Special plant production in contact with settlement	20

Conclusions

Requirements for erosion control presented in actual legislative acts and directions are not uniform. In terms of soil conservation it is necessary to apply, at all possible events, the acceptable values of soil loss which are presented in STS No. 75 4501.

Currently used computing methods regards all-important erosive factors, therefore are they in principle equivalent.

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